THÜNEN

Building Organic Bridges

Volume 3
Indonesia – Sri Lanka

Proceedings of the 4th ISOFAR Scientific Conference
at the Organic World Congress 2014

13–15 October 2014 in Istanbul, Turkey

Gerold Rahmann and Uygun Aksoy (Editors)

Thünen Report 20

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International Society of Organic Agriculture Reserach

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IFOAM
INTERNATIONAL FEDERATION OF ORGANIC AGRICULTURE MOVEMENTS

Ege Üniversitesi 1955

'Building Organic Bridges' with Science

FOREWORD

Plants and animals or in a broader sense, mother-nature, has been serving mankind from time immemorial. If you consider agriculture, as cultivation or domestication of plants and animals then you may start evaluating the impact of mankind since the last 12,000 years. Today, still, agriculture provides food for all living organisms, and fibre and in some cases fuel for human beings. The World today nurture more than 7.2 billion as of April 2014 even if the ecological footprint has exceeded one.

According to UN databases[1], in 1980, out of 4.4 billion, rural population was 1.53 times more than the urban population. Those who were the producers were more than the consumers. In 2015, the rural/urban population ratio is estimated as 0.85 revealing that more will consume and less produce. If this ratio is dissected according to the regions of development: rural/urban population ratio is 0.27 in more developed regions, 1.05 in less developed and 2.30 in least developed regions of the World. Urban growth rate peaked (2.24 %) between 2000 and 2005. Rural growth rate that was 1.13 % between 1985 and 1990 is estimated to be 0.05 % between 2015 and 2020 and then at negative rates. By 2035, 61.7 % of the population will live in urban areas where as 38.3% in rural. So, less people in more and less developed regions of the world will try to supply food for more and more consumers or urban and peri-urban areas in developed regions will become more intensified for adequate agro-food production. Additionally, there are other major issues as changing life styles and consumption habits as higher calories and high consumption of animal products. Relationship between health especially of non-transmissible diseases and nutrition is a bottom-line for many, and new evidences strengthening these relationships appear through research as technology advances. Consumers in more developed regions of the world are becoming concerned about long-distance transfers of agricultural products, energy consuming distribution channels, loss of diversity, erosion of traditional foods or processing techniques. Agricultural land is threatened by intensification, urbanization, non-agricultural activities e.g. mass tourism, mining and climate change. How can agricultural production counteract these diverse issues and still be sustainable?

Organic agriculture rooting on health, ecology, fairness and care principles as defined by IFOAM is practiced in 164 countries according to 2012 data[2]. 88 countries possess a legislative framework for organic agriculture. How many have mutual recognition? Are there any derogations and why? The market size has reached to 63.8 billion US dollars. In all 164 countries data at least on production are collected. The product flows are still towards enlarging organic markets in more developed regions of the world e.g. US or Germany. Domestic markets are enlarging. Who consumes more organic and how much they spend? Why do the consumers prefer organic food/do they also prefer organic non-food products? Are they healthier? What are the health aspects? What are the quality attributes or is it the vital quality that makes it different than conventional systems? In which as-

[1] Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects, 2014: The 2010 Revision and World Urbanization Prospects: The 2011 Revision Monday, April 14, 2014; 7:13:02 AM

[2] Willer, H. an d J. Lernoud (Eds.), 2014: The World of Organic Agriculture. Statistics and Emerging Trends 2014. FIBL-IFOAM Report. Frick and Bonn

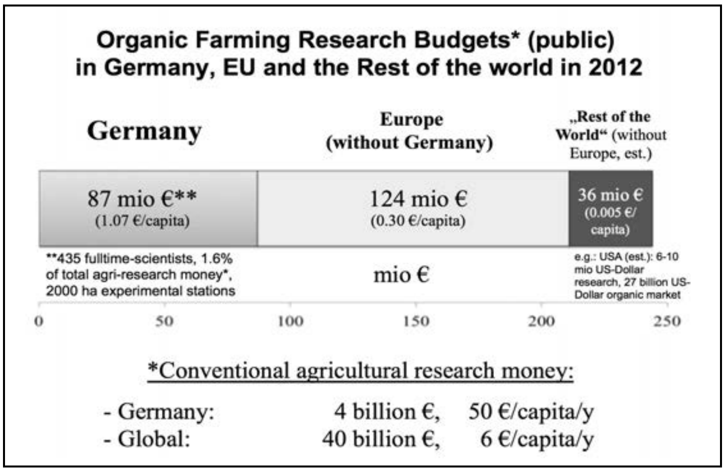
pects are organic more sustainable? Does sustainability of agricultural land differ from non-agricultural organic certified areas? How does organic system contribute to climate change?

Organic management systems aim for finding solutions to these and many other questions through research. The research objectives should derive from real-time or envisaged problems, and outcomes should find paths for quick implementation. Science is needed not only to prove its merits to the general public and lobby but also to put forward solutions to site specific problems. These can be exemplified as: Finding solutions for soil fertility management under arid conditions? How to increase yields; by developing high yielding varieties better adapted to organic conditions, by decreasing losses or by managing the value chains? What are the tools that organic farmers have in preserving animal health, which breed are resistant?

Research and innovation contributes to diversity, to competitiveness and to sustainability. In this respect, scientific meetings are major tools to establish fora to exchange results and experiences. Compared to conventional agriculture, the number of researchers and research projects and available funding is more limited in research on organic food and farming and the concept is much younger. These peculiarities enhance the importance of communication and interchanging among stakeholders. The IFOAM Organic World Congress is the unique opportunity for researchers, policy makers, extension specialists, practitioners and other stakeholders for exchanging knowledge and experiences; to share results and reversely to bring problems to the attention of world-wide research community.

The 18th IFOAM Organic World Congress held on 13-15 October, 2014 in Istanbul-Turkey targets to **'build organic bridges'**. The Scientific track will contribute to bridging not only scientists but also institutions and disciplines, and to linking more developed and less developed, rural and urban, research to extension, plant to animal, farm practices to world-wide problems and producer and consumers. Organic is a management system that requires a diversity of inputs from different disciplines, therefore, an international Congress is the best medium to blend them.

The Scientific Track is organized with special efforts of the co-organizers, International Society for Organic farming Research (ISOFAR; www.isofar.org) and EGE University (Turkey; www.ege.edu.tr). Organic e-prints (www.orgprints.org) acted as the hub for collection, revision and maintaining of all the papers. There were 568 manuscripts and abstracts received for the Scientific Track. Abstracts were not evaluated since the authors were obliged to submit full papers. About 96 reviewers - 37 from Turkey and 59 from all over the world (ISOFAR network) - contributed to the review process (double-blind: 1 reviewer international, 1 reviewer Turkish, final assessment and decision by the scientific board).



Source: compiled by Rahmann

At least, 300 papers have been accepted. They are from 51 countries and represent the countries, were 87 % of the global organic farm land and 75 % of the global organic farms are located (see table below the foreword). It is obvious, that organic farming is practiced world wide (but less the 1 % of the total farm land is managed organically), the organic markets are mainly in the western world (Europe, North America, Japan: 94 %) and the research is mainly done in Europe (publication share in web of science: 84 %, at the 4th ISOFAR congress: 69 %).

The global balance between organic production, consumption and research is not "fair" and "healthy" and has to overcome; a huge challenge for the organic world. The science can help, but the resources for organic farming research is in all regions of the world not sufficient to overcome the challenges and much less compared to the production, market or farmers numbers. Even in Europe, where organic farming research has left niches and became respected and reputable, the overall public funding for research is less than 1% of total public funded agricultural research, despite organic farm land has a share above 4% of the total farm land. This is not fair and politicians and decision makers in all countries on the world need to re-allocate the public research fund in direction to organic farming (see Figure).

All accepted papers are presented oral or as poster in 24 sessions and will try to help to

- bridge the gap between poor and rich areas of the world
- bridge the gap between scientific knowledge and practice
- bridge the gap between new and old technology

This 4th ISOFAR scientific congress will also bridge the knowledge presented in the 3rd ISOFAR Congress in 2011 in South Korea with the one to be organized in 2017. This Book of Proceedings will further help to disseminate and archive the accumulated vast information on organic agriculture.

We wish to express our sincere thanks to all who have contributed in organization of the 18th Organic World Congress (www.owc2014.org), namely IFOAM (www.ifoam.org) and BUĞDAY (www.bugday.org), and to those who delivered presentations or participated in the Congress, prepared manuscripts, reviewed, supported, and many others. Special thanks go to MILENA MATTERN and SYLVIA FENNERT from the Thuenen-Institute (www.ti.bund.de) who spent a lot of time to make the lay-out of this Proceeding and to the president of the Thuenen-Institute and therefore the German government, who gave the generous and valuable donation for printing and the facilities to do the work.

The papers are ordered by countries (country of the first author), not by sessions or disciplines. These decisions are made to make the proceedings affordable (all volumes can be purchased individually) and to merge and bridge the world and not split by disciplines and sessions. You find search facilities (indexes) to find all papers by discipline, eprint-number, keywords or sessions in each volume. A download of the full proceeding is possible under the webpage of ISOFAR (www.isofar.org) and as individual papers under organic eprints (www.orgprints.org). Due to the fact that all papers together comprise 1,300 pages, the printed Proceedings are split into four volumes. These proceedings comply all submitted, accepted for oral or poster presentation and revised manuscripts, but does not imply that they are all presented. The content of the papers are in responsibility of the authors and do not need to comply with the editors opinion.

Prof. Dr. GEROLD RAHMANN (Thuenen-Institute, Germany)
Prof. Dr. UYGUN AKSOY (EGE University, Turkey)

October 2014

Table: Comparison of the World of Organic Farming: Production, consumption, research and the representation of the countries on the 4th ISOFAR scientific congress 2014

Region / country	Organic farm land 2012 (ha) [1]	share on total (%)	Producers [1] (certified farms)	Share (%)	Sales[1] (million Euro)	share	4th ISOFAR papers [2]	share	Scientific publications [3]	share
Africa	1,073,657	3%	540,988	30%	1,000	1%	24	8.0%	221	4%
USA and Canada	2,790,162	7%	16,659	1%	23,000	48%	10	3.3%	459	8%
Latin America	6,857,611	11%	315,889	18%	1,000	1%	6	2.0%	245	4%
Asia	3,706,280	10%	619,439	35%	2,000	4%	49	16.3%	509	9%
Europe	10,637,128	29%	291,480	16%	21,000	44%	206	68.0%	4,676	84%
- only EU27	*9,518,234*	*26%*	*236,803*	*13%*	*19,000*	*40%*	*183*	*61.0%*	*4,330*	*78%*
Oceania	12,185,843	33%	14,138	1%	1,000	2%	5	1.7%	274	5%
World (Total)	37,245,686	100%	1,789,359	100%	48,000	100%	300	100%	5,569	100%
Data from participating countries (4th ISOFAR scientific congress 2014)										
Argentina	3,796,136	2.7%	1,699	0.1%	n.d.		1	0.3%	21	0.4%
Australia	12,001,724	2.9%	2,129	0.1%	942	2.0%	4	1.3%	169	3.0%
Austria	542,553	19.7%	11,575	0.6%	1.065	2.2%	7	2.3%	58	1.0%
Bangladesh	6,810	0.1%	9,335	0.5%	n.d.		2	0.7%	12	0.2%
Belgium	59,220	4.3%	1,274	0.1%	435	0.9%	4	1.3%	17	0.3%
Bolivia	32,710	0.1%	9,837	0.5%	n.d.		1	0.3%	4	0.1%
Brazil	687,040	0.3%	14,437	0.8%	n.d.		3	1.0%	113	2.0%
Bulgaria	25,022	0.8%	978	0.1%	7	0.0%	3	1.0%	3	0.1%
Canada	841,216	1.2%	3,718	0.2%	1.904	3.9%	6	2.0%	107	1.9%
China	1,900,000	0.4%	n.d.		791	1.6%	8	2.7%	209	3.8%
Colombia	34,060	0.1%	4,775	0.3%	n.d.		1	0.3%	7	0.1%
Denmark	162,173	6.1%	2,677	0.1%	901	1.9%	15	5.0%	109	2.0%
Estonia	133,779	14.8%	1,431	0.1%	12	0.0%	2	0.7%	5	0.1%
Ethiopia	140,475	0.4%	122,359	6.8%	n.d.		1	0.3%	13	0.2%
Finland	188,189	8.2%	4,114	0.2%	120	0.2%	8	2.7%	53	1.0%
France	975,141	3.6%	23,135	1.3%	3.756	7.8%	15	5.0%	109	2.0%
Germany	1,015,626	6.1%	22,506	1.3%	7.590	15.7%	58	19.3%	187	3.4%
Ghana	19,893	0.1%	3,464	0.2%	n.d.		1	0.3%	15	0.3%
Greece	309,823	3.7%	21,274	1.2%	58	0.1%	6	2.0%	45	0.8%
Hungary	124,402	2.9%	1,433	0.1%	n.d.		6	2.0%	4	0.1%
Iceland	8,246	0.4%	39	0.0%	n.d.		1	0.3%	4	0.1%
India	1,084,266	0.6%	547,591	30.6%	46	0.1%	16	5.3%	94	1.7%
Indonesia	74,034	0.1%	8,612	0.5%	n.d.		1	0.3%	9	0.2%
Iran	43,332	0.1%	6,120	0.3%	n.d.		4	1.3%	29	0.5%
Iraq	n.d.		n.d.		n.d.		1	0.3%	n.d.	
Italy	1,096,889	8.6%	42,041	2.3%	1.720	3.6%	19	6.3%	101	1.8%
Japan	9,401	0.2%	2,137	0.1%	1.000	2.1%	1	0.3%	52	0.9%
Kenya	4,969	0.0%	12,647	0.7%	0	0.0%	1	0.3%	36	0.6%
Luxembourg	3,720	2.8%	96	0.0%	68	0.1%	1	0.3%	n.d.	
Morocco	17,030	0.1%	120	0.0%	n.d.		1	0.3%	4	0.1%
Netherlands	47,205	2.5%	1,672	0.1%	761	1.6%	8	2.7%	120	2.2%
New Zealand	133,321	1.2%	1,365	0.1%	205	0.4%	1	0.3%	105	1.9%
Nigeria	9,473	0.0%	597	0.0%	n.d.		14	4.7%	64	1.1%
Norway	55,500	5.4%	2,725	0.2%	160	0.3%	7	2.3%	43	0.8%
Philippines	96,317	0.8%	3,010	0.2%	n.d.		1	0.3%	37	0.7%
Poland	609,412	3.9%	23,430	1.3%	120	0.2%	2	0.7%	26	0.5%
Portugal	201,054	5.8%	2,434	0.1%	21	0.0%	6	2.0%	20	0.4%
Slovenia	32,149	6.6%	2,363	0.1%	38	0.1%	1	0.3%	10	0.2%
South Korea	19,312	1.0%	13,376	0.7%	343	0.7%	2	0.7%	18	0.3%
Spain	1,621,898	6.5%	32,195	1.8%	965	2.0%	8	2.7%	150	2.7%
Sri Lanka	19,496	0.8%	403	0.0%	n.d.		3	1.0%	8	0.1%
Sweden	480,185	15.4%	5,508	0.3%	885	1.8%	4	1.3%	98	1.8%
Switzerland	123,000	11.7%	6,060	0.3%	1.411	2.9%	15	5.0%	71	1.3%
Syria	19,987	0.1%	2,458	0.1%	n.d.		1	0.3%	11	0.2%
Tanzania	115,022	0.3%	145,430	8.1%	n.d.		1	0.3%	14	0.3%
Tunisia	178,521	1.8%	2,396	0.1%	n.d.		1	0.3%	7	0.1%
Turkey	442,582	1.8%	2,396	0.1%	n.d.		7	2.3%	73	1.3%
Uganda	228,419	1.6%	188,625	10.5%	n.d.		4	1.3%	11	0.2%
UK, Great Britain	638,528	4.0%	4,650	0.3%	1.882	3.9%	10	3.3%	88	1.6%
USA	1,948,946	0.6%	12,941	0.7%	21.038	43.6%	4	1.3%	77	1.4%
Vietnam	23,400	0.2%	4,385	0.2%	n.d.		2	0.7%	20	0.4%
Sum	32,381,606	100%	1,339,972	100%	48.244	100%	300	100%	2.660	100%
Share of World	87%		75%		99%		100%		48%	

[1] Data from IFOAM/FibL survey "Statistics of the Organic World". 2013; [2] Number of papers accepted for the 4th ISOFAR organic congress 2014.
[3] Papers found in scientific journals with impact factor, search done in June 2014 in the Web of Science with the keywords „organic farming" and „organic agriculture" with Endnote® software; n.d.: no data

Scientific board (coordinators)

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Control of fruit flies pest on organic guava fruit by using organic insecticide

AGUS KARDINAN[1]

Key words: organic insecticide, fruit fly, guava fruit

Abstract

Guava fruit (Psidium guajava) is a mainstay commodity in Bogor – Indonesia. Its production reaches 15 tons per ha per harvest at every three day interval. Nevertheless, one of the obstacle in securing the productivity is fruit flies pest (Bactrocera spp.) which can cause 50% or even up to 100% yield losses. So far, the control measures done by the farmers is by using synthetic insecticide spraying, wrapping fruits, and fencing garden with nets nearly as high as 3 meters to deter attack of fruit flies. Such control measure is expensive and causes problems with insecticide residues in fruits and environments that adversely affect human health and the environment. A technique control that is considered environmentally friendly is by using an organic insecticide made from plants (botanical insecticide), such as basil plant (Ocimum spp) and Tea tree (Melaleuca bracteata). The use of organic insecticides derived from the distillation of basil (Ocimum spp) and tea tree (Melaleuca bracteata) leaves containing methyl eugenol ($C_{12}H_{24}O_2$) is effective to control fruit flies in guava orchard, is able to decrease substantively pest attack and consequently increase the farmers income. Since organic insecticide is considered environmentally friendly, therefore its application in organic farming practice is strongly encouraged.

Introduction

Guava fruit (*Psidium guajava*) is a mainstay commodity in Bogor – Indonesia. Its production reaches 15 tons per ha per harvest at every three day interval. Nevertheless, one of the obstacle in securing the productivity is fruit flies pest (*Bactrocera* spp.) which can cause 50% or even up to 100% yield losses, either quantitatively by falling fruit, or qualitatively by rotten fruit caused by infestation of fruit flies larvae into the fruits (Broughton, 2004).

So far, the control measures done by the farmers is by using synthetic insecticide spraying, wrapping fruits, and fencing garden with nets nearly as high as 3 meters to deter attack of fruit flies. Such control measure is expensive and causes problems with insecticide residues in fruits and environments that adversely affect human health and the environment. A technique control that is considered environmentally friendly is by using an organic insecticide made from plants (botanical insecticide), such as basil plant (*Ocimum* spp) and Tea tree (*Melaleuca bracteata*). Essential oil obtained from distillation of basil and tea tree leaves contain methyl eugenol ($C_{12}H_{24}O_2$) acts as attractant for fruit flies. Fruit flies will consume methyl eugenol before matting. Methyl eugenol consumed is as a compound to result sex pheromone in fruit flies body to attract their couple (Nishida, 1996; Nishida and Fukami, 1988). By locating methyl eugenol in the trap, fruit flies get trapped. This technique is considered as environmentally friendly technique, hence can be applied in organic farming practice.

Material and Methods

Preparation of organic insecticide (Attractant)

Organic insecticide is obtained by distillation of basil (*Ocimum* spp) and tea tree (*Melaleuca bracteata*) leaves resulting essential oil containing methyl eugenol ($C_{12}H_{24}O_2$) approximately 80%. There are two formula of botanical insecticide used in the research, i.e. (a) essential oil as attractant of fruit flies which is located in the trap and (b) essential oil mixed with glue (sticky trap) which is smeared on the plastic bottle surface.

Research consisted of two steps:
(1) Preliminary research is done before control with organic insecticides, i.e. by calculating the intensity of the fruit fly infestation in three villages, at guava fruit garden area of approximately 2 hectares each, by

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taking a random sample of 100 pieces of fruit, then separated between damage fruit caused by fruit flies attack and healthy fruits. The intensity of the attack is calculated by the formula:

$$I = \frac{a}{b} \times 100\%$$

a = damage fruit; b = total of fruit observed

(2) Further research is done after treatment with organic insecticide by observing the attack rate changes on garden using organic insecticide, compared to levels of attacks in garden with synthetic insecticide (Farmers practice).

Control technique by using organic insecticides is done in two ways, i.e. (1) by dropping attractant as much as 1 ml on a cotton bud located in the fruit fly traps made from mineral drinking water bottles, then hung them as high as around 2 meters above the ground with 20 traps per hectare, and (2) by mixing attractant with glue (sticky trap), then smear on the mineral drinking water bottle surface then hung them on guava tree as high as around 2 meters above ground level. The number of trap per hectare is 20 traps. Number of fruit fly trapped calculated every 2 weeks with the replenishment of essential oils (attractant) in the bottle traps and sticky traps replacement. This activity is carried out continuously for a year. Observation on the fruit flies attacks is carried out every 3 months.

Result and Discussion

Preliminary Reserach

The data of fruit flies infestation on the fruit at each garden is shown at Table 1.

Table 1. Infestation of fruit flies at each guava garden

Location	Fruit flies infestation (%)
Garden 1	56
Garden 2	61
Garden 3	60

Intensity of fruit fly pests in both gardens is quite high (56% to 61%). It indicated that fruit flies infestation at all gardens is not significantly different (relatively homogenous).

Further research

On further research, the number of fruit flies trapped is observed every two weeks, both on the bottle trap and the sticky trap, as in Table 2.

Table 2. Average number of fruit flies trapped every two weeks

Control techniques	Average number of fruit flies trapped/trap/2 weeks
Sticky trap	86
Attractant trap	54

The above data showed that both methods used were effective in trapping fruit fly pests. However, sticky trap (mixing of attractant and glue) method is more effective than the use of attractants in the bottle trap.

Intensity of fruit flies observed at every 3 months interval showed that guava orchard (farmers practice, without organic insecticide), infestation of fruit flies fluctuated at approximately 60%, as compared to the garden using organic insecticide, either by using sticky trap or attractant trap showed a considerable reduction, although in the first 3 months indicated no significant reduction, but in the following 6 months a significant decrease in the level of attack to reach the level of 31% to 35% attacks (Figure 1) is noticed. This figure remain high. However, with continuously control, the attack rate is expected to further decline.

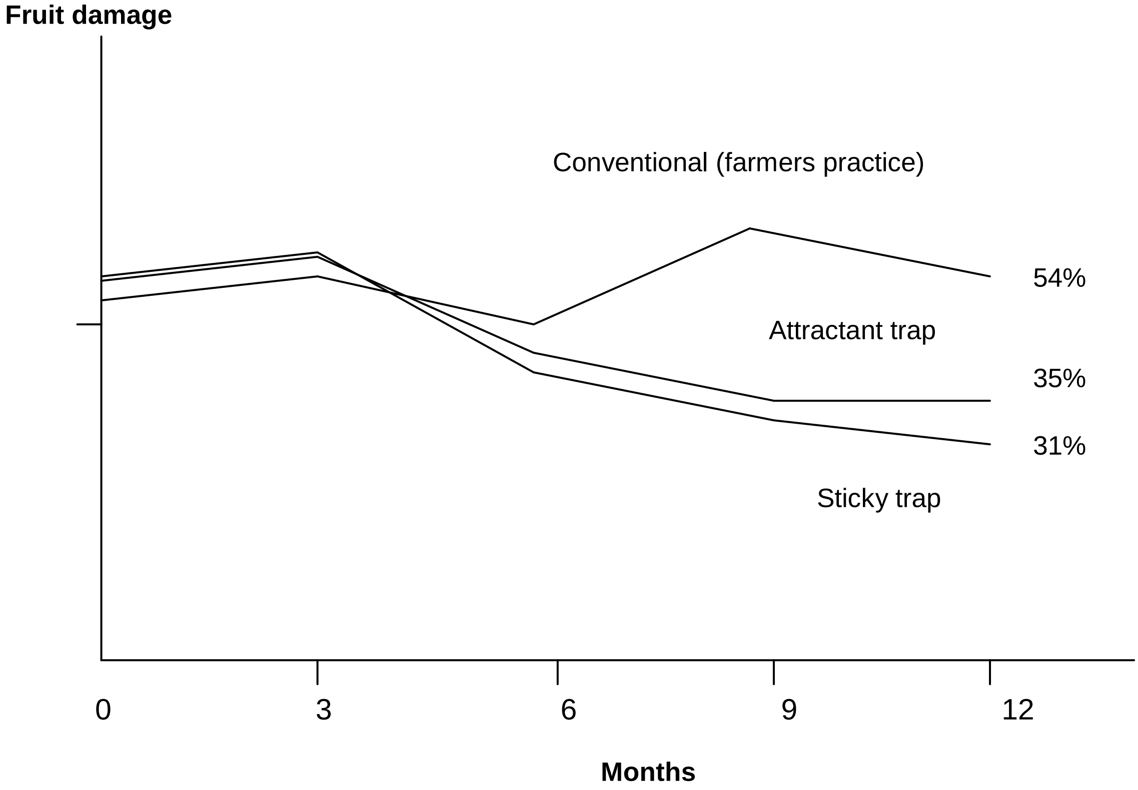

Figure 1. Infestation of fruit flies at guava fruit orchard

The gain benefit by the farmers is not only from the decrease of fruit flies intensity which led to increase in fruits yield, but also saving as cost reduction on synthetic insecticides. Both increase in yields and savings of cost of insecticides let to higher income for the farmers. In addition, using organic insecticides is environmentally friendly, affecting better consumers and environmental health.

Conclusion

The use of organic insecticides derived from the distillation of basil (*Ocimum* spp) and tea tree (*Melaleuca bracteata*) leaves containing methyl eugenol ($C_{12}H_{24}O_2$) is effective to control fruit flies in guava orchard, so that it is able to decrease pest attack and consequently increase farmers income.

Suggestion

Since organic insecticide (botanical insecticide) is environmentally friendly and low in cost, therefore its application to organic farming practice for controlling fruit flies is encouraged.

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Organic Agriculture and Nanotechnology

LEILA JAHANBAN[1], MOHAMMADREZA DAVARI[2]

Key words: "Organic farming ", "Organic foods", "Nanotechnology", "Standards"

Abstract

Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. Nanotechnology is a rapidly developing domain of research and practice, the terminology is in a state of flux and usage is evolving. In agriculture, nano-pesticides and nano-sensors are changing the nature of agricultural production. In regard to use of nanotechnologies in organic production currently, there are no national or international regulation, definitions, licensing or declaration requirements. We are still a long way off from conclusively assessing nanotechnologies or individual substances with nanoparticles, since we do not yet have the toxicological and ecological bases to do this. In our view, all of nanotechnology applications should be evaluated case by case. Positive or negative lists seem to be a good tool to regulate the use of nanotechnology in organic agriculture.

Introduction

As per the definition of FAO, organic agriculture defined as an unique production management system which promotes and enhances agroecosystem health, including biodiversity, biological cycle and soil biological activity, and this is accomplished by using on-farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs. Thus organic farming as a system which avoids the use of synthetic inputs such as fertilizers, pesticides, hormones, feed additives etc.

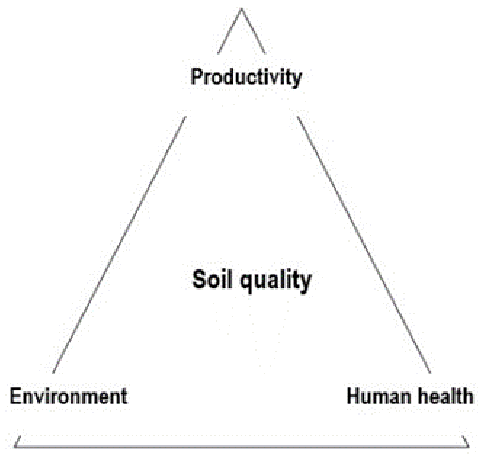

Figure 1. Soil quality and the three related concerns in organic farming (Schjonning et al. 2004)

On the other hand, Nanotechnology is the fast growing science of the ultra-small; it is creating engineered particles in the size range 1 to 100 nanometers (Paul and Lyons, 2008). Nanomaterials include nanoparticles and nanoemulsions and nanostructures including nanocapsules, nanotubes, fullerenes quantum dots and nanowires (Blike, 2008). This technology is being used increasingly in numerous area of agricultural production.

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Fig. 2. Distribution by sub-category of nanotechnology products classified as 'Food and Beverage' (PEN, 2010).

Nanotechnology in food and agriculture

They are also just a preview of what appears to be a flood of food and farm applications of nanotechnology moving to market. In the food industry alone, experts estimate that nanotechnology will be incorporated into $20 billion worth of consumer products by 2010. Five out of ten of the world's largest food companies are aggressively exploring the potential of the really small to make really big improvements in packaging, food safety, and nutrition. Similarly, in agriculture, some of the world's largest makers of pesticides, fertilizers, and other farm inputs and technologies are betting on nanotechnology to bring unprecedented precision to crop and livestock production. These applications are commonly known as "agrifood nanotechnology." However, while it is clear that agrifood nanotechnology is expected to become a driving economic force in the long-term, less certain is precisely what to expect in the near-term. This R&D is not just restricted to developed countries. Developing countries such as Iran have adopted their own nanotechnology programmes with a specific focus on agricultural applications. The Iranian Agricultural ministry is supporting a consortium of 35 laboratories working on a project to expand the use of nanotechnology in agro sector. The ministry is also planning to hold training programs to develop specialized human resources in the field. They have already produced their first commercial nanotechnology product Nanocid, a powerful antibacterial product which has potential applications in the food industry. The product has also widespread applications in the production of various kinds of detergents, paints, ceramics, air conditioning systems, vacuum cleaners, home appliances, shoes and garments. India has allocated 22.6 million USD in its 2006 budget to the Punjab Agricultural University in Ludhiana, in acknowledgement of its pioneering contribution to the Green Revolution. Its research on high-yielding crop varieties helped boost food production in the 1960s and new projects include the development of new tools and techniques for the agriculture industry.

Organic agriculture and nanotechnology

The organic community has adopted four guiding principles, the CHEF principles: care, health, ecology and fairness (IFOAM, 2005). By contrast, nanotechnology is quickly moving from the laboratory onto supermarket shelves and out kitchen tables. Therefore we investigated in a literature review and a comparison of the finding with the organic standards of organic farming to what degree nanotechnology can be applied in organic food production. In regard to use of nanotechnologies in organic production currently, there are no national or international regulation, definitions, licensing or declaration requirements. However, there is action on national and international levels regarding the regulation and standardization of nanotechnology. Nanotechnology is currently not addressed in any organic standard, other than that of the Soil Association (2008). The regulations do not restrict the use of nanotechnology in general. Because little is known about the impact on environment and human health, precaution should be taken when it comes to applying this technology in organic food production. The organic sector is concerned that the latest developments in nanotechnologies will lead to an insufficiently considered use of nano-particles (the product of the nanotechnologies) within the agrifood sector. Nano-particles are increasingly available and there is a serious lack of relevant toxicological studies addressing their impact on the environment and human health. There exists a high level of uncertainty on how nanotechnology affects the products, the people and the environment. The organic sector is strategically positioned as a safe, healthy and environmentally friendly food alternative. An exclusion of nanotechnology from the organic food chain would be in line with the philosophy and principles of organics and would serve as a precautionary act to protect organic consumers, processors and farmers (Scrinis & Lyons, 2007; Paull & Lyons, 2008).

Table 1: Potential applications for nanotechnologies in the agricultural and food sectors, and their opportunities and risks (Nowack and Speiser, 2008)

Potential applications	New properties/ opportunities	Risks for organic systems
A. Addition of substances in the form of nano particles to food and animal feed		
Examples: Colouring, flavours and vitamins in nanocapsules	Dissolve better in beverages	Directly absorbed by the body, effect unknown!
B. Auxiliary substances		
Fertilizers	Less fertilizer needed due to selective application	Greater mobility?
C. Medicines		
(Vetrinary) Medicines	Medicines with nanoparticles can be targeted more precisely	Side effects on animal health systemic Displacement/accumulation in meat, milk, eggs?
D. Packaging		
Biopolymers with integrated nanopartcles	More stable than other biopolymers, compostable	What happens during composting?
E. Surface treatments		
Silver nano layer on the inside of refrigerators	Antimicrobal, combats bacteria and fungi	Pass into food?
F. New techniques for processing		
Nanofilters	Fewer resources consumed more efficient	

Conclusion

It is potentially bigger than GM, with much wider uses, and of course the one technology is already feeding into the other. Nanotechnology holds the promise of great potential, but it may also pose great risks. We are still a long way off from conclusively assessing nanotechnologies or individual substances with nanoparticles, since we do not yet have the toxiclogical and ecological bases to do this. The serious lack of recognized definitions, statutory regulations and defined methods also hampers the assessment. In our opinion, all of nanotechnology applications should be evaluated case by case. Positive or negative lists seem to be a good tool to regulate the use of nanotechnology in organic agriculture.

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Humic acid and manure tea affected reproductive stage and fruit quality factors of pepino in organic production system

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Key words: compost tea, biofertilizer, total phenolics, vitamin C.

Abstract

Pepino (Solanum muricatum) a Solanaceous vegetable fruit has been of an increased interest in exotic fruit markets. The effects of sheep and cow manure teas in combination with humic acid on reproductive stage and qualitative characteristics of pepino fruit in an organic production system were evaluated. All traits were affected by combination of manure teas and humic acid except for fruit total soluble solid content. Sheep manure tea at 1:10 w/v increased fruit total soluble solid content as about 40% greater than control. Sheep manure tea (1:10 w/v) in combination with humic acid decreased required days preceding the first flower formation by 8 days. The highest fruit dry matter percentage was obtained in the same treatment, which was about 10 times greater than control. Comparing to control the total phenolic content were obtained about 62 and 37% greater, in cow manure tea (1/10 w/v) and humic acid treatments, respectively. Greatest number of flowers, fruit set percentage, earliness and ascorbic acid content were greatest when humic acid applied solely.

Introduction

Organic fertilization is a global strategy to maintain natural fertility of the soil through increased soil microorganism activity (4). The use of composts from different organic sources improve physical, chemical and biological characteristics of soil (2). Increased seed germination, growth and yield are responses to plant hormones, micro- and macronutrients exist in composts and compost tea (11).

Humic substances are produced through the decay of plant and animal residues by soil microorganisms (7). Humic acid improves plant growth through better absorption of nutrients from the soil (10).

Pepino (*Solanum muricatum*) a Solanaceous vegetable fruit has been of increasing interest in exotic markets. Despite numerous studies on pepino plant nutrition, studies on organic fertilization is lacking. The aim of this study was to investigate the possibility of applying two manure teas and humic acid on the physiology of plant reproductive phase and fruit quality characteristics in organic farming.

Material and methods

Cuttings of pepino (*Solanum muricatum* cv. Kanseola) having 2-3 leaves and 3-5 healthy buds were rooted in peat : perlite (2:1 v/v) under greenhouse conditions and transferred to the field after danger of frost in late April. Treatments consisted of sheep and cow manure teas (1:5 and 1:10, w/v) in combination with or without humic acid (Humistar® containing 6.8% humic acid at 50 L/ha) as soil drench. Treatments started two weeks after plant establishment and continued for 10 weeks on a weekly basis.

The number of days from transplanting to first flower formation, fruit set percentage and the number of days from transplanting to harvest the ripe fruits were determined. Fruit quality factors including fruit dry matter percentage, total soluble solids, total phenolic content and vitamin C were measured.

Results and discussions

Plants treated with cow manure tea at 1:5 (w/v) ratio died after the first treatment. Therefore, all statistics and comparisons were based on 1:5 and 1:10 (w/v) sheep manure tea and 1:10 (w/v) cow manure tea.

Number of days from transplanting to first flowering

Sheep manure tea (1:10) plus humic acid resulted the minimum number of days to first flowering (Table 1). This could be related to the more availability of manure tea nutrients in the presence of humic acid. It is stated that humic substances enhance biochemical processes (respiration and photosynthesis), chlorophyll content, plant nutrient uptake and plants biological activity (3).

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Table 1. Mean comparison of some pepino fruit characteristics in response to manure tea and humic acid

Manure tea	Application ratio	Humic acid	Days to first flowering	Days to first harvest	Ascorbic acid (mg/100g)
Sheep	1:5	0	33.33 bc	53.66 c	12.03 bc
		50 L/ha	34.60 bc	64.00 ab	13.86 ab
	1:10	0	36.00 b	66.66 ab	11.60 bc
		50 L/ha	31.60 c	53.00 c	14.90 a
Cow	1:10	0	37.00 ab	60.61 ab	10.14 bc
		50 L/ha	33.33 bc	70.00 a	16.30 a
Control	-	0	39.60 a	70.00 a	9.93 c
		50 L/ha	36.30 ab	58.00 bc	15.26 a

Values with the same letter in each column have not significant differences based on Duncan's multiple test range at $p<0.05$.

Fruit set percentage

The greatest fruit set percentage was observed in humic acid treatment (Figure 1). This could be due to increased absorption of macro and micro elements (3) which are involved in better plant performance for floral parts (6).

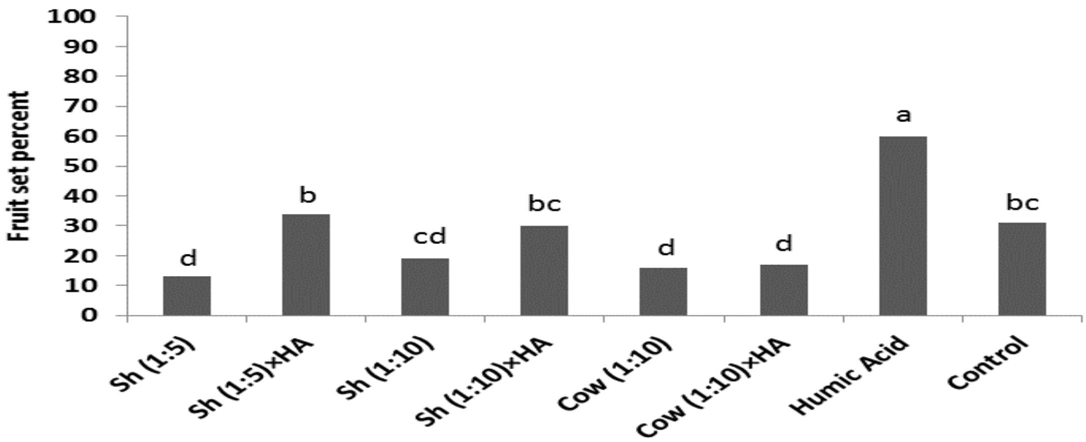

Figure 1. Effect of humic acid (HA), compost tea of sheep (Sh) and cow (Cow) manure on pepino fruit set percent

Days from transplanting to first harvest (earliness)

Cow manure tea, whether used alone or in combination with humic acid caused fruit maturity to delay. However, high concentrations of sheep manure tea without humic acid and humic acid at low concentrations can caused earlier crop than those treated with humic acid alone (Table 1). This could be due to twice amount of nitrogen in sheep manure tea than cow manure tea (data not shown). It has been reported that the application of nitrogen-rich fertilizers caused earlier tomato crop (5).

Total soluble solids (TSS)

The maximum TSS was found in the treated plants with 1:10 sheep manure tea with about 40% greater than other treatments (Figure 2). Similar results have been obtained in earlier study on pepper plant (8).

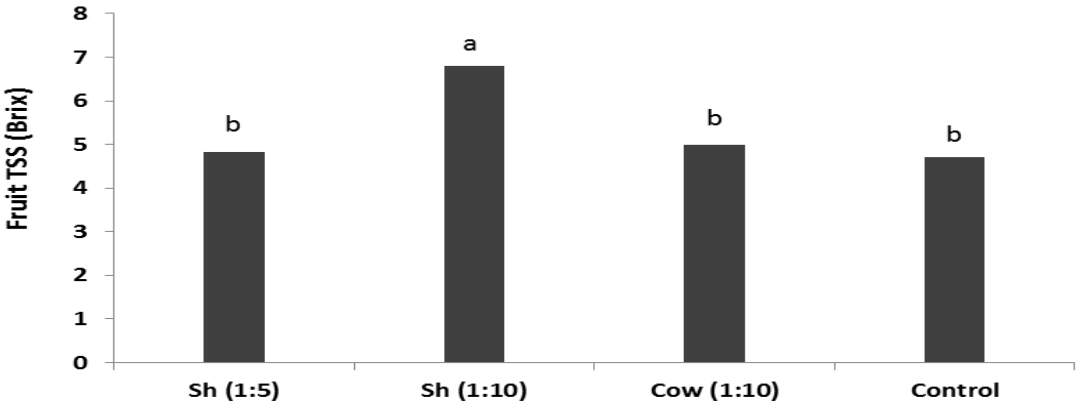

Figure 2. Effect of compost tea of sheep (Sh) and cow (Cow) manure on pepino fruit total soluble solid (TSS).

Fruit dry matter percentage

Combination of humic acid with sheep manure tea 1:10 resulted the highest percentage of fruit dry matter (Figure 3). Organic compost or manure teas contain appropriate amounts of macro- micro elements and carbohydrates which can increase fruit weight by enhancing assimilation (1).

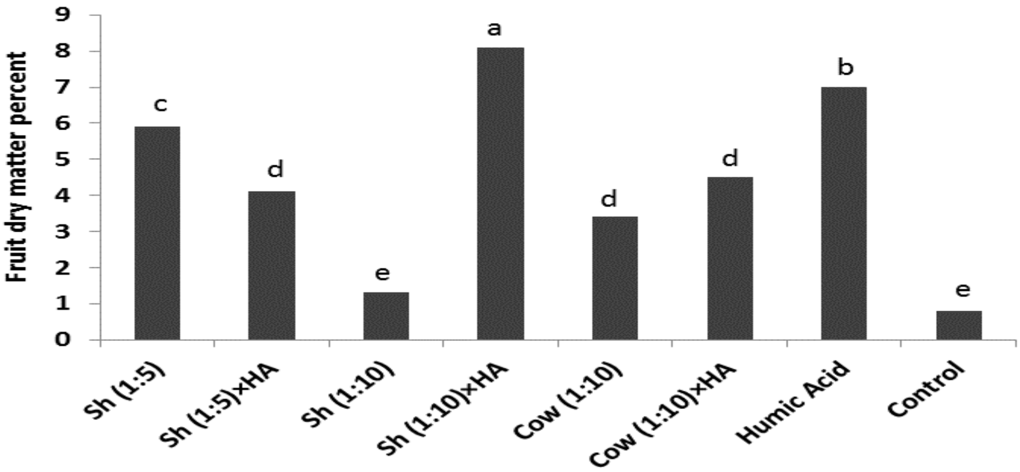

Figure 3. Effect of humic acid (HA), compost tea of sheep (Sh) and cow (Cow) manure on pepino fruit dry matter percent

Total phenolics and ascorbic acid content

The greatest amount of total phenolics was found in cow manure tea 1:10 and humic acid alone which were over 62% and 50% greater than control, respectively (Figure 4).

Treatments contained humic acid caused greater levels of ascorbic acid comparing to no humic acid containing treatments (Table 1). It has been shown that high concentrations of ascorbic acid in tomato could be produced if just one time humic acid is applied during plant growth cycle (9).

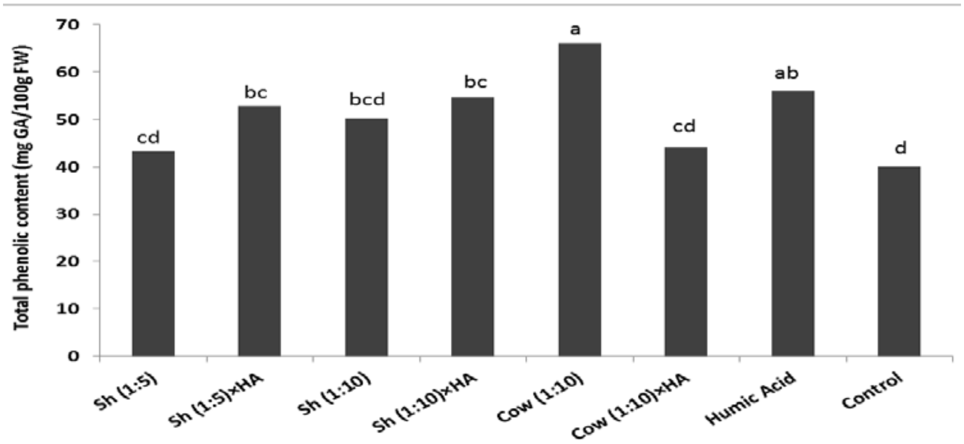

Figure 4. Effect of humic acid (HA), compost tea of sheep (Sh) and cow (Cow) manure on pepino fruit total phenolic content

Conclusion

The use of organic materials such as humic acid, compost and byproducts for plant nutrition in organic production systems should be considered. Desired biochemical or physiological processes and fruit quality factors could be obtained by the right choice of organic fertilizers or application rates.

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Biological nitrogen fixation and growth parameters correlations of alfalfa (*Medicago sativa* L.) genotypes under organically managed fields with limited irrigation

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Key words: Alfalfa, BNF, Organic plant breeding, Growth parameters

Abstract

*To identify the effective characters and their relative importance in improvement of BNF, two separate field experiments were conducted under irrigated and rain-fed organic managements of dry, Pannonian region of east Austria. The experiments were laid out in an α-lattice design with two replications and 18 genotypes (eight Iranian ecotypes and ten European cultivars). Plant height was positively and significantly correlated with leaf area index (LAI) and shoot dry matter (DM) under both conditions. Positive correlations were found between biological nitrogen fixation (BNF) and shoot DM (r = 0.61** and 0.87**, irrigated and rain-fed management, respectively). Regarding correlation coefficients, high yielding genotypes had taller plants and denser stands, especially under rain-fed condition. In path analysis, all direct effects of BNF components were positive in both conditions, while some of the indirect effects were negative. These can be regarded in selection models to avoid undesirable negative effects. Plant height and LAI can be considered as primary selection criteria for improving shoot DM, while crop re-growth and plant height, with antonymous effects, were more important for improving root dry matter.*

Introduction

Legume fodder crops such as alfalfa are an essential component of organic system especially in arid and semiarid conditions. Identification of effective characters, their interrelationships and relative importance in improvement of target characters such as dry matter yield or biological nitrogen fixation (BNF) is the key step and essential part of any breeding program, especially for organic farming. BNF can be regarded as one of the most important properties of alfalfa cultivars for organic systems because it determines the N benefit to following non-legumes and thus their yield potential. Main and target traits in legume fodder crop improvement such as dry matter yield, abiotic and biotic stress tolerance, and protein content can be considered as different characters associated to the quantity of N_2 fixation. In this study, interrelationships among different agro-economic traits of 18 alfalfa genotypes from different geographical origins and also direct and indirect effects of characters on BNF, shoot and root dry matter were studied under irrigated and rain-fed organic managements in the dry, Pannonian region of east Austria.

Material and methods

Eight Iranian ecotypes and ten European cultivars were evaluated in two different conditions, irrigated in Gross-Enzersdorf (48º12' N, 16º33' E) and rain-fed in Raasdorf (48º15' N, 16º37' E), of the research station of the University of Natural Resources and Life Sciences (BOKU), Vienna, Austria during 2006-08. Field experiments were established in certified organic (Austria Bio Garantie) farms where were stockless without organic manures application. The soil type in both sites was a Calcaric Phaeozem from loess with a silty loam texture. Additional information about sites and experiments is described in Moghaddam et al. (2011). The seeding density was 25 kg ha^{-1}, adjusted by the germination rate of the cultivars. The field plots, in both experiments, were laid out in an α-lattice design with two replications. Twelve characters including crop re-growth (cm) (CR), plant height (cm) (PH), number of stems per m^2 (STN), leaf to stem ratio (LSR), leaf area index (LAI), shoot dry matter (DM), stubble DM, root DM, shoot protein content (SHCP), stubble protein content (STCP), root protein content (ROCP), total biomass yield (TBS) and biological nitrogen fixation

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(BNF) were measured. Crop re-growth was measured 18-20 days after each harvest based on the average of plant height (cm) in 3 points per plot. Leaf area index (LAI) was measured using LAI-2000 Plant Canopy Analyzer (LI-COR, Lincoln, NE), before each harvest. Biological Nitrogen Fixation (BNF) was estimated by the "extended difference method" for each plot (Giller, 2001). Nitrogen content was determined in dry plant organs with an isotope ratio mass spectrometer (IRMS-ThermoQuest Finnigan DELTAplus) in the laboratory of the Department of Chemical Ecology, University of Vienna. Protein content (CP) based on dry matter of different plant parts (shoot, stubble and root) was calculated by multiplying N content of plant parts by a factor of 6.25. Phenotypic correlations between traits based on adjusted LS-mean of genotypes across years (n=18) were calculated for each management. Also, the relative importance of direct and indirect effects of characters (causal variables) on BNF, shoot DM and root DM (as effect or dependent variables) were determined in a set of structural models by path analysis for each condition. Standardized partial regression coefficients from the regression analysis were used as path coefficients for the respective predictor variables. Correlation and path (standardized partial regression coefficient) coefficients were computed by the software SPSS (version 15) and indirect effects by Excel spread sheet program. The result of path analysis was displayed diagrammatically as a path diagram, for each condition.

Results

Breeders make effort to develop suitable new cultivars by selection and determination of suitable selection criteria for different environment conditions to find high yielding cultivars more easily. In this study, the correlations between some characters were condition-specific. It showed that genotypes with rapid crop re-growth in stress condition may avoid from stress effects and finally can produce more dry matter yield. Low and non-significant correlations between stem numbers per m^2 and shoots DM under both conditions can be interpreted in the way that in low input cropping system in organic farming increasing the stem number per m^2 caused more competition among stems to get water and nutrients. This is more obvious in the irrigated trial with increased stem number per m^2 compared to the rain-fed condition. Stem number is an important yield component and main trait in indirect selection for yield improvement in conventional breeding programs (Portablia et al., 1982). The positive correlation between root dry matter and crop re-growth in both conditions and negative correlation between root DM and shoot DM can explained the reason of rapid re-growth of some genotypes under irrigated condition. Specifically adapted cultivars to non-stress condition show greater root DM, resulting in more root nitrogen reserves by means of larger taproots and greater nitrogen concentration and consequently faster shoot re-growth (Ardakani et al., 2009a,b; Annicchiarico, 2007; Avice et al., 1997; Raza et al., 2013Rotili et al., 1994; Haliloglu and Sengul, 2008). Regarding to correlations among plant height, LAI, Shoot DM and total biomass yield, it may be concluded that the high yielding genotypes had higher plants and denser stands, especially under rain-fed condition. In this study, all direct effects of BNF components were positive in both conditions, while some of indirect effects were negative. Different negative indirect effects of these main characters on BNF via each others or other characters in the model impede the BNF improvement. With regard to results of path analysis and positive cooperation in both conditions, plant height and LAI can be considered as primary selection criteria for improving shoot DM. It can also be deduced from genotype means for different characters that the high yielding genotypes had higher plants and denser stands, especially under rain-fed condition. Crop re-growth and plant height can be considered as primary selection criteria, with antonymous effects, for improving root dry matter. With regard to importance of plant height in indirect selection for improving shoot DM and consequently BNF, selection must be done for taller and rapidly re-growing individuals and genotypes.

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Tripartite symbiosis of Lentil (*Lense culinaris* L.), Mycorrhiza and *Azospirillum brasilense* under Rainfed Condition

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Key words: Dry land farming, Azospirilum, lentil, root colonization, VAM fungi, Yield components

Abstract

A field experiment was conducted aiming to determine the possibility of improving the lentil performance when co-inoculated with Vesicular Arbuscular Mycorrhiza (VAM) fungi and Azospirillum under natural rain-fed conditions, in Iran. Results showed the substantial impact of VAM fungi on grain protein, root colonization and shoot dry weight. Highest value for shoot dry weight recorded in plants which inoculated with G. intraradices and highest values for root colonization and grain protein content was observed in plants which inoculated with G. mosseae. Also, Azospirillum had a significant effect on shoot dry weight and root colonization. A significant differences on grain protein content observed when combination of both microorganisms have been used.

Introduction

Seed inoculation with *Azospirillum brasilense* and soil inoculation with the vesicular arbuscular mycorrhizal fungi have been long recognized as biofertilizer technologies. The classical mutualism relationship of arbuscular mycorrhizal fungi and a majority of crop roots plays a direct role in nutrient cycling rates and patterns in agroecosystems contributing markedly to nutrient capture and supply, water retention, alleviating the environmental abiotic stresses and improving the pathogen resistance resulting in improvements of crop health and yield in sustainable agroecosystems (Azcon et al., 1997; Annaduraia et al., 2002; Daei et al.,2009; Safapour et al., 2011; Ardakani et al., 2009, 2011; Zakikhani et al.,2012). Lentil (*Lens culinaris* Medik.), an old world grain legume food crop that was domesticated in the Near East and is broadly cultivated in semi-arid Mediterranean, south Asia, Indian sub-continent, south America and Iran. Water deficiency is a major limiting factor of crop yield in arid and semi-arid areas (Moghaddam et al., 2012). Iran has an arid or semiarid climates mostly characterized by low rainfall and high potential evapotranspiration. The average annual precipitation over the country was estimated to be around 250 mm, occurring mostly from October to March (Nazemosadat et al., 2006). So, shifting toward the efficient use of water and soil resources and implementing of the principles of sustainable agriculture are highlighted recently. Present paper examines the effects of application of biofertilizers in order to enhance the quantity and quality of yield of the lentil with the aid of mycorrhizal mutualistic and Azospirillum associative relationships under rain-fed conditions.

Material and methods

This field study was conducted in, Khalkhal, Iran, (37º 37′ N latitude, 48º 32′ E longitude and altitudes of 1796 m) on 2011-2012 growing season. The yearly average precipitation (30-years long term period) is 370 mm but the precipitation on this particular growing season has recorded as 230 mm by Khalkhaal synoptic meteorology institute. The treatments were arranged as factorial experiment based on randomized complete block design with 4 replicates. The experimental treatments consisted as follow:

--Mycorrhizal inoculation in 3 levels (M_0 = without inoculation, M_1 = *Glomus intraradices* and M_2 = *G. mosseae*) Mycorrhizaes with the population of 10^5 *spor.g*$^{-1}$

-- *Azospirillum* inoculation in 2 levels (A_0 = without inoculation and A_1 = inoculation with *A. brasilense*) with the population of 10^8 *cfu.g*$^{-1}$

-- Lentil cultivar in 2 levels (L_1 = large grain Mashadi and L_2 = small grain Naaz). Seeds were provided by Agriculture department of the province. Each plot was consisted of 6 rows, 25 cm apart. Distance between plots and replications were arranged to be 1 and 2 meters, respectively. No chemical fertilizers were applied during the course of experiments and weeds were eliminated with mechanical methods. For measuring percentage of root colonization root samples were taken and washed with FAA (Formalin Acetic Acid

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Alcohol) solution for further procedures. Philips and Hayman (1970) method was used for staining the roots. The gridline intersect method was applied introduced by Giovannetti and Mosse (1980) and results expressed in percentage.

Results

Mean comparison of treatments imparted significant differences between different levels of Mycorrhizal inoculations and application of *G. intraradices* resulted in the foremost value (115.78 g m^{-2}) while the non-inoculated treatments showed the least value (108.61 g.m^{-2}) for shoot dry weight. Mean comparison of treatments revealed that inoculation with Azospirillum substantially (2.8% more) affected the shoot dry weight (114.97 g m^{-2}) in comparison with control (111.73 g m^{-2}). Mean comparison of treatments imparted significant differences between different levels of Mycorrhizal inoculations as in application of *G. mosseae* resulted in the foremost percentage of root colonization (34.56%) and the inoculated treatments with *G. intraradices* showed (33.1%) of myco-colonization whilst the measured colonization in non-inoculated treatments recorded as (22.24%). Inoculation with Azospirillum increased the percentage of root colonization (30.30%) statistically significant over non-inoculated treatments. The maximum measured value (24.31%) for percentage of grain protein content was recorded in treatments with *G. mosseae* inoculations while the minimum value was (20.03%). Applications of Mycorrhiza and Azospirillum did not resulted in improvement of grain yield albeit the drastic decline in annual precipitation (230 mm) vis-à-vis the long term average (370 mm) might be the reasoned to be main cause. It can be assumed that application of biofertilizer under rain-fed and severe drought will not result in improvement of biological yield, but rather it aids the survival of stressed plant.

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Effect of Seaweed Extract and Phosphorous Application on Growth and Yield of Pea Plant

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Key words: seaweed, kelp40, phosphorous, pea, cultivar

Abstract

Effect of seaweed extract "Kelp 40" and phosphorous application on two pea cultivars was investigated during the growing season 2011-2012. Pea Pisum sativum L. cultivars namely "Little Marvel" and "Fabreca" were cultivatd and sprayed twice at 3-5 true leaf stage and after two weeks later with "Kelp 40" at three concentrations (0, 2 and 4 ml/L). Phosphorous as P_2O_5 at two levels (0 and 160 kg. P_2O_5/ha) added two weeks after seed germination. Data obtained indicated that the seaweed extract "Kelp 40" had a significant effect on some growth and yield parameters of two pea cultivars. A positive correlation noticed between seaweed effect and concentration. Data indicated that "Kelp 40" gave the better values in all parameters studied.

Introduction

The statistical data by Iraqi Agricultural Ministry explain that the productivity of pea plant is very low as compared with international average production (AOAD, 2006) therefore, attention should be paid to improve the productivity of this important crop by applying a new agricultural techniques such as using organic fertilizers and natural extracts which may work as growth and yield promoters (Potter, 2005) for the many crops. Seaweed extracts widly used as organic fertilizers and natural promoters to enhance vegetative growth and increase yield of many horticultural crop, furthermore, these natural products and organic fertilizers very cheap and more safety for ecology and human as compared with chemical products and plant growth regulators. The aim of this study was to improve the vegetative and productivity of two pea cultivars by using the natural seaweed extract (Kelp 40) and phosphorous fertilizer under the conditions of north region (Mosul city) of Iraq.

Material and methods

A field experiment was carried out during the growing season 2011-2012 in vegetable farm research horticulture and landscape design department/College of Agriculture and Forestry/ Mosul University/ Mosul/Iraq. Seeds of two pea cultivars (little marvel and fabreca) were sown in 16/11/2011 the distance between plants were 30 cm and 75 cm between the rows. The commercial product seaweed extract "Kelp 40" was natural organic extract from seaweed which contains some growth regulators and nutrient elements Ca 0.03%, Mg 0.008% and Fe 0.005% (Agrochem Company, Australia). Growing plants treated with three concentrations (0, 2 and 4 ml/L) of seaweed "Kelp 40" until runoff, using tween-80 as separating agent. The first spray of "Kelp 40" was applied at 3-5 true leaf stage, while the second spray was applied after two weeks later. Phosphorous fertilizer added to soil at two levels (0 and 160 kg. P_2O_5/ha) two weeks after seed germination in banding method. The studied parameters included number of leaves/plant, number of branches/plant at the end of the experiment, number of days until the first pod maturity and dry seeds yield/plant. Factorial experiment in a randomized complete blocks design with three replicates used to carry this experiment. Statistical analysis of data was done by using (SAS, 1996).

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Results

Data in Table 1 showed that the number of leaves and branches/plant, number of days to first pod maturity and dry seeds yield/plant responded positively and significantly increased by application of all "Kelp 40" treatments with a gradual effect relative to concentrations applied as compared with control treatment. Phosphorous application caused a positive response in all parameters studied. Data revealed different results between two tested cultivars, where "little marvel" cv. was superior than "Fabreca" cv.

Table 1: Effect of seaweed extract and phosphorous on pea plant 2011-2012

	Seaweed (ml/l)			Phosphorous kgP_2O_5/ha		Cultivar		
	0	2	4	0	160	Little marvel	Fabreca	
No. of Leaves/plant	144.16	152.36	157.45	145.43	157.22	153.07	149.58	*
No. of Branches/ plant	1.624	1.992	2.083	1.823	1.976	2.013	1.786	*
No. of days to maturity	178.10	176.75	176.26	177.43	176.65	175.96	178.12	*
Dry seeds yield gm/plant	53.88	60.01	66.52	56.55	63.72	63.20	57.08	*

* significant at $P < 0.05$

Discussion

From this present study it's seem to be clear that "Kelp 40" was the most effective especially at the high concentration (4 ml/L), that may be due to that seaweed extract as a natural product containing organic matter, a lot of macro and micro elements and some plant growth regulators (Gallen and Hemingway, 1965) which induce the plant to grow well, faster and early maturity leading to high plant productivity. Early maturity in pea plant is very important because it might avoid the crop from diseases, (Potter , 2005) which consider the main problem facing crop cultivation in the world. Seaweed extract has an important role to make the plant immunity system stronger, so that may lead to give healthy plant with high production. Some reports have indicated enhanced plant yield and health in different crops following application of the seaweed *Ascophyllum nodosum*, although the mechanism of action have not been determined (Calapietra and Alexander, 2006, Sivasankari, et al., 2006). From this could be concluded that the twice foliar application of "Kelp 40" at 4 ml was the most effective concentration. So we can recommend to use "Kelp 40" as organic fertilizer to get more in safety organic culture for human health and ecology.

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Filtrate seaweed extract as biostimulant in nursery organic horticulture

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Key words: organic nursery, Ascophyllum nodosum, lettuce, nutrient use efficiency

Abstract

Many naturally-derived products are used as growth promoters or biostimulants on vegetables, even if their mechanisms of action are not completely clarified. Seaweeds and seaweed products are admissible as organic fertilizers in the Annex I of the Reg. (EC) No. 889/2008, although their biostimulant properties are not recognized in organic farming.

After a previous bioassay on maize germination (definition of optimal dose), a filtrate seaweed extract (FSE) was applied at different doses to a greenhouse organic lettuce, for assessing its biostimulant effect on vegetable growth and nutrient uptake.

At the highest dilution, FSE increased of lettuce shoot dry weight and related nutrient uptake, particularly in relation to P and K, confirming that FSE biostimulant activity acted without any nutritional effect. Thus, the FSE appeared to be a good opportunity for promoting the early-stage vegetable development for organic nursery production.

Introduction

Many naturally-derived materials are recognized as biostimulant for vegetables growth, although their mechanisms of action are not still completely clarified. In the Annex I of the Reg. (EC) No. 889/2008, the "seaweeds and seaweed products" are inserted as admissible organic fertilizers. However, some natural hormones contained in seaweeds increase plant root development (Jameson, 1993). *Ascophyllum nodosum* extracts were able to improve seedlings emergence and vigor in many crops (Demir et al., 2006), being their plant-growth promoter activity yet recognized by reference bioassay on "model" crops (Rayorathet al., 2008). Since the biostimulant activity should be expressed at low rate of application, in the present research we applied two diluted doses of filtrate seaweed extract to a greenhouse organic lettuce, to evaluate the biostimulant effect on vegetable growth and nutrient uptake.

Material and methods

A fluid filtrate seaweed extract (FSE) from *Ascophyllum nodosum* L., produced after micro-grinding, flocculation and filtration in aqueous solution, was considered as parent materials for following dilutions. Elemental content was: 1,7% C_{org}, 0.05% N, 0.08% CaO, 0.34% SO_3, 0.40% Na_2O, 0.10% MgO, 0.8 mg/100g Fe, 3.5 mg/kg Zn, 20.0 mg/100g Cu.

Preliminary bioassay - A previous screening on *Zea mais* L. (cv. Suarta, class 300) seeds was performed by applying decreasing dilutions of FSE (1/600, 1/500, 1/400, 1/300 and 1/200 v/v) for identifying the optimal rates to put in evidence the biostimulant activity. The bioassay was performed in a growth chamber (12h/12h light/dark cycle, 28°C, 80% humidity), by adding 50 mL of each FSE solution to little pots(∅=6 cm) filled with quartz sand, where 2 maize seeds/pot were placed. Test was realized in three replicates. At third true leaf (early-stage maize cropping cycle), following parameters were measured: root length (cm), root and shoot fresh/dry weight (g), total dry biomass (g). Results were evaluated by one-way analysis of variance (F test) at $P \leq 0.05$ and the means of treatments were compared by Duncan test at $P \leq 0.05$.

Greenhouse trial - After definition of the best FSE rates, that means 1/500 and 1/250 v/v dilutions, a greenhouse trial was conducted in containers. Plantlets of about 6 cm high of *Lactuca sativa* L., var. Romana, were transplanted in 1,5 L plastic pots containing a high-fertility soil, whose main characteristics are the following: silty-loamy soil, 7.6 pH, 29.5 meq/100g CEC, 1.8 % organic matter, 0.12 % N_{tot}, 8.7 C/N.

Plantlets were sub-irrigated through saturation of pot bottom zone by saucers filled with distilled water (150 $mLH_2O \times pot^{-1}$). The fluid FSE was added at the two (1/500 and 1/250 v/v) aqueous dilutions, directly to the irrigation water, once a week for the first 4 weeks. Drip irrigation was guaranteed every 3 days. Each treatment was performed in 6 replicates, taking treatment without FSE addition as control. After 90 days from transplantation, plantlets were evaluated through the following measurements: root fresh/dry weight, shoot

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fresh/dry weight and dry matter, number of leaves, LAI, specific leaf fresh/dry weight, total dry biomass. Leaf macro and micro elements (P, K, Ca, Mg, Fe, Na, Mn, Cu, Zn, B) content and total chlorophyll were determined by simultaneous plasma emission spectrophotometer (ICP-OES) on dry matter, incinerated at 400°C for 24 hours. Results were evaluated by one-way analysis of variance (F test) at P ≤0.05 and the means of treatments were compared by the Duncan test at the P ≤0.05. Macro and micronutrients contents in vegetables were then evaluated by vector analysis which consists in the simultaneous comparison of plant yield (i.e. biomass dry weight) and nutrients content, by an integrated bi-dimensional graphic format (De Lucia et al., 2013).

Results

Preliminary bioassay – Results obtained in preliminary test on maize seeds are showed in Figure 1. At the 1/300 and 1/500 v/v dilutions, FSE showed the highest growth-promoter attitude: actually, even if the maize root elongation was not influenced, both the shoot dry weight and the total dry biomass of seedlings were significantly increased, confirming the expected biostimulant effect.

Greenhouse trial – In Table 1, lettuce yield parameters are reported. After treatments with 1/250 and 1/500 v/v of FSE, significant increases of lettuce shoot dry weight, shoot dry matter, specific leaf dry weight, root dry weight and total dry biomass were recorded, even if the 1/250 v/v FSE rate determined a significant decrease in shoot fresh weight. Lettuce LAI values were lower in all treated lettuces with respect to the untreated ones.

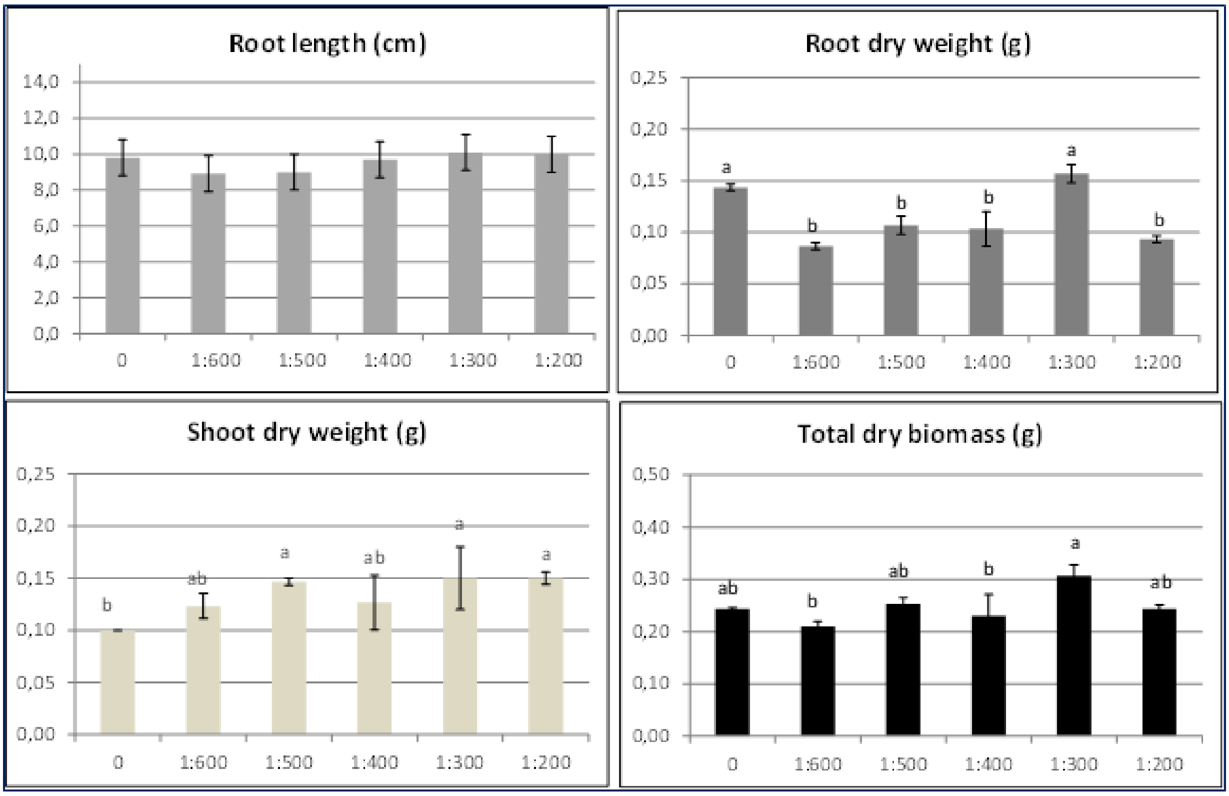

Figure 1. Statistically different seedlings parameters of maize after FSE addition (0 = untreated control; 1/600, 1/500, 1/400, 1/300 and 1/200 v/v dilutions). Different letters means significant differences at 50% (P<0.05).

Table 1. Lettuce yield parameters

Dose	Shoot fresh weight (g)	Shoot dry weight (g)	Shoot dry matter (g)	Leaf area – LAI (cm^2)	Specific leaf fresh weight (g/cm^2)	Specific leaf dry weight (g/cm^2)	Number of leaves	Root dry weight (g)	Total dry biomass (g)
Control (C)	66.14 a	4.13 b	6.26 b	1596.8 a	41.53	2.61 b	24	1.28 b	5.41 b
Low dose (L, 1/500 v/v)	63.48 a	4.58 a	7.23 a	1571.4 a	40.39	2.91 a	25	1.49 a	6.06 a
High dose (H, 1/250 v/v)	57.86 b	4.37 ab	7.57 a	1480.0 b	39.09	2.95 a	24	1.46 a	5.83 a
Significance	**	*	**	*	NS	**	NS	**	*

* significant at P<0.05; ** significant at P<0.01; *** significant at P<0.005

For evaluating lettuce nutrient use efficiency, changes in shoot dry weight and leaf nutrients content were plotted, normalizing them with respect to the same crop parameters obtained in the untreated lettuce, as percentage respect to these control values (intersection point between X/Y axes, Figure 2).
This vector analysis applied to the greenhouse lettuce showed that the low FSE rate (1/500 v/v dilution) gave the highest crop yield (+11% of shoot dry weight), with a corresponding decrease in vegetable nutrient content, being vectors of P, K, Mg, Fe and Mn below the isolines theoretical curves. Results indicate an improved nutrient use efficiency of lettuce when FSE was added at lower dose respect to the untreated control. Otherwise, the higher 1/250 v/v dose increased lettuce shoot dry weight at minor extent (+6%), and seemed to positively influence P and K nutrient use efficiency.

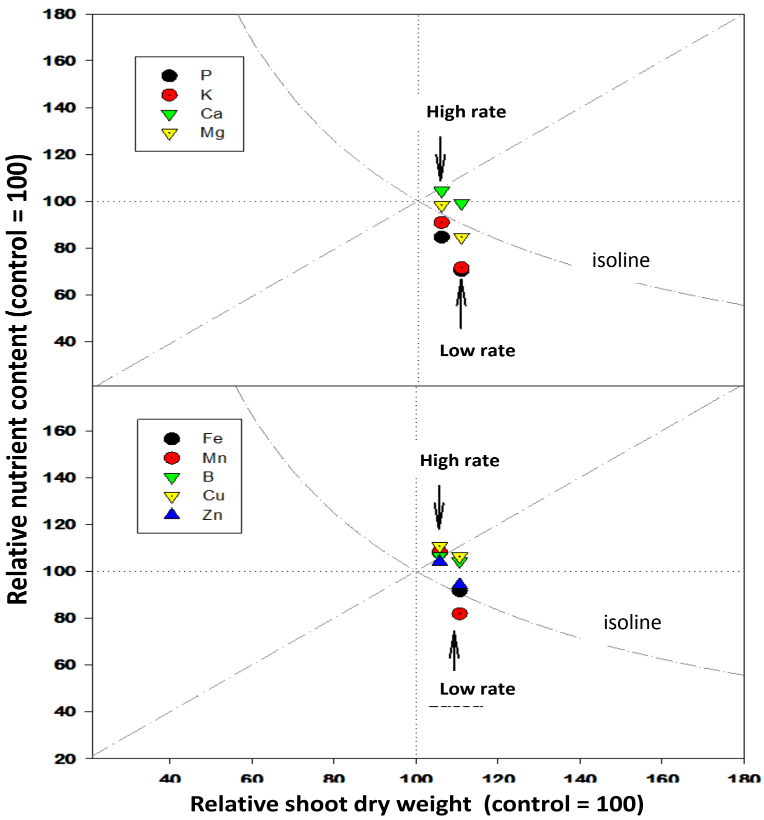

Figure 2. Vector analysis of P, K, Ca, Mg, Fe, Mn, B, Cu Zn shoot content vs. shoot dry weight in lettuce after FSE addition (High rate = 1/250 v/v; Low rate = 1/500 v/v).

Discussion

This research showed that the filtrate seaweed extract from *Ascophyllum nodosum* L*.,* in particular at the lowest rate, was able to promote the development of lettuce root apparatus and, as a consequence, the final lettuce yield. The biostimulant effect was expressed not only by the increase of lettuce LAI, but also promoting a highest crop quality, that means more compact vegetable product, more resistant to dryness on the basis of the net increase of shoot dry matter. The improved nutrient use efficiency of the lettuce at the highest dilution, particularly in relation to P and K, confirmed that the biostimulant activity of the formulate has acted without any nutritional effect: then, the FSE appears to be a good opportunity for promoting the early-stage development for organic vegetable nursery production, also taking into account its admissibility as organic fertilizers in the Annex I of the Reg. (EC) No. 889/2008.

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Bioenergetic landscapes – reduce stress and restore health using electromagnetic properties of plants

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Key words: Healing Gardens, Lecher antenna, Electromagnetic fields, Bio-Resonance, Landscape Architecture, Bioenergetic Garden

Abstract

All plant species have therapeutic properties used since ancient times as alimentary medicines. Today it is possible to choose and use also the peculiar electromagnetic properties of plants for our benefit.

Bioenergetic Landscapes is a new method allowing us to create particular interactions among plants and the natural and artificial magnetism of the place, measuring afterwards the positive effects on each organ of human body. While designing a Bioenergetic Landscape Garden, it involves using ***Lecher Antennae*** *to identify and measure the specific energies of the environment and the plants and use those with the most favourable properties for the body, by planting them in particular positions of the garden. This can greatly increase the area covered by their beneficial electromagnetic properties, using the best biological qualities of each species, amplified and spread in the environment by particular waves of the natural electromagnetism.*

Introduction

The bio-electromagnetic energies emanating in our Biosphere and all living plants has beneficial or harmful influences in our body. A lot of vegetable species have therapeutic properties in their active principles and are used for making medical or alimentary preparations.

Bioenergetic Gardens or Healing Gardens are thought to create psychological well-being or to sensory stimulate disabled people, old people with Alzheimer's disease or simply children.

Recent researches demonstrate beneficial interaction between plants and man at a psychological, sensory and emotional level (Ulrich et. al.1991), Ulrich (1984), (Lohr et.al.1996) and those plants can help our well being at energetic level.

Lecher antenna, detect and measure these energies and Bioenergetic Lanscape Gardens are constructed to bring about harmony within the atmosphere and restore human health at energetic level.

Material and methods

Indians use specific plants and tree species for worshiping. Undefined and unconscious forms of "empathy" towards the beneficial powers of the vegetable world are commonly experienced, and they are still expressed in some practises of ancient cultures which suggest embracing the trunk of a tree to obtain a reassuring contact and a considerable energetic support. Not all species are used. Probably this can occur because all the physical shapes (human, animal, vegetable and mineral) are forged and controlled by fields of *electromagnetic energy*, as many studies have pointed out (Frohlich 1988).

Researchers have discovered in our Biosphere some natural "*electromagnetic" grids.* Intersecting points of the grids seem to have different biological influence than the lines. This can influence the plants standing on them. The placement of *Plumeria alba,* has been done considering these energy lines, at Essel Mining office Garden, India. (*Fig.1*). Plants standing on intersecting points grow stunted but standing on lines grow uniformly.

Recently these elements encouraged new studies to evaluate and use the interaction among man, plants and electromagnetic fields, viewing the matter by an "*energetic*" point of view.

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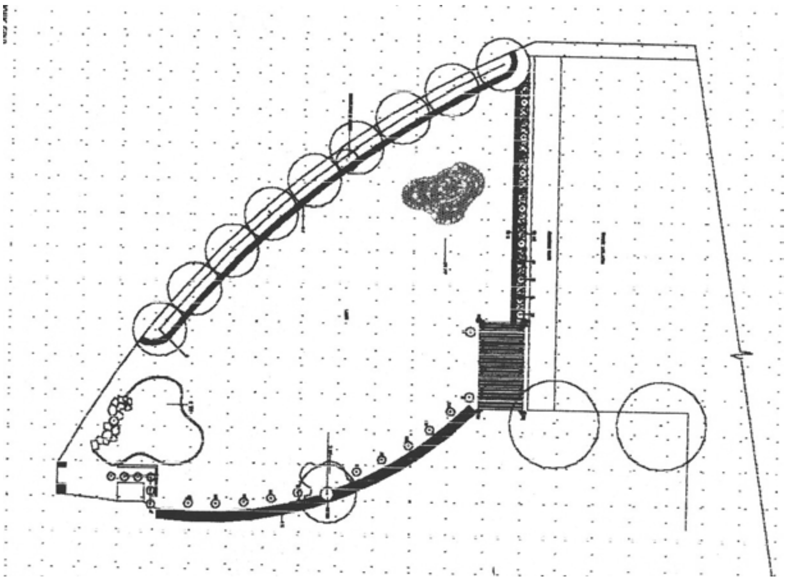

Fig. 1

The research started from a careful study in the field of bio-electromagnetism in particular from the new discoveries and instruments of survey and measurement realised by Walter Kunnen (1921-2011) Founder and Director of the Institute of Research on the Biosphere "Archibo Biologica" of Antwerp (Belgium), whom Nieri is collaborator. These researchers have refined an advanced instrument for bio-physic measurements; the *Lecher Antenna (Fig.2).*

This manual instrument allows utilizing the biological sensitivity of man to measure the most subtle electromagnetic fields having a significant interaction with human organism. During the last forty years, the antenna enabled to discover both the presence of biologically interesting natural electromagnetic fields and the specific vital frequencies nourishing and spread by each human organ. A skilled operator with the antenna can measure accurately their intensity on each polarity separately, obtaining in this way the best information about the biological effects of electromagnetism on the vital processes. With these knowledge and instrument, the author could realise his studies in vegetal field.

Fig. 2 Lecher Antenna of Dr. Walter Kunnen

Results

Many years of experiments pointed out that, *all plants emit electromagnetic waves, some of them resonating on the same frequencies that of our different organs.* Moreover, each species has its specific characteristic influence, emitting biological frequencies of different intensity on each polarity (Nieri, 2009). These weak, but highly significant electromagnetic fields are able to influence the "***antenna man***" and the *biological energy ofvarious organs* in a specific way. The research also verified that, *trees and large plants can interact and influence the natural and artificial electromagnetism of the place* with their own *"biologic"* and *"energetic"* properties, affecting the health of human organs in different ways and in a wide area, around.

From these studies, the author developed the "*Bioenergetic Landscapes"*, an innovative technique to plan and create "*bioenergetic gardens*", able to *optimise* and *amplify* consciously the beneficial radiations of selected plants, especially trees (the "active plants"), placing them in determined positions, after conducting exact electromagnetic surveys, managing in this way to positively influence the human body, also from considerable distance. As each plant has its peculiar biological influence, in a bioenergetic garden, *it is possible to decide on which organs or functions of the body we want to obtain the best benefits.*

To create a *Bioenergetic Garden*, the first step is to analyse the electromagnetism of the area with the aim to determine the presence and the course of specific natural electromagnetic *vectors*. They will be utilized as *"carrying waves,"* able to amplify and spread up to 20-30 metres of distance, the peculiar and biological quality of electromagnetic fields of different chosen plants. The therapeutic space so created is called "*bioenergetic area"*. To obtain these beneficial results, the "*active plants*" will be chosen among those most useful to generate the desired positive effects (i.e. influence on nervous or cardio-circulatory system, thyroid etc.) and accurately positioned in specific points, along the course of these vectors. Some tree species give beneficial effects on the whole body, others on the functioning of particular organs while others, on the contrary, could be considered noxious or disturbing. For example, among beneficial plants, we can find the *Holly*, whose effects are very positive on the nervous system; the *Evergreen Oak*, beneficial on the cardio-circulatory system; or the *Laurel,* which has a very good effect on the immunity system. *Banyan (Ficus bengalensis) or Pippal (Ficus religiosa)* to energise the whole body and facilitate meditation, *Indian Tulasi* (*Ocinum sanctum or* basil) to detoxify and energise the digestive system as well as relieve from cough and cold.

Plants to avoid include *Oleandar*, *Yew*, and some *Ficus* varieties showing detrimental effects. For example, the *Walnut Tree* and a common house plant, *Ficus benjamina*, has been found to have adverse effects on the *cardio-circulatory* system.

The exact location of these plants will be harmonically integrated in a more complex project of the area, to enhance the aim of the garden, using the most beneficial areas for healing and relaxation. The work finishes with a final survey and creating a *Legend* in which the characteristics of the *bioenergetic garden,* the beneficial areas generated by plants and their principal beneficial effects on the human body is shown.

Tens of "electro sensitive" people have up to now can test with particular satisfaction the efficiency of this technique and of these gardens and green areas indoor and outdoor, in which they experience a nervous relief and clear beneficial influences. The particularly positive effects on the human body have been many times confirmed also by physicians after measurements made on people with up-to-date instruments of 'bio resonance' (*i.e. Performance 2001, method E.T.)*, Bioelectrography (*GDV- Gas Discharge Visualization*) of prof. K. Korotkov (St. Petersburg State University), and a new advanced device of measurements, the "Futura scientific imaging camera" conceived to see invisible electromagnetic phenomena in different spectral bands ranging from X-Ray to Infrared (D. Gullà-Italy) *(Fig 3).*

Fig.3 Electromagnetic visualization of a Bioenergetic influence by a Linden Tree made by "Futura" device

Bioenergetic Landscapes allows verifying the state of health and vitality of trees and plants, trying to find the biospheric origin of their diseases.

Finally plants can be submitted, such as human beings, to eventual biological compatibility tests, in collaboration with phytopathologists, to find the most effective products for the care and health of the vegetable plants. In July 2004, in collaboration with Prof. Aldo Zechini D'Aulerio, professor of Vegetable Pathology at the University of Bologna (Italy), the author has completed a study on the health of plants in a big public park in Bologna, comparing successfully electromagnetic surveys on plants with traditional scientific observations.

Discussion

With Bioenergetic Landscape techniques, it is also possible to clean the Indoor spaces (of residence, offices, department stores, hospitals, schools etc.) by blocking the flow of noxious and polluting energies, emitted from certain natural or artificial electromagnetic vectors, causing harm to human organs or health and allowing the beneficial energies to flow and benefit in particular places. It is possible to design and construct a Green Space and realise a Bioenergetic Landscape for the Hotels, SPA and Wellness Centers, Health and Disabled Facilities, Nursing Homes and Rest Centers, Schools, public and private gardens, terraces, roof gardens and the creation of "bioenergetic" pathways in woods, forests and Historical Parks with authentic natural therapeutic characteristics. On the basis of preliminary assessment and tests before on the ground, it will be possible to landscape the green space underlining the potentiality of the area, obtaining the best biological benefits from the plants used, while at the same time retaining all their aesthetic features.

This innovative technique could also be used in creating Bioenergetic Farms to produce food with strong and harmonised bioenergetic properties.

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Fattening system influences fatty acid composition in organic Maremmana bullocks

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Key words: Maremmana cattle, fattening systems, pasture, fatty acids.

Abstract

Organic EU Regulation gives preference to indigenous breeds. Maremmana is a very rustic and long-lived Italian cattle breed. Rearing system, quality of the pasture and possible concentrate integrations can influence the quality of meat and its fatty acid composition. Trials were carried out in an organic farm of Grosseto province. We considered the 3 fattening systems: in the feedlot, on pasture, on pasture integrated with concentrate. After the slaughtering, from a sample of Musculus longissimus thoracis, lipids were extracted and acidic composition was determined by chromatography. Results indicated that rustic cattle breeds can be conveniently raised on pasture for the whole fattening period, and demonstrated that grazing can positively influence the quality of the meat fatty acid composition, reducing significantly the Saturated Fatty acids incidence, increasing the Polyunsaturated Fatty acids incidence, and at the same time diminishing the Thrombogenic index and Atherogenic index value.

Introduction

Organic UE Regulation No 889/2008 states that, in the choice of breeds or strains, account shall be taken of the capacity of animals to adapt to local conditions, their vitality and their resistance to disease. Preference is to be given to indigenous breeds and strains.

Maremmana is a very rustic Italian cattle breed, which seems to be the direct descendant of Italian aurochs (*Bos primigenius*) (Giorgetti et al., 2009) and is part of the group of Grey longhorn cattle, diffused in many EU countries (e.g. Grey Cattle or Hungarian Steppe Cattle).

Selection has always been directed towards disease resistance and adaptation to the harsh environment, where Maremmana cattle live, and generally these cattle never are treated against parasites (Martini, 2001).

Maremmana has a grey coat that is darker in males and lighter-coloured in females, with white apical pigmentation, and it is a long-lived breed that can reach an age of 15-16 years.

Calving is spontaneous and the calves weigh 30-40 kg at birth. They reach a weight of 180-220 kg by the age of six months, thus confirming the cow's milk-producing capacity. Adult females weigh about 600-800 kg, whereas the males reach a weight of 1000-1200 kg.

Maremmana cattle can graze all the year, utilizing, in the summer and winter periods, the Mediterranean scrub as source of food and refuge.

This breed is widespread in the Italian regions of Tuscany and Latium and around 9800 head are enrolled in the official Herd Book (ANABIC, 2013).

EU organic Regulation states also that organic animal farming should be based mainly on grazing in order to assure animal welfare and a proper exploitation of pastures.

In Tuscany, as in the whole Mediterranean area, pastures produce grass only in limited periods (spring and autumn) and traditional beef cattle are traditionally fattened in boxes within stables from the age of 6-8 to 18-20 months. Local farmers are convinced that the grazing negatively influences the quality of the meat. Unfortunately also organic farmers are limited by these climatic and cultural problems, and many researches on this field had to be done to demonstrate the importance of the grazing for the animal welfare and the quality and safety of productions (Martini et al., 2009).

Rearing system, quality of the pasture and possible concentrate integrations can influence the quality of meat and its fatty acid composition.

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The aim of this research is to compare the fatty acid muscle composition of Maremmana bullocks reared in different fattening systems.

Material and methods

The trials were performed at the Filetto organic farm (controlled by ICEA) property of Metallifere Hills Mountain Community (Grosseto province). We utilized analytical laboratory data from Maremmana bullocks fattened from 1996 till 2005, and slaughtered at different ages.

Since, climatic-environmental conditions, organic diets feedstuff and genetic animal lines were all similar, we considered, as variability factors, the 3 fattening systems utilized:

1) In the feedlot, with a diet composed by hay (ad libitum) and concentrate (0.8 UFC/kg DM and 150 g CP/kg DM) administered considering the medium animals live weight (FL).

2) On pasture, represented by grazing land and mixed forest, with the presence of *Quercus cerris*, *Quercus pubescens, Ostrya carpinifolia, Fraxinus excelsior* and *Fraxinus ornus* (P).

3) On pasture, integrated with concentrate (0.8 UFC/kg DM and 150 g CP/kg DM): 1 kg for 100 kg of animals live weight (P+C).

After the slaughtering, from a sample of *Musculus longissimus thoracis*, lipids were extracted following the Folch et al. (1957) method, and acidic composition of total lipids was determined by methyl esters chromatography.

The following acidic fractions and ratios were considered: Saturated Fatty acids (SFA), Monounsaturated Fatty acids (MUFA), Polyunsaturated Fatty acids (PUFA), Polyunsaturated Fatty acids n3 (PUFA n3), Polyunsaturated Fatty acids n6 (PUFA n6), Myristic acid + Palmitic acid (14:0+16:0), MUFA/SFA, PUFA/SFA, PUFA n6/PUFA n3, PUFA n3/PUFA n6, Linoleic acid/a-Linolenic acid (18:2n6/18:3n3). Besides, Thrombogenic index (TI) and Atherogenic index (AI) were determined following Ulbricht and Southgate (1991) method.

Analytical data were subjected to ANOVA, considering the fattening system as fixed factor. Means were compared by Tukey test.

Results

Fattening system strongly influenced the acidic composition of *Musculus longissimus thoracis* fat (Table 1).

Maremmana bullocks on pasture, without concentrate integration (P), showed the best fatty acid composition for the human health: significant smaller SFA incidence, and TI and AI ratio; at the same time, greater PUFA, PUFA n6 incidence and MUFA/SFA, PUFA/SFA and 18:2n6/18:3n3 ratio.

Pasture with concentrate integration (P+C) determined greater SFA, MUFA, MUFA/SFA incidence, and TI and AI ratio; at the same time smaller PUFA, PUFA n3, PUFA n6 incidence and PUFA/SFA and 18:2n6/18:3n3 ratio.

Bullocks in the feedlot (FL) showed greater SFA incidence and TI ratio like group P+C, but also grater PUFA, PUFA n3, PUFA n6 incidence like group P.

Discussion

Results indicated that rustic breeds, like Maremmana, may be conveniently raised on pasture for the whole fattening period, and demonstrated that grazing can positively influence the quality of the meat fatty acid composition, reducing significantly the SFA incidence, increasing the PUFA incidence, and at the same time diminishing the TI and AI value.

Table 1: Muscle fatty acids and health indices

	Fattening system			Sign.
	Feedlot (FL)	Pasture (P)	Pasture integrated with concentrate (P+C)	
Samples n.	23	14	25	-
Saturated Fatty acids (SFA) %	42.92 a	39.41 b	43.24 a	***
Monounsaturated Fatty acids (MUFA) %	30.42 b	31.66 ab	35.21 a	***
Polyunsaturated Fatty acids (PUFA)%	26.68 a	28.92 a	21.56 b	***
Polyunsaturated Fatty acids n3 (PUFA n3) %	4,13 a	4.03 ab	3.03 b	**
Polyunsaturated Fatty acids n 6 (PUFA n6) %	22.55 a	24.88 a	18.53 b	***
Myristic acid + Palmitic acid (14:0+16:0)	23.04	23.22	22.63	n.s.
MUFA/SFA	0.71 b	0.80 a	0.81 a	***
PUFA/SFA	0.63 ab	0.75 a	0.51 b	***
PUFA n6/ PUFAn3	5.72	6.55	6.50	n.s.
PUFA n3/ PUFA n6	0.18	0.16	0.16	n.s.
Linoleic acid/a-Linolenic acid (18:2n6/18:3n3)	10.48 b	15.81 a	10.39 b	***
Thrombogenic index (TI)	0.77 a	0.66 b	0.80 a	***
Atherogenic index (AI)	0.49 ab	0.45 b	0.54 a	***

** significant at P<0.01; *** significant at P<0.001
Different letters indicate significant difference among means in the same row (P<0.05) (Tukey test).

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Effect of cover crop management and compost application on soil N fertility of organic melon

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Key words: green manure, roller crimper, soil mineral nitrogen, nitrogen budget

Abstract

A field experiment was carried out in Central Italy on growing melon (Cucumis melo L.) after barley (Hordeum vulgare L.). Three different systems of cover crop termination (green manure, roller crimper and fallow, as control) were combined with three doses of compost (0, 15 and 30 t ha^{-1} d.m.) in a strip plot design. The main objective of the research was to evaluate their effects on organic melon production and on soil nitrogen (N) fertility. Marketable yield and quality and soil N availability along the melon cycle were determined and a simplified N budget calculated. Green manure (GM) treatment showed the highest total and marketable yield, followed by fallow (FA), while roller crimper (RC) was characterized by a significant lower yield respect to the other two treatments (45% and 62% of the marketable yield of GM and FA, respectively). Soil N fertility of GM and FA were characterized by N deficit unless combined with compost application at the dose of 15 t ha^{-1} d.m.

Introduction

Soil fertility management in organic farming is mainly based on organic sources of nutrients. Unfortunately, timing of soil mineralization of organic materials and the consequent nutrients availability is often asynchronous respect to plants needs. Cover crops grown for their nutrient value are mainly incorporated into soil as green manure (GM), but there is a wide literature on the benefit of killing cover crops by the use of roller crimper (RC) mainly for weed control also on vegetable production (Canali et al., 2013). However, information about the combined effect of alternative cover crop management strategies and compost application on soil fertility and N availability to vegetable crops are scarce (Montemurro et al., 2013). The main objective of this research was to evaluate the effects of alternative methods of termination of barley (*Hordeum vulgare* L.) combined with different doses of compost, on organic melon (*Cucumis melo* L.) production and on soil N fertility.

Material and methods

The research was carried out at the Monsampolo Vegetable (MOVE) long term experiment, located at the Vegetable Research Unit of the Research Council for Agriculture (CRA-ORA) in Monsampolo del Tronto (AP) (latitude 42° 53' N, longitude 13° 48' E), in Marche Region (Central Italy). The type of soil is a Fluventic Haploxerept, fine silty, mesic (USDA, 2006), with hydric regime xeric. In a strip plot experimental design, melon (*Cucumis melo L.*) was cultivated after barley (*Hordeum vulgare L.*), utilized as cover crop in the rotation. The first factor was barley management and the following treatments were compared: (i) FA: fallow (control), in which barley was not cultivated and soil tilled before melon planting; (ii) GM: green manure, in which, at flowering, barley biomass was chopped and ploughed into the soil and (iii) RC: roller crimper, in which the barley biomass was flattened in order to obtain a natural soil mulching layer made of the barley biomass. The second factor was the compost dose which was applied, on a dry matter basis, as follow: (i) 0 (control), in which compost was not added; (ii) 15; in which compost was applied at the dose of 15 tons d.m. ha^{-1}; (iii) 30; in which compost was applied at the dose of 30 tons d.m. ha^{-1}. Melon was harvested according to fruit ripening. Total yield was calculated as the sum of the different harvest. Marketable and not marketable yield were evaluated according to local market standards. In order to evaluate mineral nitrogen availability to plants, soil samples were collected four times (at 0, 28, 63 and 85 days after transplanting) for soil mineral nitrogen determination. Moreover, a simplified N budget was calculated in order to evaluate either short and long term soil N fertility of compared treatments.

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Results

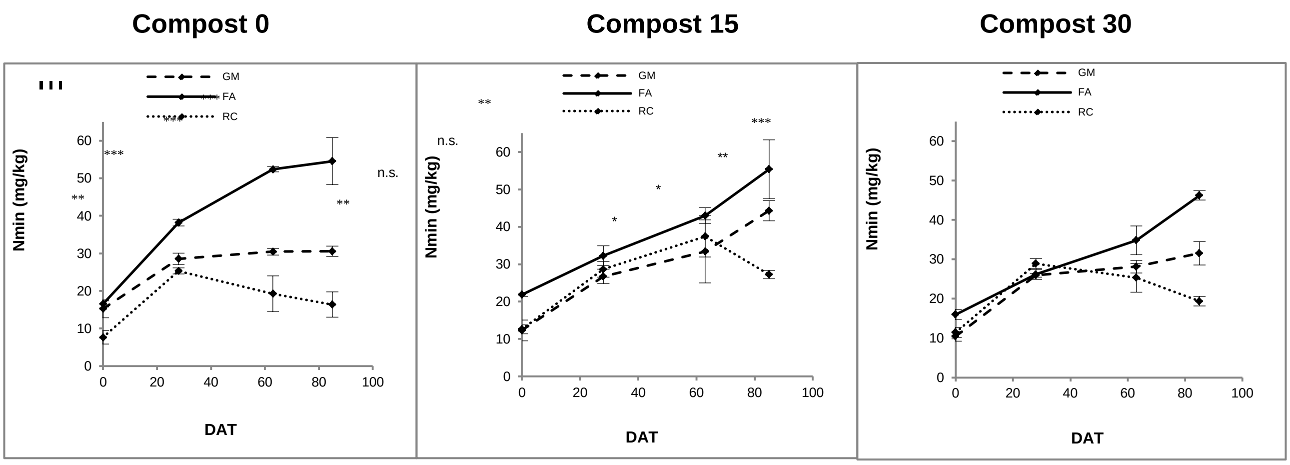
The total and marketable yield are reported in Table 1.

Table 1: Total and marketable yield of melon

	Total		Marketable		Not marketable	
Cover crop management	**kg plant $^{-1}$**	**fruits plant $^{-1}$**	**kg plant $^{-1}$**	**fruits plant $^{-1}$**	**kg plant $^{-1}$**	**fruits plant $^{-1}$**
GM	4.0 a	3.0 a	3.3 a	2.4 a	0.7 a	0.7 a
FA	2.8 b	2.3 b	2.4 b	1.8 b	0.4 b	0.5 ab
RC	1.6 c	1.6 c	1.5 c	1.4 c	0.1 c	0.2 b
Compost dose						
30	3.0 a	3.5 a	2.5 a	1.8 a	0.6 a	0.7 a
15	3.0 a	2.4 a	2.6 a	2.0 a	0.4 ab	0.4 ab
0	2.0 b	2.0 a	2.1 a	1.7 a	0.3 b	0.3 b

The mean values in each column followed by a different letter are significantly different according to LSD and DMRT (two and more than two comparisons, respectively) at the reported probability level.

GM treatment showed the highest total and marketable yield, followed by FA. RC was characterized by a significant lower yield respect to the other two treatments. The doses of compost showed less evident results, with similar yields for treatments 15 and 30 tons of compost and lower yield for compost dose 0. In Figure 1 (a,b,c) are shown the curves of available soil mineral nitrogen (at different compost doses) during the melon cycle, divided by cover crop management. The FA treatment showed always the highest values followed by GM and RC. Nevertheless, compost dose affected the significance of the differences. As far as the comparison between the two systems of cover crop termination (GM and RC) is concerned, the RC treatment showed the lowest amount of soil available nitrogen at any dose of compost applied.



n.s. = not significant differences; * = P ≤ 0.05; ** = P ≤ 0.01;*** = P ≤ 0.001, according to DMRT. Bars = ± Standard Deviation.

Figure 1: Soil mineral nitrogen (at different doses of compost) during the melon crop cycle, divided by cover crop management

A simplified budget of nitrogen for melon is reported in Table 2.

Table 2: N simplified budget for melon (kg ha^{-1})

			FA			RC			GM		
		Source	0	15	30	0	15	30	0	15	30
Input	**Off farm**	**Min Avail N**	66 b	87 a	64 b	30 e	50 cd	46 d	61bc	49 d	42 d
		Barley	0	0	0	127 b	114 bc	85 c	173 a	105 bc	108bc
	In farm	**Organic fertilizers**	47	47	47	47	47	47	47	47	47
		Compost	0	303	606	0	303	606	0	303	606
		Total	113 g	437 d	717 d	204 f	514 c	784 a	281 e	504 c	803 a
Output		**Yield**	159 cd	224 c	174 cd	114 d	85 d	70 d	323 b	376 ab	438 a
		Not mark. yield	0	4	4	0	0	2	0	0	0
		Crop residues	52 bc	54 b	60 b	36 bc	33 bc	24 c	63 b	59 b	105 a
		Min Avail N	218 a	221 a	185 a	65 c	109 bc	77 bc	122 b	177 a	84 bc
		Total	429 c	503 bc	423 c	215 d	227 d	173 d	508 bc	612 ab	627 a
Difference (Input - output)			-316 e	-66 d	294 c	-11 d	287 b	611 a	-227 e	-108 d	176 c

The mean values in each column followed by a different letter are significantly different according to LSD and DMRT (two and more than two comparisons, respectively) at the reported probability level. n.s., not significant; ***, P < 0.001; **, P < 0.01; *, P < 0.05.

Available mineral nitrogen is considered as an input when measured on soil samples collected at transplanting and as an output when measured at harvest. In both cases, available soil mineral N was significantly higher in FA compared to RC and GM. In particular, at harvest, soil mineral N in FA, at different compost doses, was from 100 to 230% higher than RC and from 25 to 120% higher than GM. On the other side, at compost dose 0 and 15, total N input was significantly higher in GM and RC respect to FA due to the amount of nitrogen supplied by the cover crop either incorporated to soil (GM) and flattened (RC). Total N output was significantly higher in GM compared to FA, while the lowest values were shown by RC. The difference (input - output) of the compared treatments put in evidence a N surplus for RC at compost dose 15 and 30, while a N deficit for both FA and GM at compost dose 0 and 15. The low melon yield of RC could be due to the low amount of available soil mineral N along the crop cycle. Both GM and RC showed, at transplanting, a lower soil mineral N respect to FA, probably as consequence of N barley uptake in the previous months. During melon cropping cycle, the mineralization rate of native soil organic matter allowed an increasing availability of soil mineral N for FA, while a prevailing process of N immobilization was probably at the basis of the lower soil mineral N for GM and RC. In particular, for RC, an important role in soil N mineralization was possibly played by the significant lower soil temperature due to the natural mulch (about 5 °C lower than GM and FA along the whole cropping cycle) (data not reported). Lower soil temperatures influenced also the phenological phase of melon, which is a macrotherm crop, with significant delay in fruit ripening and harvest (data not reported). The analysis of the simplified N budget allows some considerations regarding short and long-term soil N fertility. The high amount of available soil mineral N of FA, at harvest, could represent an advantage in case melon is followed by another crop in few days time (as in our rotation, where melon is followed by fennel transplanting in two weeks time). On the other hand, the risk of nitrate leaching increases if melon were not followed immediately by another crop. The analysis of the data regarding the difference (input - output) put in evidence the high N deficit of FA and GM at compost dose 0. These results underline that soil N fertility cannot be managed in the long term without the incorporation to soil of exogenous organic matter and that green manuring of barley is not sufficient *per se* to supply the nitrogen needs of the crop. RC treatment, at all compost doses, seems the more equilibrated in terms of N input - output.

Discussion

The combination of different systems of cover crop termination and compost dose had significant effects on organic melon production and on short and long term soil N fertility management. Barley green manuring determined the highest yield and a sufficient amount of soil mineral N available for the next crop (short term effect), but a deficit of N reduced the sustainability of this system of cover crop management if not associated with a compost application (compost dose 15). Roller crimped barley was not competitive in terms of yield, probably because melon, as a macrotherm plant, needs high soil temperature, while the fallow system (control) showed the worst N deficit. Also in this case, the sustainability of the system was increased by the application of compost dose 15.

Acknowledgments

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Endophytic fungal populations acting on soil suppressiveness in fruit tree orchards

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Key words: Antibiosis, antagonism, apple, *Fusarium* spp., soil functioning, soil microbial population

Abstract

Fruit production in central Europe takes place in permanent cropping systems and is affected by replant disorders, although soil organic matter content does not represent a fertility limiting factor in those growing areas. The consequent crop yield decline is mainly due to biotic causes, even if it is mediated by plant vigour. Therefore, the most appropriate strategy for controlling replant disease in organic cropping systems of central Europe is to exploit biological soil resources. To prove feasibility of this strategy, functionality of two populations of endophytic fungi isolated in apple orchards was evaluated. Antibiosis and potentiality of plant growth promotion, as observed in Fusarium oxysporum, as well as antagonism toward the pathogen Cylindrocarpon in apple tree root colonization, as observed in binucleate Rhizoctonia, indicate the possibility to reduce root pathogens and to increase plant growth in renewed apple orchards by exploiting microorganisms naturally present in soil.

Introduction

The vast majority of fruit tree production in Europe takes place in intensive cropping systems and is affected by replant problems. This etiology is mainly due to biotic causes but, it is mediated by plant vigour, physiological state of plants and a-biotic factors. Therefore, yield decline is the main indicator of replant etiology for farmers. This study is a step in a line of research which focuses on exploitation of natural resources of orchard soils and aims at developing innovative cropping practices which will enable biodiversity preservation and increase soil health.

Soil fungi are well known indicators of soil functioning in both arable and permanent crops. For this reason, a study was carried out to identify the root endophytic fungal species indigenous in apple orchards of Europe, having beneficial impact on plant growth in three apple growing areas where organic management represents a consistent part of land invested with orchards.

The achievement of these objectives should lead to the third part of this research strategy aiming at defining agronomic tools suitable to increase soil inhabiting beneficial microbial populations.

Material and methods

Plant growth response was the main parameter adopted to evaluate soil health in this study. A plant growth assay was performed on soil samples coming from replanted orchards of three European apple growing areas (Italy, Germany and Austria). Rooted cuttings of clonal M9 rootstock was used as target plant. A control soil subjected to a gamma ray sanitisation cycle (corresponding to the standard treatment used in food sterilization) for each sampling site was inserted in this trial to quantify plant growth reduction caused by the replant problems. At the end of bioassay, qualitative and quantitative evaluation of fungal endophytic communities (obtained from 1944 root explants from 243 rootstock plantlets) showed that: (1) root colonization frequency reaches a total of 60%; (2) only two populations were negatively correlated to plant growth (*Cylindricaropn*-like fungi group and *Pythium* spp.); (3) Fusarium and binucleate Rhizoctonia populations, accounting for 50% of total fungal endophytes, did not result negatively correlated to plant growth (Manici et al. 2013).

Starting from those two non pathogenic fungal populations, specific tests were performed to identify their interaction with plants to identify their functionality in relation to crop production and soil health in apple orchards.

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Results

The plant growth increase of 40% in gamma ray treated soils as compared to natural soils confirmed the biotic origin of replant disease in apple orchards (Manici et al. 2013). However, the analysis of microbial communities showed that this result seemed to be caused by a different ratio among root endophytic fungal populations, rather than by a consistent reduction of fungal root pathogens (Manici et al. 2013). Among them, Rhizoctonia was significantly and negatively correlated to Cylindrocarpon (*P<0.05*, Coeff Corr:-0.23, for 81 paired samples; *P<0.01*; Coeff Corr=-0.88 for 3 paired treatments consisting of 27 samples each: replanted soil, row strip soil, gamma treated soil (Fig. 1). This outcome suggests antagonism between binucleate *Rhizoctonia* sp. and *Cylindrocarpon*-like fungi in colonizing roots. Within the Fusarium population, a bioassay with culture filtrate with three pure colonies of *Fusarium oxysporum*, the most abundant species (33% of total *Fusarium* spp.), showed antibiosis toward Cylindrocarpon in poisoned media and an auxin production in 100 ml, varying from 0.9 to 2.55 mg l^{-1} after a one-week incubation period.

Discussion

Antibiosis and growth promotion of *F. oxysporum* suggests the potentiality of soil inhabiting Fusarium spp. to reduce rootrot agents and increase plant growth in renewed apple orchards. This finding is consistent with the high ability of Fusarium genus to produce biologically active compounds (Azevedo and de Araujo 2007).

At the same time the colonizing ability of the binucleate Rhizoctonia population, having a non pathogenic behaviour, seems to act antagonistically to *Cylindrocarpon*-like fungi, having a role in growth reduction of replanted orchards. This finding is consistent with what has previously been observed in fungal ecology applied to apple and forest crops (Grönberg et al. 2006; Kelderer et al. 2012).

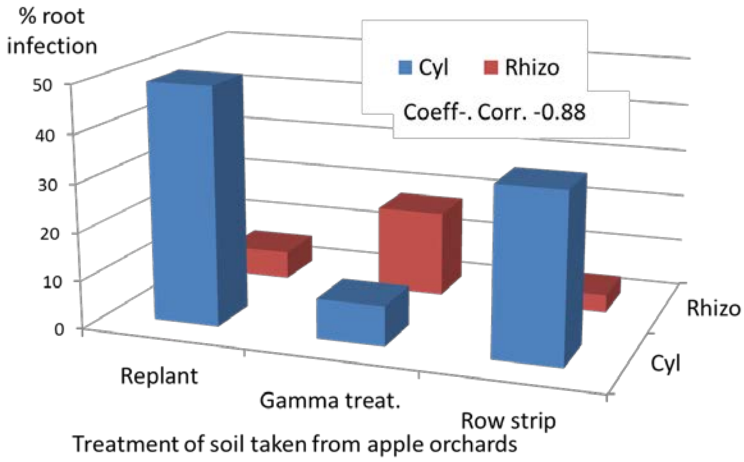

Fig. 1. Abundance of pathogenic population of *Cylindrocarpon*-like fungi (Cyl.) as compared to binucleate *Rhizoctonia* sp. (Rhizo) in soil from 9 replanted apple orchards in Europe. The negative correlation between those two populations revealed their antagonism in colonizing apple roots.

Functionality of two common root colonizing fungi occurring in apple orchards, as observed in this study, supports the existence of soil biological resources acting as additional beneficial factors in soil suppressiveness and suggests the potential advantages to exploit these natural resources for developing innovative cropping practices in organic agriculture. Indeed, soil fungi living saprophytically in soil are the primary microbial contributors to the carbon metabolism process (Bailey et al. 2002). In addition, soil fungi represent the part of microbial biomass most susceptible to plant residue incorporation into the soil, as well as to cropping practices (van der Wal et al. 2006). Finally, soil fungal community composition is strongly affected by vegetative cover (Broeckling et al. 2008).

Findings so far obtained support the original challenges of the project, namely that microbial populations naturally present in orchard soils are a resource to be exploited for increasing soil health and sustaining high quality fruit production.

Acknowledge
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Living mulch and vegetable production: effect on crop/weed competition

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Key words: competitive ability, cover crop, roller crimper, cauliflower, leek

Abstract

Two field experiments were carried out in order to test the effect on weed management of living mulch introduction in organically managed cauliflower (Brassica oleracea L.) in Central Italy and leek (Allium porrum L.) in Denmark. Burr medic (Medicago polymorpha L.) and Dyers Woad (Isatis tinctoria L.) were sown as living mulch in Central Italy and Denmark, respectively. Different living mulch managements and cultivars were tested in strip plot designs. The main objective of the research was the evaluation of their effects on both crop growth and weed suppression. Biomass of crops, living mulches and weeds were measured and competitive indices were used to assess their competitive relationships. The burr medic showed the lower weed biomass when sowed later than crop, avoiding competitiveness on crop. Furthermore, dyers woad showed the highest tolerance to competition when late sowed.

Introduction

Cover crop introduction into rotation can contribute to create an unfavourable ecological environment for weeds, ensuring the biodiversity and soil protection. The weed suppressive potential of the cover crop may depend on plant species, place in crop rotation and management. Thus, interseeded cover crops (living mulch) can be introduced to improve the competitive ability of vegetable crops, which are commonly weak competitors against weeds (Baumann et al., 2000), matching their sowing with the cash crop transplanting. The selection of proper living mulch species and cultivars can uncouple weed and crop suppression, then filling the ecological niches otherwise used by weeds, without smothering the crop. Also the interseeding timing and the living mulch spatial distribution (i.e. on the entire field or stripped) can contribute to achieve this result (Masiunas, 1998). In order to study the benefits and shortcomings of living mulch introduction on crop competitiveness, the InterVeg research project is evaluating the use of living mulches in vegetable cropping systems in different European environments. This paper presents the preliminary results of living mulch introduction (sowing dates and spatial distributions) on weed and crop competitive relationships in organic cauliflower and leek cultivars in the IT and DK experiments.

Material and methods

The Experiment 1 was carried out at the Vegetable Research Unit of the Consiglio per la Ricerca e la sperimentazione in Agricoltura (CRA-ORA) in Monsampolo del Tronto (AP), (42°53'N, 13°48'E), along the coastal area of the Marche Region, Central Italy. In a strip plot experimental design with two factors and three replicates, cauliflower (*Brassica oleracea* L. var. *botrytis*) was grown within August 2011 and January 2012 with Burr medic (*Medicago polimorpha* L. var. *anglona*) as living mulch. The first factor was Burr medic management and the following treatments were compared: (i) control (no living mulch – No lm), (ii) living mulch early sowing (at cauliflower transplanting – Early) and (iii) living mulch late sowing (three weeks delayed after cauliflower transplanting – Late). The No lm treatment was managed and weeded in accordance to the standard agronomic practices, commonly used by organic farmers in the area. The Early and Late treatments were weeded until the living mulch sowing. The second factor was the cauliflower genotype and three different cultivars were compared (Emeraude –Em– , a hybrid cultivar, and – VCO1 and VCO2 – two open-pollinated, locally adapted cultivars). The Experiment 2 was carried out at the Research Centre at Aarslev (55°18'N,10°27'E) in Denmark. In a strip plot experimental design with two factors and three replicates, leek (*Allium porrum* L.) was grown within May and October 2012 alternating with Dyers Woad (*Isatis tinctoria* L.) living mulch strips. The first factor was Dyers Woad management and the following treatments were compared: (i) control (no living mulch – No lm), (ii) living mulch early sowing (sown 4 weeks

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delayed after leek transplanting – Early) and (iii) living mulch late sowing (sown 7 weeks delayed after leek transplanting – Late). In order to meet the specific needs of this study, in contrast with the standard agronomic practices for leek production in Denmark, the No lm treatment was unweeded. The living mulch Early and Late was weeded until the living mulch sowing. The second factor was the leek genotype and two different cultivars were compared (Hannibal –Ha– an open-pollinated cultivar, and Runner –Ru– a hybrid one). In order to allow the competition assessment among crop, weeds and living mulch, besides the plots with the three components simultaneously present (hereafter reported as "mixed plots"), additional stands were included in triplicate in both the experiment 1 and 2 layouts. Stands with only one component ("pure crop", "pure weed" and "pure living mulch" for crop, weeds and living mulch, respectively) and two components ("living mulch - crop mix" –weeded–, and "living mulch - weed mix" – no crop) were realized. At the end of the crop harvest, aboveground total crop, living mulch and weed biomasses were determined in each plot/stand and for each treatment. Competitive indices (Weigelt and Jolliffe, 2003; Paolini et al., 2006) were calculated by using the measured biomass (Table 1). The RB was calculated for each component (RBc, RBlm, RBw for crop, living mulch and weeds, respectively). The C_b was calculated for either the crop against weeds - living mulch mix (C_bc) and the crop - living mulch mix against weeds ($C_b$clm).

Table1. Competitive indices used for competitive evaluation

Index	Calculation	Evaluation
Agronomic Tolerance to Competition (ATC%)	(Y_{mix}/Y_{pure}) * 100	The highest is the value the lowest is the competitive effect on crop yield
Relative Biomass (RB)	B_{AB}/B_A	The highest is the RB value the lowest is the tolerance of the component to competition
Competitive balance index (C_b)	$Ln[(B_{AB}/B_{BA})/(B_A/B_B)]$	If C_b is greater than, less than or equal to 0, the component is more, less, or equally competitive.

Notes:
Y_{mix}, Y_{pure} : the crop yield in presence of competitors and the crop yield in absence of competitor ("pure crop").
B_{AB}, B_{BA}, B_A, B_A: the aboveground biomass of the A component in mixture with B, of B in mixture with the A, of A in pure stand and of the B in pure stand respectively.
A: component for which the index is calculated to (i.e. crop; weeds; living mulch - lm)
B: component or components in mixture with A (i.e. crop; weeds; lm; crop – weeds; crop – lm; lm – weeds)

Results

Experiment 1: ANOVA results and average values regarding the biomass parameters and competitive indices are reported in Table 2. No significant difference for living mulch biomass was recorded between Early and Late treatments, whereas the Early one showed the highest weed biomass and the lowest crop biomass. Furthermore, the Early treatment showed the lowest RBc, highlighting a stronger decrease in cauliflower biomass compared to pure condition (absence of competition) than Late and No lm treatments. On the contrary, the RBw was higher in Early than Late and No lm treatments. Also the ATC% and C_bc showed the lowest value in Early treatments putting respectively in evidence the cauliflower's low tolerance to competition and competitive ability, when the living mulch was interseeded at crop transplanting. On the other hand the No lm and Late treatments did not differ for most of the evaluated parameters except for C_bc, which showed the highest value in the weeded No lm treatment. However, the C_bc index showed a positive value (and then, competitive ability) in the Late treatment too. Also the highest value of $C_b$clm in the Late treatment underlines the high weed suppressive potential of living mulch-crop mix when the living mulch interseeding is delayed with respect to cauliflower transplanting. Then, the results showed the Late treatment as a possible alternative to the standard agronomic practices of the area, ensuring similar weed control and avoiding the cauliflower suppression. As far as genotype factor is concerned, Em cultivar showed the highest biomass, whereas the VCO2 was characterized by the highest living mulch production. The Em and VCO2 cultivar showed the highest and the lowest values for all the competitive indices except for RBw (no significant difference among cultivars), respectively. However, the positive C_bc value highlighted an high competitive ability for all the cultivars. Moreover, the $C_b$clm showed the competitiveness of the living mulch - cauliflower mix against weeds for all the cultivars, where Em showed the highest value and the VCO2 the lowest one. These results put in evidence the high competitiveness of Em hybrid but also a good suitability of the VCO1 cultivar to living mulch interseeding.If you use tables, please make it as following example (Table 1):

Table 2. Experiment 1. Italian cauliflower. Biomass and competitive indices.

	C	LM	W	RBc	RBw	ATC%	C_bc	$C_b$clm
LM management (M)								
No lm	8.41 a	-	0.14 b	0.86 a	0.03 b	54.2 a	+3.93 a	-
Early	2.28 b	0.42	2.01 a	0.25 b	0.40 a	25.1 b	-0.14 c	+0.81 b
Late	7.44 a	0.64	0.77 b	0.80 a	0.15 b	66.8 a	+1.28 b	+1.63 a
Level of significance	***	n.s.	**	***	**	***	***	**
Cultivar (Cv)								
Em	8.02 a	0.23 b	0.48	0.90 a	0.10	59.6 a	+2.72 a	+1.99 a
VCO1	4.59 b	0.40 b	1.22	0.46 b	0.24	49.9 ab	+0.92 b	+1.32 ab
VCO2	5.52 b	0.96 a	1.22	0.56 b	0.24	36.5 b	+1.43 b	+0.55 b
Level of significance	***	**	n.s.	***	n.s.	*	**	**
Mean	6.04	0.53	0.97	0.64	0.19	48.7	+1.69	+1.19
M x CV	n.s.	n.s.	n.s.	n.s.	n.s.	**	n.s.	n.s.

Notes: Early = early living mulch sowing treatment: Late = late living mulch sowing treatment; No lm = control treatment. Em = Emeraude hybrid; VCO1 = open - pollinated cultivar 1; VCO2 = open - pollinated cultivar 2; C (Crop); LM (living mulch); W (weed): above ground dry biomass (t ha^{-1}). The mean values in each column followed by a different letter are significantly different according to DMRT at the $P \leq 0.05$ probability level. n.s., *, **, *** non-significant or significant at $P \leq 0.05$, 0.01, 0.001

Experiment 2: The high weed pressure characterizing the experiment 2 did not allow to separate the living mulch and weed biomasses, thus the RBw and $C_b$clm were not determined. ANOVA results and average values regarding the biomass parameters and competitive indices are reported in Table 3. The three LM management treatments did not significantly differ for all the considered parameters except the ATC%, showing the highest value in the Late treatment. Moreover, a low competitive ability of the leek in all the systems (C_b<0) was highlighted. This could be related to the particularly high weed pressure during the experiment and due to the lack of weeding. Concerning the genotype factor (CV), the Ha cultivar showed the highest crop biomass, ATC%, RBc and C_bc, resulting more competitive than Ru. The T x CV interaction was found significant for leek biomass, RBc and ATC%. By splitting the results by the CV factor and executing ANOVA for the M one, significant differences among treatments were found in the Ha cultivar, whereas no differences in Ru were shown. More in depth, the Ha cultivar showed higher biomass production in the living mulch treatments compared to the control (4.44 and 5.15 t ha^{-1} in the Early and Late treatments against 3.37 t ha^{-1} in the No lm - $P \leq 0.05$). Similarly, the RBc showed the highest value for Early (0.68) and Late (0.79) treatments than No lm (0.52) ($P \leq 0.05$). The ATC % showed the highest value for Late treatment (88.3%) than Early (63.8%) and No lm (48.7%) ones ($P \leq 0.01$). This evidence underlined the capability of the Ha cultivar to tolerate the competitive environment during the experiment, and demonstrated its ability to grow in the living mulch intercropping system.

Table 3. Experiment 2. Danish leek. Biomass and competitive indices.

	C	LM-W	RBc	ATC%	C_bc
LM management (M)					
No lm	3.22	2.57[(1)]	0.53	50.2 b	-0.47
Early	3.37	2.72	0.54	52.3 b	-0.69
Late	3.90	2.65	0.63	68.4 a	-0.36
Level of significance	n.s.	n.s.	n.s.	**	n.s.
Cultivar (Cv)					
Ha	4.32 a	2.33	0.66 a	66.9 a	-0.19 a
Ru	2.67 b	2.98	0.47 b	47.0 b	-0.82 b
Level of significance	***	n.s.	***	***	***
Mean	3.50	2.65	0.56	56.9	-0.50
M x CV Sig.	**	n.s.	**	**	n.s.

Notes: [(1)] aboveground dry weed biomass. Early = early living mulch sowing treatment; Late = late living mulch sowing treatment; No lm = control treatment; Ha = Hannibal; Ru = Runner. LM-W = living mulch and weed above ground dry mixed biomass(t ha^{-1}); C = crop above ground dry biomass (t ha^{-1}). The mean values in each column followed by a different letter are significantly different according to LSD (CV comparison) and DMRT (M comparison) at the $P \leq 0.05$ probability level. n.s., **, *** non-significant or significant at $P \leq 0.01$, 0.001.

Discussion

The results highlighted the role of agricultural choices in the living mulch introduction in obtaining an effective weed suppression. Both the living mulch timing of sowing and the cultivar had a key role in the competitive success of the crop against both weeds and living mulch. These preliminary outcomes showed the late sowing of the LM ensuring an unfavorable environment for weeds avoiding crop suppression. Moreover, our findings indicated similarities in competitiveness between hybrid and open pollinated/local adapted cultivars.

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An econometric analysis for the evaluation of Risk of non-compliances in Turkey

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Key words: organic certification, risk of non-compliance, Turkey

Introduction

Risk-based analysis is becoming a key concept in the EU organic certification systems. Given that organic food imports from extra EU countries is conditional to the fulfilment of analogous standards, the strongly export oriented organic production of Turkey should benefit from a risk based analysis of non-compliance.

In this paper we analyse the data from inspections of a European control bodies in Turkish farms to analyse risk patterns of non-compliance with the organic regulation. Non-compliance in organic farming is a topic that is receiving recently a growing interest. Gambelli et al. (2012a 2012b, 2013a 2013b), Zanoli et al. (2013), Zorn et al. (2012, 2013), have analysed the issue of noncompliance at the European Level, while Zanoli et al. 2012, has proposed an analysis of sampling outcomes of organic inspections in Turkey. This study is a prosecution of the research of Zanoli et al. (2012) and can be considered as another attempt to analyse the issue of non-compliance in Turkish organic farming, based on a different methodological approach exploiting logit econometric models.

The aim is to find empirical evidence for crops that could be considered as increasing the risk of non-compliance with the organic production rules using an econometric approach. Organic Farming in Turkey is still a small sector but is growing steadily over the last years, mainly driven from export of typical Turkish products like raisins, fruit, and vegetables. Small farms are "intrinsically organic", so they can more easily be converted from a technical point of view than large farms, but their small dimension in many cases does not allow bearing the additional costs of certification. For this reason small organic operators are often organised as collective "projects" to share the cost of certification (Sayin et al., 2005). Given that the largest part of organic production is exported to Europe and that the EU organic regulations have been taken as a reference by the Turkish Ministry of Agriculture and Rural Affairs, it is no surprise that six of the seven authorized companies in Turkey for organic certification are from Europe (Olhan et al., 2005).

In this paper we analyse archives a European based control body operating in Turkey and concerning the results of sampling procedures of organic products. In what follows we consider a farm as non-compliant if it has received a sanction. We use a logistic regression model to explain how different risk factors might explain differences between compliant and non-compliant farm. Data and methods are described in the second section, results and discussion are shown in the third and fourth section, and the conclusions terminate the paper.

Materials and Methods

We want to analyse if the farms that are compliant with the organic production rules are significantly different from those that are not compliant. This analysis could help in designing more efficient inspection schemes, which could reduce the cost of certification, considered as a main obstacle for the competitiveness of Turkish organic farms (Rehber and Turhan, 2002).

To analyse possible risk patterns of noncompliance we use available information at the farm level, concerning the type of crops, the farm size (acreage) and the farmers' gender and age. Our aim is to find if the occurrence of non-compliance is associated to the structural characteristics of the farms (risk factors). Data are obtained from a sample of farms certified by a European control body in the period 2008-2009. Basically two types of information are available: one referring to structural information for the certified farmers and processors and one referring to the sampling procedures implemented by the control bodies, that are used to check for possible non-compliance. If samples are positive to illegal substances, the farmer/processors are considered non-compliant with the organic regulation and are sanctioned by de-certifying the whole production lot. In more severe cases, the whole production of the farm/operator is excluded from further certification. However at the farm level we have not direct information about the reason

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that led to non-compliance, we only can measure what farm has been sanctioned due to non-compliance, and relate this information with the farms' structure. The number of inspected farms and the respective share of sanctioned farms are shown in Table 1.

Table 1 – Number of farms and non-compliances by year

	2008	2009
Total Farms	1,911	2,816
Sampled farms	433	540
of which sanctioned	19 (2%)	31 (6%)

The number of farms inspected increases in the period 2008-2009, and the variability of the datasets is confirmed by the information shown in Table 2. Farm size in particular is relatively stable between 2008 and 2009 for what concerns the average UAA size of total and sampled farms, but the size of sanctioned farms is particularly high in 2009. The high values of standard deviation confirm the general dispersion of data in the dataset, which should be taken into consideration when interpreting the results of the analysis of potential determinants of non-compliance.

Table 2 – Utilisable arable area: total, sampled and sanctioned farms

	Total farms	Sampled farms	Sanctioned farms
Average UAA, 2008 (ha)	8.8	18.3	11.3
std dev	44.7	91.4	12.2
Average UAA, 2009 (ha)	7.1	17.5	54.6
std dev	32.7	72.7	172.8

A logit model is used to analyse the effects of the different risk factors on the probability of non-compliance. The dichotomous dependent variable is a dummy that distinguishes between those that after the inspection have been considered as non-compliant and have received a sanction, from those that did not. The explanatory variables, or risk factors, are the structural variables describing the farm (see the list of risk factors in Table 3). Given that no information is available about the reason that led to the non-compliance, the logit model can only consider if the occurrence of sanctions is more likely when some crops are produced, or some structural factors are present in the farm. Two models are considered, for 2008 and 2009 respectively.

Results and discussion

Table 3 shows the results of the logit models for 2008 and 2009. Figures in bold refer to risk factors that show a significant effect on the likelihood of non-compliance. Industrial crops, grapes and land in conversion are risk factors that are found as statistically increasing the risk of non-compliance in both 2008 and 2009. Vegetables and citrus (2008 only), and other arable crops (2009 only) show a positive and significant coefficient as well but. Some risk factors show negative and significant coefficients (i.e. reducing the risk of non-compliance): cereals, fruits, (for 2009) and farm's size (for 2008).

These results are partially consistent with those of Zanoli et al. (2012), with some relevant differences concerning citrus and nuts (both found as low risk crops in Zanoli et al., 2012). Despite the obvious structural differences between the two countries, the Italian case provides relevant information for Mediterranean organic production, which could be used as a benchmark for the main findings of the analysis of the Turkish organic farms similar analysis made for Italy (Gambelli et al., 2011a; 2011b; 2012a; 2013a). Similarly with the Italian situation, a higher risk of non-compliance is concerning farms producing vegetables, industrial crops, grapes and non-organic land.

Table 3 – Statistical relevance of risk factors: results from logit models, 2008 and 2009

Year	2008	2009
Nr of obs.	433	540
LR chi2(13)	61.35	84.81
Prob > chi2	0.00	00.00
Pseudo R2	0.2474	0.3206
Log likelihood	-93.3258	-89.8561
Risk factors		
male	n.a.	3.617457
age	-.0257915	-.0136234
nr of crops	.0189398	.4111241
farm's size (UAA)	**-.0056115***	.0000907
cereals	-.4921014	**-3.182699*****
pulses	n.a.	.2728798
Industrial crops	**4.110313*****	**4.192004*****
herbs	.6867938	-.4305907
other arable land	n.a.	**2.449913****
fruits	.2994321	**-3.297888*****
nuts	-.5067467	.1770873
citrus	**2.155746***	1.153483
grapes	**1.514964****	**1.747566****
olives	-.7586481	.1873999
vegetables	**1.733436****	.5848617
conversion	**1.750529*****	**1.28727****
constant	**-2.197595****	-7.236873

Significance levels : * 0.1 ≤ p < 0.05 ; ** 0.05 ≤ p < 0.01;*** p≤ 0.001

Conclusions

Results of this study are partially consistent across the two years of analysis, and also with previous studies in this field. Our results indicate a rather reassuring situation concerning the risk of non-compliance, and therefore the overall quality, at least for the main Turkish organic products. The relevant risk factors in both years of the analysis are quite few. Fruits and nuts represent the main organic productions in Turkey (Sayne et al. 2005). Our results show that none of the two products is a statistically relevant risk factor, and fruit production shows even a negative effect on the risk of non compliance (2009 only). Such conclusions represent therefore a positive aspect in terms of development of export potentials.

These results are also relevant for what concerns the domestic demand for organic products. Akgüngör et al. (2010) show a relevant interest of urban Turkish consumers for certified organic products, and a considerable consumers' concern about aspects like health and hygienic characteristics of the products, while İlyasoğlu et al., (2010), show how Turkish consumers confidence in organic food is still moderate. The rather reassuring picture in terms of limited risk of non compliance for the main organic products emerging from our analysis seems could represent an important base for a further development of domestic demand for organic products.

Given these considerations, the potential of a reliable and efficient certification system seems particularly relevant. From this point of view a more structured framework to guide risk-based inspections and sampling is advisable. There is a need for more information particularly at the operator's level, as structural data alone cannot completely explain non-compliant behaviours. Efforts in this direction are suggested also for the European certification systems (Dabbert, 2011). The Turkish inspection system is well adapted to the EU system, and could therefore further enhance the integration with the developments that the European certification systems will experience.

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Risk assessment in EU organic certification system: a systematic literature review

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Key words: Organic Certification, Non-compliance, Risk Factors, Systematic Literature Review

Abstract

This paper provides an overview of the recent studies on risk-based inspection in EU organic certification systems with the aim to evaluate the most relevant risk factors or farm types that are more likely associated with non-compliance. We have conducted a systematic revision of the literature regarding risk-based certification in EU organic farming. Our analysis provides a new systematic approach yielding a structured qualitative summary of the results of the publications.

Introduction

Recently, growing attention is being paid to the various aspects of certification in organic farming, which was for a long period a rather unexplored issue from a scientific point of view. The CERTCOST research project (www.certcost.org) has analysed in depth different economic aspects related to the issue of certification, and a growing number of scientific studies has been recently published, focussing in particular on the determinants of risk of non-compliance (NC) with the organic regulation. The objective of this study is to review the recent studies on risk-based inspection in organic farming and to reach an overall evaluation of the most relevant risk factors or farm types that are more likely associated with NC. A systematic revision of the literature was conducted in order to undertake a comprehensive analysis of all published studies (including accepted and in print publications at the date of our analysis) on risk of NC in EU organic certification systems. We have searched for studies regarding risk based certification in EU organic farming. The selected papers follow a range of different methodological approach, focus on different countries, and are published in a range of scientific reviews with different impact factors. Our analysis provides a new systematic approach yielding a structured qualitative summary of the results of the publications Results are normalised according to a synthetic index reflecting the number of time a risk factor is found as relevant, and the overall scientific relevance of the publication they refer to.

Material and methods

A systematic revision of the literature was conducted in order to undertake a comprehensive analysis of all published observational studies on risk of non-compliances in EU organic certification systems. We have performed searches using multiple term related to "risk based", "organic certification" and "non-compliances" in two computer database (scopus and organic e-print). Two general types of approaches are available. The first measures the effect of each risk factor singularly taken on the probability of NC occurrence [3-6; 8-12]. The second type of studies considers the risk of NC with respect to a set of farm types [2;3;8;11].
Single risk factor approach. The list of the single risk factors we have taken into consideration in this group of publication is summarised as follow. *Farm management complexity:* both in term of complex crop rotation, and/or different parallel livestock productions; *Farm size*: utilizable arable area in hectares; *Farmers' NC attitude*: farmers that have committed non-compliances in previous year and/or different type of non-compliances within the same year; *Farmer's experience:* the number of years the farm has been organically managed (in most of the publications, the number of years a farmer has been certified by the CBs was taken as a proxy, as the information on the actual number of years a farm was organically managed was not available); *Herd size*: total number of livestock units; *Licensee*: farmers who sell their products on the organic market; *Non organic land:* farms that have conventional and/or in conversion land; *Other certification schemes:* farmers who participate to other certification schemes besides the organic one, like ISO environmental schemes, Demeter certification, etc.; *Processing activity*: farmers who have processing activities in addition to the ordinary farming activities. Apart from the risk factors above mentioned, the available publications considered whether any specific crop or livestock increased (or decreased) the risk of non-compliances. The crop categories were: arable crops (*cereals, industrial crops, dry pulses, root crops, GMO-risk crops*[2]), *erbs*, fodder crops (*grasslands, green fodder*), permanent crops (*olives, grapes, fruit,*

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citrus, nuts), unused land (*fallow) and vegetables*. For the livestock types, five main categories were considered: *cattle, goats, pigs, poultry and sheep.*
Farm type approach. According to the available publications, four farm types can be considered. *Arable*: refers to farms where only arable crops are cultivated, with no livestock production and no fruit and horticulture production; *Fruit/horticulture: r*efers to farms specialised in fruit, vegetables, herbs, and aromatic plants, with no livestock and no arable crop production; *Livestock*: includes farms with livestock breeding (cattle, sheep, pig, poultry); *Mixed:* includes farms with a combination of livestock, arable and horticultural production not classified in other farm type due to mixed status.
Here we rank risk factors and the farm types according to a Risk Score that considers a "weighted" frequency a risk factor (or farm type) is found as having significant impacts in terms of risk of NC.

Concerning risk factors, for each publication *j* we take into consideration which risk factor is reported as having a significant Risk Effect (RE) on the risk of NC (either positive effect, i.e. increasing risk, or negative effect, i.e. decreasing risk). We consider that relevant risk factors increasing the risk of non-compliance have a RE = 1, while those decreasing risk have RE = -1; RE = 0 indicate no relevant impact on risk. In order to take into consideration the publication relevance, for each publication *j* we also develop a "publication weight", which is based on the following parameters: journal relevance (impact factor), geographical coverage (number of EU country analysed) and sample size of the analysis (nr of cases considered). These parameters are summarised in a publication weight score (PW_j).

For the j-th publication it results: $$PW_j = \frac{\frac{IF_j}{\max IF} + \frac{NR_j}{\sum_{j=1}^{n} NR} + \frac{SZ_j}{\sum_{j=1}^{n} SZ}}{\max PW} \qquad (1)$$

where IF_j = j-th impact factor ; NR_j = j-th number of EU country analysed; SZ_j = j-th nr of cases considered.

The normalized risk score (NRS) for each factor is then computed as: $NRS_i = \frac{RS_i}{|\max RS|}$ (2) where

i = risk factor / farm type; j = 1 n (n=total nr of publication);RE_i = i-th risk effect; PWj = j-th publication weight; RSi = i-th risk score = $\sum_{j=1}^{n} RE_i \; PW_p$

In our analysis max RS refers to *Poultry* (hence NRS=1.00): it shows RE=1 in six publications out of eight; also, these publications show high PWs. On the other hand the lowest NRS = -0.27 refers to *Citrus*, which shows RE = -1 in four publications (with an average PW of 0.33); RE=0 in three publications and RE = 1 in one publication (with PW of 0.13).

Results and discussion

In Table 1 we show the NRS of the different risk factors and farm types considered in the reviewed publications. High positive (negative) values of NRS indicate that the risk factor/farm type is considered as increasing (decreasing) the risk of NC in numerous and relevant publications.

Table 1: Classification of risk factors/farm types by NRS

Risk factors	**High Risk of NCs NRS: 0.66 / 1.00**	**Medium Risk of NCs NRS: 0.30 / 0.65**	**Reducing Risk of NCs NRS: -0.27 / 0.00**
Structural risk factors	*Farm size (0.95)* *Farmers' NCs attitude* (0.81)* *Non organic land (0.70)* *Processing activity (0.68)*		*Farmer's experience (-0.24)*
Crop risk factors	*Cereals (0.80)* *Industrial crops (0.79)* *Root crops (0.75)* *Grapes (0.74)*	*Fallow (0.53)* *Grassland (0.52)* *Dry pulses (0.47)* *Green fodder (0.36)* *Vegetables (0.35)* *GMO risk crops (0.30)*	*Fruit (-0.05)* *Olives (-0.22)* *Citrus (-0.27)*
Livestock risk factors	*Poultry (1.00)* *Cattle (0.75)* *Pig (0.75)*	*Sheep (0.32)*	-
Farm types	*Livestock farm (1.00)* *Arable farm (0.72)*	-	*Mixed farm (0.00)*

Please note that a high NRS indicates the likelihood a risk factor/farm type has to increase the risk of NC, but not necessarily the size of the risk increase. Also note that the analysis of the single risk factors and of the farm types have been performed separately, and that the number of publications dealing with farm types are quite few. In our analysis NRS ranges between -0.27 and 1.00. For reasons of space limitations, Table 1 only show high, medium and reducing risk factors/farm types. The risk factors/farm types not listed have a NRS between 0.00 and 0.29. In Table 1 we distinguish between structural, crop and livestock risk factors. Among structural risk factors, the *Farmers' NC attitude* plays a crucial role in the risk evaluation. *Farmers' NC attitude* can be considered as a general proxy for the personal attitude of farmers to fraud (for more details on this aspect see 1 and 8). *Farm size, Non-organic land,* and *Processing activities* are also emerging as factors increasing the risk of non-compliances. On the other hand *Farmers' experience* is the only structural risk-decreasing factor. With reference to the specific crops and livestock risk factors, the analysis shows that *Root crops* and *Industrial crops*, and the livestock production in general are critical risk factors: *Industrial crops* and *Root crops* are in fact indirectly related with livestock production as they can be used as animal feed. Livestock production in general (*Cattle, Pigs* and *Poultry*) is found as a high risk factor. From this point of view it is relevant to note how *Grassland, Fallow land* and *Green manure,* ranked as medium risk factors, are crops often found in relation with livestock production. Finally, Mediterranean crops like *Fruit*, and *Olives* and *Citrus* in particular, are classified as risk reducing factors. For what concerns the analysis of farm types, results are quite consistent with those of the single risk factors: the *Livestock farm* type reaches the highest NRS, and the *Arable farm* type is also ranked a high risk.

Conclusion

Some general conclusion can be drawn from this structured literature review. Firstly, structural factors like size, processing, not fully converted farms, are top ranked in terms of risk. Farmers' attitude to NC, though only a proxy of actual farmers' behaviour, is showing that personal aspects of the farmer might play a crucial role in the risk assessment. Secondly, livestock related activities are much more related to NC, while extensive and "southern" productions reduce the risk of NC. However these results are based on the analysis of available researches, which are still not very numerous, originating from few authors and mainly referring to structural aspects. Due to the general scarcity of data in particular, very little can be said in terms of risk associated with personal characteristics of the farmers (age, sex, crime records, etc.) and with economic aspects like turnover, financial indicators and so on. We think that structural and managerial data are not sufficient to provide an exhaustive evaluation of risk of NC, and ultimately a proper risk-based analysis. The availability of a more detailed and homogeneous set of data could represent an important step towards a more formalised and structured approach to risk based analysis in the field of organic agriculture.

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Improving food quality for the organic poultry meat sector: a Quality Function Deployment approach

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Key words: House of Quality, QFD, organic poultry meat, quality determinants.

Abstract

The paper presents results from an Italian study on the development of the food quality for poultry meat into the organic sector, using the Quality Function Deployment (QFD) technique. Results show that among the visual characteristics of poultry meat consumers assign greater importance to attributes strictly related to the animal welfare issue. Price and product appearance (colour and fat presence) come as second. To meet these needs, producers can effectively operate along the supply chain by acting on: housing type, genotype lines and stocking density (animal concentration/mq). Information about these issues (labelling) should also be provided to the consumers.

Introduction

Exploiting dynamic and heterogeneous consumers demand often involves different supply chain categories with their different viewpoints. In the case of meat, consumers just ask for a tasty and tender meat (Parasuraman et al., 1985), and only recently for differentiation in quality levels, while producers seem more interested in limiting biological variation (Grunert, 2003). Sensorial aspects, but also health and the place of origin are also important when selecting animal food products. In the case of poultry meat, parameters that affect quality are complex and can be controlled through all supply chain (production stages, slaughter and meat processing). This study analyses some of the quality determinants of organic poultry meat as viewed by different points of view. Food quality, beyond being rooted in the consumers value system, is a matter of the supply chain members, but only when they all share a common or at least similar view of the pathway to build it. This study applies the Quality Function Deployment (QFD) approach in order to translate consumer needs into appropriate products and processing characteristics for poultry meat. Consumer attitudes towards the quality of poultry meat as well as expert assessment opinions about the interaction between product quality characteristics and the determinants of the production process were collected.

Material and methods

The QFD method, by focusing on the interactions among the different phases of the production process, encourages communication along the supply chain and between the chain members (Benner et al., 2003). It helps exploiting dynamic and heterogeneous consumers demand for food quality. In our study, we apply the QFD method for the development of poultry meat quality, from a supply chain perspective. The construction process started with the House of Quality (HoQ) or Product Planning Matrix. The methodology approach consists of defining the house dimensions: the consumer needs (the *whats*) and the ranking of the consumer needs on the left side, the processing characteristics requirements (the *hows*) on the top, and the relationship matrix where the importance ratings for each how (the *how much*) are to be defined (Benner et al., 2003). The consumer needs were obtained by using our own expertise of consumer research, while the relative ranking were determined through a choice experiment, asking the consumer when the poultry meat was selected at the point of purchase.[3] Respondents were asked to choose between two hypothetical cuts of chicken breast with a different combination of the six product attributes. Then, the preference data (elicitation of attribute attendance) were investigated (Zanoli et al., 2013) by asking the consumers to self declare the frequency of the selection of each quality cue during their choice experiment. Respondents were asked to indicate on a 9-point Likert scale (never = 1 to always = 9) how much they felt they attended to each attribute in their sequence of responses. The normalised average value of each attribute is reported in the Product Weight (*PW)* column of the HoQ (Fig. 1, left side) (Vatthanakul et al., 2010). The attribute characteristics and the relative levels for the six attributes included in the voice of consumer are: *Colour:* the colour of the chicken breast as sold on the supermarket shelves (Pink-red/Pink-yellow); *Fat:* the yellow fat presence on

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[3] A sample of 150 organic and poultry meat consumers were interviewed in autumn 2008, in Italy. See Napolitano et al. (2013) for more details on the results of the choice experiment.

the chicken breast sold (Visible/Invisible); *Farming system:* the set of farming techniques adopted to raise the chickens (Organic/Conventional); *Animal welfare:* chance for the chickens to have outdoor access (outdoor access/no-outdoor access); *Origin:* the country of origin for the poultry (Italy/Extra Italy and UE); *Price:* selling price in Euro/kg (€8/€16/€24/€32). The processing characteristics requirements, obtained by using experts' opinions, are classified into three main phases. The Production phase includes: *Genotype lines:* chickens selected for a better growth; *Gender:* females, having different growth rates, respect to males; *Age:* slaughter age is at least 81 in organic farming, in conventional farming the age is lower (avg. 55); *Final weight:* the weight of the chickens at slaughter differs for different selling purposes; *Feed composition:* feed with a high concentration of nutritional value; *Presence of GMO:* presence of genetically modified (GM) ingredients in feed composition. Organic feed allow at maximum 0.9% GM ingredients; *Free range housing type:* poultry have access to the outside; *Natural ventilation system:* natural ventilation when chickens are indoor; *High stocking density:* more than 10 chickens per ms in the poultry house; *Vaccination:* chickens are vaccinated for diseases and infections. In the Pre-slaughter phase are: *Bad handling conditions before transport:* low expertise and/or bad handling behaviour and/or lack of handling equipment; *Bad transport conditions:* low level of ventilation, lack of floor space, lack of watering facilities; *Journey duration:* high time length of the journey from farm to slaughter house; *Pre-slaughter time:* high waiting time before slaughter. Finally, in the Slaughter and meat processing phase are: *Electrical stunning methods:* stunning by an electrical equipment; *Cut-up:* chickens sold in dismembered pieces (wings, legs and front halves); *Packaged in MA:* poultry meat packaged in modified atmosphere packs (increases shelf life); *Mixture of gas:* gas mixture (CO_2 O_2 N_2) in modified atmosphere packs; *Low transport temperature:* temperature level during transport (close to 0° C); *Shelves illumination:* light sources employed for shelves illumination; *Additional labelling:* extra labelling information exceeding the current general labelling legislation. The correlation matrix was established in autumn 2009, during a focus group with an expert team. Seven experts, recruited among producers, technicians, and researchers were asked to assess the relationships between the consumer needs and the processing requirement and to rank these relationships in three levels (9: strong, 3: medium or 1: weak). In figure 1, the relationships are expressed through symbols (e.g.: the relation between 'animal welfare' and 'genotype lines' is moderate).

Results and Discussion

Results are shown in the HoQ planning matrix (Figure 1). The most important quality attributes consumers ask are predominantly related to the characteristics of the production process. The most important quality cues that the consumer checks when selecting the poultry meat from the shelves are: the animal welfare (AW = 8.37), the Italian origin (AW = 8.36) and the organic farming system (AW = 8.07). The visual characteristics of the poultry meat (fat presence and meat colour) as well as the price level are quite occasionally inspected. The main findings also show that consumer preferences are more affected by the chicken production phase rather than the following processing phases. The attributes related to the free range housing type (Relative Weight (RW) = 7.8), the chicken final weight (RW = 7.3) and the high stoking density (RW = 6.1) – strictly related to the animal welfare issue – significantly affect the perceived quality for poultry, hence the consumer willingness to pay.

Castellini et al., (2002) shows how the growing rates and the feed efficiencies significantly decrease if the chickens are reared outside and with a low stocking density. Producers are often prone to reduce animal welfare, by cutting the housing equipment and the labour cost (Napolitano et al., 2013). Hence, they should take into account that free range, low stocking density and low final weight, particularly in organic production system, are synonymous of adequate welfare and favourable environment. These results confirm previous findings (Napolitano et al., 2013 and Sundrum, 2001) showing that information about animal welfare issues – such as the housing type and the stocking density – influences the consumer willingness to pay for animal products. The genotype lines (RW = 7.4) is another important attribute affecting the perceived meat quality. Modern genotype lines, intensively selected for their fast growth rate and the feed conversion, can produce anxieties about welfare and carcass quality, especially if the animals are reared outside.

Product Weight (PW)	Quality Characteristics *Hows* / Demanded Quality *Whats*	*1st phase: production*									
		Genotype lines	Gender	Age	Final weight	Feed composition	Presence of GMO	Free range housing type	Natural ventilation system	High stocking density	Vaccination
5.83	Colour	⊝	▲	⊝	▲	⊝		○		▲	
6.37	Fat	⊝	○	⊝	⊝	⊝		⊝		▲	
8.07	Farming system	⊝	▲	⊝	⊝	⊝	⊝	⊝	⊝	⊝	⊝
8.37	Animal welfare	○	○	▲	⊝	▲		⊝	⊝	⊝	▲
8.36	Origin	▲				▲	▲	▲		▲	▲
6.81	Price	⊝	○	○	⊝	○	○	⊝	⊝	⊝	○
	Weight (W)	632.7	179.3	482.2	621.8	501.2	231.5	667.5	477.6	524.6	250.6
	Relative Weight (RW)	7.4	2.1	5.6	7.3	5.9	2.7	7.8	5.6	6.1	2.9

Product Weight (PW)	Quality Characteristics *Hows* / Demanded Quality *Whats*	*2nd phase: pre-slaughter*				*3rd phase: slaughter and meat processing*						
		Bad handling conditions	Bad transport conditions	Journey duration	Pre-slaughter time	Electrical stunning methods	Cut-up	Packaged in MA	Gas mixture	Low transport temperature	Shelves illumination	Additional labelling
5.83	Colour	▲	▲	▲	▲	○	⊝	▲	⊝	○	⊝	
6.37	Fat						⊝	▲			▲	
8.07	Farming system	⊝	⊝	⊝	⊝	⊝	○	▲	▲			⊝
8.37	Animal welfare	○	○	⊝	⊝	⊝						⊝
8.36	Origin	○	○	○		▲	▲	▲		○		⊝
6.81	Price	⊝	⊝	▲	⊝	▲	⊝	⊝	○	○	▲	⊝
	Weight (W)	433.6	433.6	423.8	490.9	412.3	464.9	205.2	184.8	143.8	149.9	649.4
	Relative Weight (RW)	5.1	5.1	5.0	5.7	4.8	5.4	2.4	2.2	1.7	1.8	7.6

Legend: ⊝ Strong Relationship 9; ○ Moderate Relationship 3 ; ▲ Weak Relationship 1

Figure 1. House of Quality for poultry meat

Nevertheless, Reiter and Bessei (1998) and Castellini (2005) confirm that slow-growing genotype lines can fully benefit of organic rearing systems (outdoor access, pasture availability, older age), whereas the fast-growing are characterized by a very low degree of adaptation (manifesting feed inefficiencies and physical problems). As a consequence, the fast growing genotype lines should not be recommended in free range systems nor under organic conditions. In the meat processing phase, additional labelling is the most relevant characteristic (RW = 7.6). In order to let the consumers better identify the quality features, is important that the relevant products characteristic are well described in the label. Additional claim about the above mentioned processing characteristics can give consumers an important tool to make informed choice.

Suggestions to tackle with the future challenges of organic animal husbandry

Determinants that affect poultry meat quality are complex. By applying the house of quality method the poultry industry could learn how to produce products that better meet consumers' expectations. Further work is needed, in particular, for what concerns the analysis of interdependency between the producer parameters (correlation roof). It is reasonable to suppose that some products and/or processing characteristic could have some interaction: supporting or conflicting each other's they could influence the producer strategy. Also, the integration of other sensorial aspect into the product quality attributes could be considered as an interesting option to deeply investigate the role of processing requirements on perceived poultry quality.

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Pathogenic fungi and Bio-control agents: Competitive bio-assay research

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Key words: *Trichoderma*, bio-control, pathogens, fungi

Abstract

Fungi of the genus Trichoderma have a track record of being antagonist to quite of a number of agricultural important pathogens. Trichoderma have some unique characteristics that make it scientifically proven and suitable bio-control agents against varieties of pathogenic organism infecting economic food crops. Trichoderma has the advantage of being environment friendly and not hazardous to the health of human beings, livestock, soil and environment. Competitive bio-assay experiment was carried out in the laboratory on the effects of Trichoderma species (T. atroviride P1 isolates, T. harzianum T22 isolates, T. viride) on some crop pathogens (Phytophthora cinnanerium, Botrytis cinaria and Rhizoctonia solani). Pure culture of Trichoderma and pathogenic fungi were replicated four times and arranged in a complete block design. The result of the experiment shows that Trichoderma species are strong competitor of P. cinnanerium, B. cinaria and R.solani. Within 72 hours, the Trichoderma species were able to grow and completely overlap the P. cinnanerium, B. cinaria and R. solani. This strong competitiveness indicated that Trichoderma species would effectively inhibit the growth of P. cinnanerium, B. cinaria and R. solani on the infected crop; thus the application of Trichoderma species in the control of P. cinnanerium, B. cinaria and R. solani infected crops.

Introduction

Biological control of disease/ pathogen is the application of natural enemies in the control/ eradication of the pathogen population. Biological control is an environmentally friendly, scientifically proven and effective means of mitigating pathogens or pests through the use of natural enemies. A world estimated loss due to crop diseases was up to 12%, while a loss due to post-harvest food spoilage was between 10 and 50%. Effective control of crop losses due to pests (micro-organism, insect and weed) therefore holds the keys for steady and stable food supply of the world. Amongst all effective and recommended controls of the crop pests, biological control holds a great promise for the future. Basically, biological control has the advantages of being environmentally friendly and not hazardous to the health of human beings, livestock and wildlife; especially now that the whole world is clamoring for IPM methods of pest control (Lorito *et al*, 2006; Woo *et al*, 2006; Olabiyi, 2009).

Fungi of the genus *Trichoderma* have a track record of being antagonist to quite a number of agriculturally important pests. It had been most effective bio-pesticides applied for crop protection since the era of traditional farming and nascent organic agriculture. *Trichoderma* have some unique characteristics that make it scientifically proven and suitable bio-control agents against varieties of pathogenic organisms infecting economic food crops. These are: non-toxic to human beings, livestock and wildlife; non-pathogenic organism on crops; compatible with other control methods (physical, chemical, cultural, planting of resistance variety); effective at low concentrations; easy and cheap to culture or produce; could be bottled or prepared in another easily distributable pack; *Trichoderma* is ubiquitous (Lorito, 1998; Olabiyi, 2009). *Trichoderma* is capable of producing secondary metabolites with antibiotic activity. Of recent, *Trichoderma* composted hardwood bark isolates, was reported to produce a metabolite (Harzianic acid) with antifungal and plant growth promoting activity. *Trichoderma* species have been formulated and used as bio-pesticides, bio-protectants, bio-stimulants and bio-fertilizer on a large variety of crops (Reino *et al*, 2008; Vinale *et al*, 2009). Objective of this study is to determine in-vitro competition bio-assay between *Trichoderma* species (*Trichoderma harzianum* P 1 isolate, *Trichoderma harzianum* T 22 isolate, *Trichoderma viride*) and pathogenic fungi (*Phytophthora cinnanerium, Botrytis cinaria* and *Rhizoctonia solani*)

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Material and methods

Preparation of** Potato Dextrose Agar **(PDA)

Dissolve 27g of Potato Dextrose Broth (PDB) and 15g Micro Agar in 1 litre of deionised water in an Erlenmeyer conical flask (2 litre capacity). Sealed properly with cork, autoclaved at 121^{o}C, and 15psi for 20 minutes. Allow the autoclaved media to cool and thereafter pour small quantity (20-25mls) into Petri dish inside the Lamina flow (sterilized condition and working tools). Cover up the Petri dish after solidification process.

Source of Trichoderma and pathogenic fungi

Pure culture of *Trichoderma* species and pathogenic fungi used for the study were obtained from Istituto per la Protezione delle Piante, CNR, Portici Italy. The *Trichoderma* species were *T. harzianum* P 1 isolate, *T. harzianum* T 22 isolate and *T. viride*; while the pathogenic fungi were *Phytophthora cinnanerium*, *Botytis cinarea* and *Rhizoctonia solani*

Introduction of bio-control agents and pathogens to PDA

Bio-control agents and pathogenic fungi were carefully introduced onto the PDA. There were 15 treatments, replicated 4 times fitted into randomized complete block desin. The treatments were *T. harzianum* P 1 isolate; *T. harzianum* T 22 ATCC isolate; *T. viride*; *P. cinnanerium*; *B. cinarea*; *R. solani*; *T. harzianum* P 1 isolate and *P. cinnanerium*; *T. harzianum* P 1 isolate and *B. cinarea*; *T. harzianum* P 1 isolate and *R. solani*; *T. harzianum* T 22 ATCC isolate and *Phytophthora cinnanerium; Trichoderma harzianum* T 22 ATCC isolate and *B. cinarea*; *T. harzianum* T 22 ATCC isolate and *R. solani*; *T. viride* and *P. cinnanerium*; *T. viride* and *B. cinarea*; *T. viride* and *R. solani* The experiment was carried out under Lamina flow and immediately after the setting up of the competition bio-assay; they were arranged in the incubator at 25^{o}C for 72 hours. Records of growth of each bio-control and pathogenic organisms were taken at every 24 hours. Picture of each treatment and treatment combinations were also taken at the 72nd hour.

Results

The results presented revealed the competiveness of *Trichoderma* species and pathogenic fungi. Table 1 shows the time interval at which *Trichoderma harzianum* (T22 isolate) grew over pathogenic fungi - *R. solani, Botrytis cinarea* and *P. cinnanerium*. It was evident that within 72 hours (3 days), *T. harzianum* (T22 isolate) hindered the growth of *R. solani, B. cinarea* and *P. cinnanerium*. It was evident that *Trichoderma* species inhibit the growth of *R. solani.* During the competition between *Trichoderma* species and *R. solani, Trichoderma* species proved to be aggressive competitor over *Rhizoctonia*. *Trichoderma* species grew faster and overlay on the pathogenic fungi (*R. solani.*). Similar trend was observed in bio-assay competition between *Trichoderma harzianum* (T 22 and P1 isolates), *T. viride* and *Botrytis cinarea* (Table 2). *Trichoderma* species grew very fast and then hindered further growth of the pathogenic fungi (*Botrytis cinarea*).

Table 3 shows the time interval at which *Trichoderma viride* grew over pathogrnic fungi - *R. solani, B. cinarea* and *P. cinnanerium* in the laboratory. It was evident that within 3 days, *T. viride* prevented the growth and development of *R. solani, Botrytis cinarea* and *P. cinnanerium*. *Trichoderma* species grew faster, overlay on *P. cinnanerium* and prevented its further growth and development. *Trichoderma* species proved to be aggressive competitor over *P. cinnanerium*. Table 4 shows the competitive bio-assay between *T. viride* and pathogenic fungi (*R. solani, B. cinarea* and *P. cinnanerium*). *T. viride* grew faster to inhibit further growth of the pathogenic fungi (*R. solani, B. cinarea* and *P. cinnanerium*). Table 5 elicits the time interval at which *T. harzianum* T 22 isolate, *T. harzianum* P1 isolate and *T. viride* suppressed the growth of the *Botrytis cinarea*. It was evident that within 3 days, *Trichoderma* species prevented the growth and development of *B. cinarea*. It was evident that *T. harzianum* (P1 isolate) grew very faster to suppress the growth of the pathogenic fungi. *T. harzianum* (T22 isolate) proved to be an aggressive competitor over *R. solani, Botrytis cinarea* and *P. cinnanerium* (Table 6).

Table 1: Competition assay between *T. harzianum* T22 isolate and pathogenic fungi (Figures are in cm)

Time (in hours)	T22 alone	T22 versus *Rhizoctonia*	T22 versus *Botrytis*	T22 versus *Phytophtora*
24	1.7 x 2.0	1.5 x 1.0	1.2 x 1.4	1.0 x 1.5
48	5.5 x 5.5	4.5 x 5.5	4.0 x 5.0	4.0 x 5.0
72	5.5 x 5.5	5.5 x 5.5	5.5 x 5.5	5.5 x 5.5

Table 2: Competition assay between *T. harzianum* P1 isolate and pathogenic fungi (Figures are in cm)

Time (in hours)	P1 alone	P1 versus *Rhizoctonia*	P1 versus *Botrytis*	P1 versus *Phytophtora*
24	0.9 x 0.9	1.2 x 1.1	1.2 x 1.2	0.9 x 0.9
48	1.8 x 2.0	2.0 x 3.0	2.3 x 2.6	2.0 x 2.4
72	3.0 x 2.8	4.0 x 5.0	3.5 x 4.5	3.5 x 2.8

Table 3: Competition assay between *T. viride* and and pathogenic fungi (Figures are in cm)

Time (in hours)	*T. viride* alone	*T. viride* versus *Rhizoctonia*	*T. viride* versus *Botrytis*	*T. viride* versus *Phytophtora*
24	2.0 x 1.5	1.6 x 1.5	2.0 x 2.0	2.0 x 2.0
48	3.5 x 5.0	3.5 x 4.7	3.6 x 5.5	4.0 x 5.0
72	5.5 x 5.5	5.5 x 5.5	5.5 x 5.5	5.5 x 5.5

Table 4: Competition assay between *Rhizoctonia* and *Trichoderma* species (Figures are in cm)

Time (in hours)	*Rhizoctonia*	*Rhizoctonia* versus T22 isolate	*Rhizoctonia* versus P1 isolate	*Rhizoctonia* versus *T. Viride*
24	0.9 x 0.9	0.9 x 0.9	0.9 x 0.9	0.9 x 0.9
48	0.9 x 0.9	0.9 x 0.9	0.9 x 0.9	0.9 x 0.9
72	1.3 x 1.2	1.0 x 1.0	1.0 x 1.0	1.0 x 1.0

Table 5: Competition assay between *Botrytis* and *Trichoderma* species (Figures are in cm)

Time (in hours)	*Botrytis*	*Botrytis* versus T22 isolate	*Botrytis* versus P1 isolate	*Botrytis* versus *T. Viride*
24	1.0 x 1.0	0.9 x 0.9	0.9 x 0.9	1.0 x 1.0
48	1.5 x 1.3	1.3 x 1.2	1.5 x 1.6	1.8 x 1.7
72	4.0 x 4.0	3.0 x 2.5	2.5 x 2.8	2.0 x 1.8

Table 6: Competition assay between *Phythophtora* and *Trichoderma* species (Figures are in cm)

Time (in hours)	*Phythophtora*	*Phythophtora* versus T22 isolate	*Phythophtora* versus P1 isolate	*Phythophtora* versus *T. Viride*
24	1.2 x 1.0	1.1 x 1.1	1.0 x 1.0	1.0 x 1.0
48	1.8 x 2.0	2.0 x 2.0	2.0 x 2.0	1.8 x 2.0
72	2.4 x 2.2	2.4 x 2.2	2.5 x 2.4	2.2 x 2.1

Discussion

The application of bio-control agents and/ or their metabolites for plant diseases control is one of the promising ways to reduce the dependence on chemicals in agriculture, particularly in crop production/ crop protection. In particular, *Trichoderma* are among the most effective bio-control bio-pesticides recommended for plant disease protection against plant diseases under organic agriculture. *Trichoderma* is listed both in Europe and USA as a pesticide permitted for use in organic farming (Woo *et al*, 2006; Olabiyi, 2004).
In recent decades, many bio-control agents have been used in plant protection. However, *Trichoderma* species have been recognized for a long period of time as registered commercial products and biological control agents for the control of plant diseases. Couples with this, is the potency of *Trichoderma* species to increase plant growth and development (Lorito *et al*, 2006; Woo *et al*, 2006). *Trichoderma* species are known

to involve in complex interactions with host plants and soil microbes. The mechanisms involved in the antagonism of *Trichoderma* species on the pathogen were reported to be competition for nutrient, induction of systemic resistance to pathogen, cell wall-lytic enzyme activity, mycoparasitism and antibiosis (Marra *et al*, 2006; Vinale *et al*, 2008; 2004; Lorito, 1998). *Trichoderma* is capable of producing secondary metabolites with antibiotic activity. Of recent, *Trichoderma* composted hardwood bark isolates, was reported to produce a metabolite (Harzianic acid) with antifungal and plant growth promoting activity. *Trichoderma* species have been formulated and used as bio-pesticides, bio-protectants, bio-stimulants and bio-fertilizer on a large variety of crops (Reino *et al*, 2008; Vinale *et al*, 2009).

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Effect of living mulch management on nitrogen dynamics in the soil – plant system of cauliflower

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Key words: vegetable production; nitrogen uptake; soil mineral nitrogen

Abstract

Living mulch management may have an effect on production of the crop and nutrient competition between the plant species in the field. In this paper, the amount of soil mineral nitrogen (N) available in the top soil during the cauliflower growing cycle and N uptake of the different components of the system were determined in two experimental sites in Italy and Slovenia where two different systems of living mulch management (early sown, late sown) were compared with a no living mulch system. Moreover, nutritional competition of a hybrid and two open pollinated cultivars against weeds and living mulch was evaluated.

Introduction

Living mulches (LM) are cover crops which are kept alive during the whole growing cycle of the main crop (Hartwig and Ammon, 2002). The InterVeg research project (Core organic II ERA-NET) aims at verifying if the introduction and proper management of LM in vegetable production systems allow similar yields and produce quality reducing the use of auxiliary off-farm inputs. This paper reports part of the results obtained on N competition among LM, weeds and cauliflower (*Brassica oleracea L.* var. botrytis) in two case studies: Italy and Slovenia.

Material and methods

Experiment 1- Italy: It was carried out at the Vegetable Research Unit of the Consiglio per la Ricerca e la Sperimentazione in Agricoltura (CRA-ORA) in Monsampolo del Tronto (AP), (latitude 42° 53' N, longitude 13° 48' E), Central Italy. In a strip plot experimental design with two factors (i.e. LM sowing time and crop cultivar) and three replicates, cauliflower was grown between August 2011 and January 2012 with Burr medic used as living mulch. Three treatments were compared: (i) control (no-LM), (ii) early sown living mulch (at cauliflower transplanting, es-LM) and (iii) late sown living mulch (three week after cauliflower transplanting, ls-LM). The cultivar factor compared a commercial hybrid (Hf_1 Emeraude) with two open pollinated local varieties (CRA-ORA 1B and CRA-ORA 2B).

Experiment 2 – Slovenia*:* It was carried out in the experimental site of the University of Maribor located at latitude 46° 28′ N, longitude 15° 38 ′E, 282 m a.s.l., in Slovenia. In a randomized block experimental design with two factors (i.e. LM sowing time and crop cultivar) and three replicates, cauliflower was grown between June and October 2012 with white clover as living mulch. In this paper, the effect of the first factor (LM sowing time) is discussed. Three treatments were compared: (i) control (no-LM), (ii) early sown living mulch (at cauliflower transplanting: es-LM) and (iii) late sown living mulch (three weeks after cauliflower transplanting: ls-LM). The cultivar factor compared two cultivars: Chambord and Snow ball. The no LM treatment was managed and weeded in accordance to the standard agronomic practices, commonly used by organic farmers in the area, both in Slovenia and Italy. Soil mineral N (sum of NO_3^--N and NH_4^+-N) at a 0-30 cm depth was determined, at planting, fast growing, start of harvest and end of harvest, in Italy, and at planting, fast growing and end of harvest, in Slovenia. Cauliflower yield and cauliflower crop residues, LM and weeds above ground biomass were measured. Total N content of each sample was determined.

Results

The main results regarding cauliflower quality and quantity yield parameters of the experimental sites of Italy and Slovenia are reported in the paper by Canali et al (2014) in the proceedings of this ISOFAR conference. In both sites, cauliflower in treatment es-LM suffered the competition of weeds and living mulch, while no-LM

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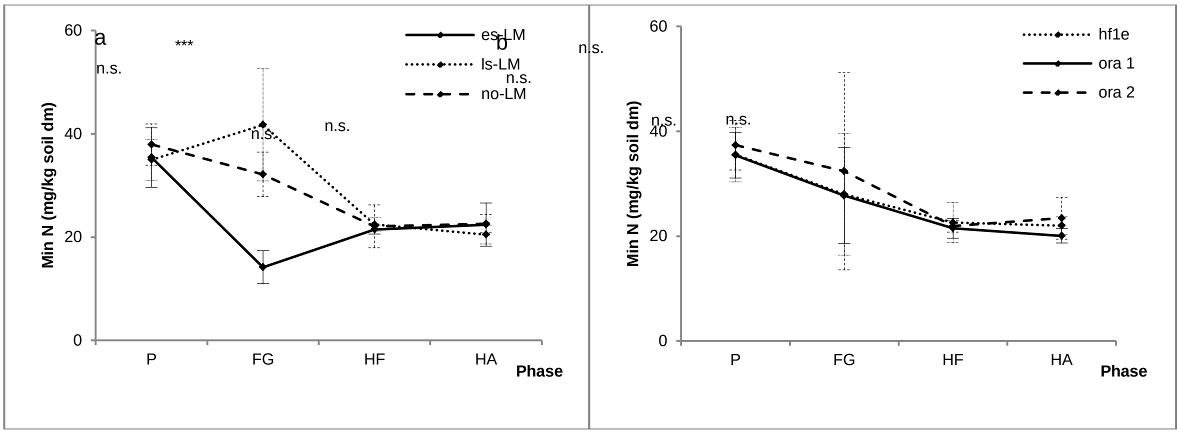
and ls-LM showed similar marketable yields (data not reported). In the Slovenian experiment, the competition of weeds and living mulch in es-LM was so strong that cauliflower was not harvested.

Soil mineral N availability

The amount of available soil mineral nitrogen along the cauliflower growth period is reported in Figure 1, for Italy. The systems of management showed (Figure 1 a) a significant effect on available soil mineral nitrogen at the fast growing phenological phase. At this phase, the early sown living mulch (es-LM) was characterized by a dramatic decrease of soil mineral nitrogen compared to the other two systems of management (no-LM and ls-LM). This trend was probably due to the high amount of mineral nitrogen taken up by weeds and LM whose growth was undisturbed in es-LM compared to ls-LM and no-LM (where mechanical weeding was operated). On the other hand, the cultivars showed no effects on the availability of soil mineral nitrogen during the whole cauliflower cycle (Figure 1 b).

N uptake and components partition in the systems

In Table 1, are reported the amount of nitrogen taken up by the different components of the system and their percentage respect to the total uptake. The es-LM showed the lowest amount of nitrogen taken up by the yield and crop residues and the highest values of N for the weeds. On the other side, no-LM and ls-LM were characterized by a comparable N uptake for all the components of the system showing a similar level of competition compared to weeds. The amount of nitrogen in the LM biomass was low and significantly higher in ls-LM than es-LM. On the other side, the system of management of LM significantly influenced the amount of nitrogen taken up by the weeds. In particular, for N uptaken by weeds, ls-LM was lower than es-LM, showing exactly the opposite pattern of the N uptake of the living mulch component. As far as the cultivar factor is concerned, the hybrid was characterized by a higher amount of nitrogen taken up by both crop yield and residues compared to CRA-ORA 1B and CRA-ORA 2B. For LM and weeds no significant differences were observed. In Figure 2, the amount of available soil mineral nitrogen along the cauliflower growth period**,** for Slovenia**,** is reported. Since in es-LM treatment cauliflower did not grow, soil mineral nitrogen was not determined.



es-LM = early sown living mulch; ls-LM = late sown living mulch; no-LM = no living mulch.Hf1e = Emeraude hybrid; ORA 1 = open-pollinated cultivar 1; ORA 2 = open-pollinated cultivar 2; n.s. = no significant differences; *** = P ≤ 0.001 according to DMRT. Bars = ± Standard deviation.

Figure 1 (a, b): Amount of available soil mineral nitrogen along the cauliflower growth period (a: by living mulch system of management) and (b: by cultivar) in Italy.

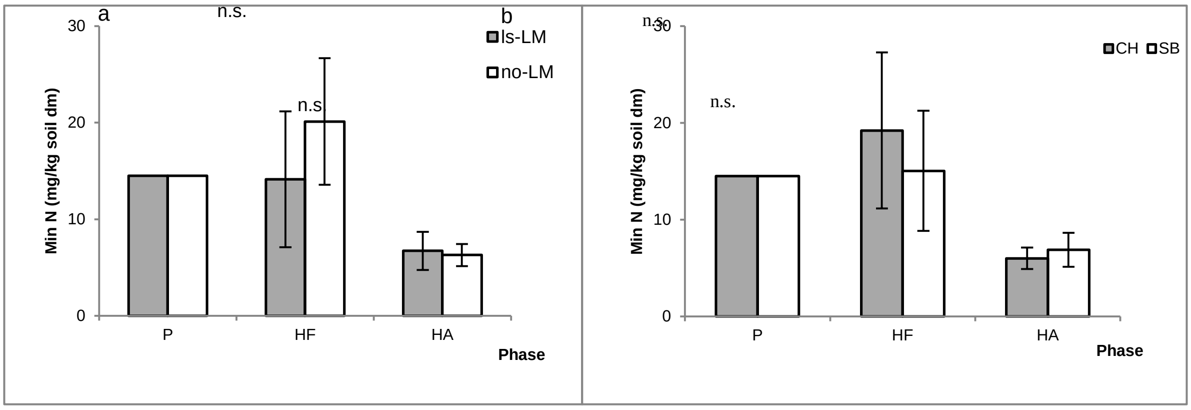
In the other two treatments, no significant differences were observed at the three sampling times (Figure 2a). A very similar trend was observed when soil mineral nitrogen is related to cultivar (Figure 2b).

Table 1:The amount of N taken up (kg N ha^{-1}) by the different components of the systems in Italy related to living mulch system of management and cultivar.

Source of variation	System						Cultivar					
	es-LM	%	ls-LM	%	no-LM	%	Hf1 Eme	%	CRA-ORA 1B	%	CRA-ORA 2B	%
N yield	39.1 b	37	82.3 a	30	95.3 a	36	92.0 a	36	70.9 b	33	60.9 b	33
N crop residues	37.4 b	35	164.2 a	60	164.4 a	63	148.7 a	58	115.4 b	54	81.9 c	45
N living mulch	3.8 b	3	16.8 a	6	-		7.3	3	12.2	6	15.2	8
N weeds	26.4 a	25	9.8 b	4	2.2 b	1	8.7	3	13.7	7	26.2	14
N total	106.7 b		273.1 a		261.9 a		256.7		212.2		184.2	

es-LM = early sown living mulch; ls-LM = late sown living mulch; no-LM = no living mulch. Hf1 Eme = Emeraude hybrid; CRA-ORA 1B = open-pollinated cultivar 1; CRA-ORA 2B = open-pollinated cultivar 2.The mean values in each column followed by a different letter are significantly different according to LSD and DMRT (two and more than two comparisons, respectively) at the $P \leq 0.05$ probability level.

In Table 2, the amount of nitrogen taken up by the different components of the system is reported. The results showed that, in es-LM, 100% of the nitrogen taken up is in the combination of weeds and living mulch, because cauliflower was not harvested. In the other two treatments, comparable yields were obtained (data not reported) even if N taken up by yield was higher in no-LM than ls-LM.



P = planting, HF = head formation; HA = harvest.ls-LM = late sown living mulch; no-LM = no living mulch. CH = Chambord; SB = Snow Ball. n.s. = no significant differences according to LSD (two comparison). Bars = ± Standard Deviation.

Figure 2 (a, b): Amount of available soil mineral nitrogen along the cauliflower growth period (a: by living mulch system of management) and (b: by cultivar).

On the other hand, as far as the cultivar factor is concerned, weeds (and living mulch) grew more in plots where cv. Snow Ball rather than cv. Chambord was cultivated. An opposite pattern of N taken up was observed for crop residues.

Table 2: Amount of nitrogen taken up by the different components of the systems in Slovenia related to living mulch system of management and cultivar.

Source of variation	System						Cultivar			
	es-LM	%	ls-LM	%	no-LM	%	CH	%	SB	%
N yield	-	-	64.5 b	30	84.5 a	65	72.6	34	76.4	28
N crop residues	-	-	36.6	17	44.9	35	49.3 a	23	32.2 b	12
N weeds/living mulch	139.7	100	113.4	53	-	-	91.2 b	43	161.9 a	60
N total	139.7 b		214.5 a		129.4 b		213.1		270.5	

es-LM = early sown living mulch; ls-LM = late sown living mulch; no-LM = no living mulch. CH = Chambord; SB = Snow Ball.The mean values in each column followed by a different letter are significantly different according to LSD and DMRT (two and more than two comparisons, respectively) at the $P \leq 0.05$ probability level.

Discussion

The results obtained in both the Italian and Slovenian experimental sites showed that the time of living mulch sowing influenced the productive performances and the nutrient competition among cauliflower, LM and weeds. In particular, in Italy, sowing of living mulch legume species at cauliflower transplanting (es-LM) gives to weeds a competitive advantage compared to the cash crop. In Slovenia, weeds in es-LM did not allow cash crop yield at all. Hybrid cultivar, in Italy, showed a better performance compared to the two open pollinated cultivars. On the other side, in Slovenia, Chambord cultivar seemed to better compete respect to weeds and living mulch.

Acknowledgments

This study has been carried out in the frame of the ***InterVeg***research project: Enhancing multifunctional benefits of cover crops – vegetables intercropping (Core Organic II ERA-NET). The project is funded by the National Agricultural Ministries.

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Effect of living mulch on pest/beneficial interaction

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Key words: Cauliflower, arthropod fauna, *Pieris brassicae*, parasitization, bioindicators.

Abstract

The aim of this study was to evaluate the effect of cover crops on pest/beneficial dynamics and to test the potential of living mulch on enhancing biological control against insect pests. The research, carried out in the frame of the InterVeg (Core Organic II) project, involved four European countries: Germany, Slovenia, Denmark and Italy. Three crops were tested: cauliflower, leek and artichoke. The preliminary results obtained in Italy on cauliflower, indicated that the living mulch did not affect the infestation of the cabbage butterfly, Pieris brassicae, showing no detrimental effect of this technique on pest dynamics. A very high level of parasitization against cabbage butterfly was detected either in the living mulch crop (88%) and in the sole one (63%). Living mulch showed to increase the spider and rove beetle activity density, while the carabid activity density was slightly higher in the sole crop.

Introduction

Biodiversity and complexity are considered to be essential for the stability and balance of the living component of ecosystems (Pimentel 1961). According to these criteria, crop diversification is an agricultural strategy that can be used to manage insect populations; in fact susceptible plants may be supported by nearby non-host plants, reducing density of the host-plant and increasing the presence of natural enemies (Andow 1991).

Many studies showed that intercropping and living mulch (LM) can have positive impact on plant pests and diseases as well as weed control (Sans and Altieri 2005, Jones and Sieving 2006), although this trend cannot be considered a general rule, but evaluated on a case-by-case approach. For example, trials carried out by Hinds and Hooks (2013) in northeastern United States showed that the number of striped cucumber beetle (*Acalymma vittatum* F.), found on leaves of zucchini plants, was significantly lower in sunn hemp (*Crotalaria juncea* L.) interplanted plots compared to bare-ground treatment plots. In North America, soybean grown with alfalfa LM had an increase of natural enemies and showed a delay in *Aphis glycines* Matsumura establishment (Schmidt et al. 2007). A study on the population dynamics of whiteflies and aphids and their associated natural enemies was carried out in zucchini, to compare living and synthetic mulch; results showed that LM had consistently fewer adult whiteflies and aphids compared with the standard mulch treatments. LM treatments had higher natural enemy populations than synthetic mulch and bare-ground treatments (Frank and Liburd 2005).

The aim of our study was to evaluate the effect of cover crop – main crop intercropping on pest/beneficial dynamics and to test the potential living mulch on enhancing biological control against insect pests. The research, carried out in the frame of the InterVeg (Core Organic II) project, involved four European countries: Germany, Slovenia, Denmark and Italy. In each country, two main vegetable crops were considered: cauliflower (*Brassica oleracea* L. var. *botrytis*), common for all and leek (*Allium ampeloprasum* L.) for Germany, Slovenia and Denmark. Due to the different climate and market demand, in Italy leek was substituted by artichoke (*Cynara cardunculus* L.). In more detail, the first project year was aimed to identify the key pests for each of the studied trophic system (i.e. combination of main crop, living mulch and its arthropods community of each site) with the objective of successively transferring this knowledge to a larger scale at the second year of the study. Accordingly, in this paper the first year results obtained in Slovenia, Denmark and Italy are presented. Moreover, as case study, the results obtained in a larger scale experiment carried out on the Italian cauliflower trophic system are discussed, in order to have a comparison of the ecological services provided by each treatment (LM *vs* no LM, control treatment) in a pilot farm.

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Materials and methods

Small scale experiment - During the first year, in each country, an insect survey by visual observations was carried out at small scale (experimental site). The pest and beneficial data recorded on the different treatments (LM *vs* no LM) were pooled in order to have a general overview on the arthropod fauna. This choice was made because of the small size of the plots, which could cause a bias in the relative abundance of the insects between the treatments. In particular, one sampling per month was carried out, checking 5 organs (leaf or flower) per plant on 30 plants. A total amount of 150 sampling points, randomly selected, was checked every month during the cultivation period. In the case of Denmark, selective techniques as sticky yellow traps and Diptera eggs traps were added to the visual evaluation, to determine the presence of trips and flies. Moreover, in all the sites an evaluation of the damage caused by insect pests on the plants was carried out at harvest. The pest damage was recorded considering a relative score, defined by the severity of injuries suffered by plants. The scores of pest damage were 0 = absence; 1 = light; 2 = intermediate; 3 = heavy.

Large scale experiment - During the second project year, a larger scale experiment was carried out on the Italian cauliflower/annual medicago (*Medicago polimorpha* L. var *anglona*) trophic system in an organic farm (pilot farm) located in the Pescara province (Central Italy). A cauliflower plot with the annual *medicago* as LM was compared with the sole cauliflower crop. The size of each plot was 500 m² and the two plots were at a distance of 100 m in order to reduce the cross effect between the treatments. A total amount of 100 organs per treatment, randomly selected, was checked at every sampling, either in the LM and in the sole crop treatment. Presence/absence of the key pest was recorded. By this planning, one sampling every two weeks was carried out during the cultivation season, checking 5 organs (leaf or flower) per plant, on a total of 20 plants per treatment.
In order to quantify the effectiveness of biological control strategy against the key-pest in each treatment, the percentage of parasitisation was determined collecting a minimum sampling size of 15/20 larvae of the key pest per plot in each sampling. The sample of mature larvae was collected and dissected to check the presence/absence of parasitoid larvae inside it. Lastly, in order to have a complete overview of the fields, it was decided to investigate also the soil arthropod fauna, with the aim to compare the ecological sustainability among the treatments.

A minimum of 4 traps were placed in each treatment, in order to reach a density of one pit fall trap per 200 m^2. The traps were active for two weeks in each sampling. The content of the traps was transferred to the laboratory, and the number of Carabids, spiders and other soil bioindicator groups within each trap were counted.

Results

Small scale experiment - In Table 1 the results of the small scale monitoring are reported for each country. In Italy, the key-pests of cauliflower and artichoke were *Pieris brassicae* (L.) (large white or cabbage butterfly) and aphids, respectively. In Denmark, the dominant pest on cauliflower was the small white *Pieris rapae* (L.), while in Slovenia *Phyllotreta* spp. was most frequent.

Table 1- Key pest determined and percentage of infested leaves

Country	Cauliflower	Artichoke	Leek
Italy	*Pieris brassicae* 66.9%	Aphids 32.3%	-
Denmark	*Pieris rapae* 37.3%	-	Aphids 41.1% Trips 41.1%
Slovenia	*Phyllotreta spp.* 69.73%	-	No record

Large scale experiment - As far as the large scale experiment carried out in the pilot farm in Italy is concerned, the results showed that *P. brassicae* infestation, the key-pest of this crop in the Italian scenario, did not show any difference between the LM and the sole crop treatment (Chi-square test P>0.05) (Fig. 1).

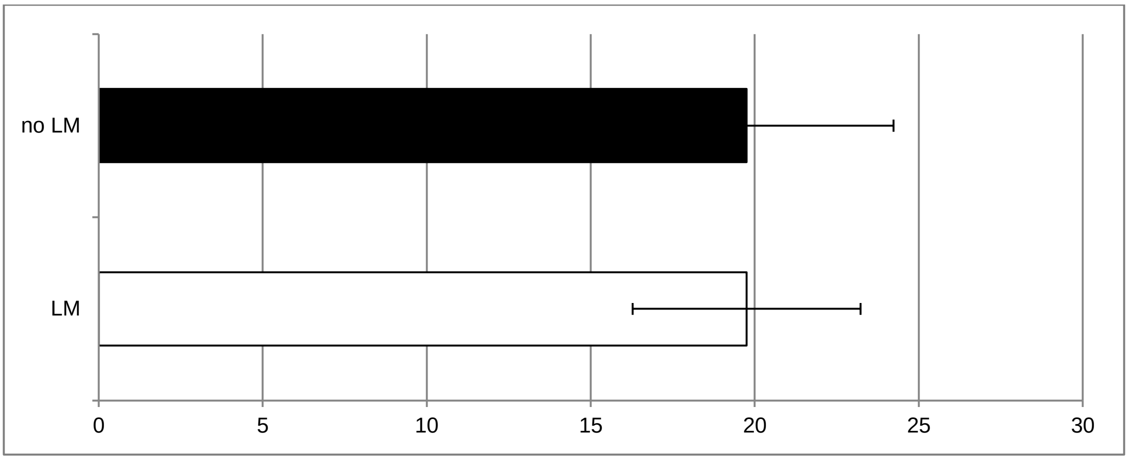

Figure 1 – Cumulative percentage of infested leaves by *P. brassicae* (bars indicate standard errors of binomial distribution).

Also, the percentage of parasitized larvae was higher in LM in comparison with the no LM, sole crop control treatment, even if this difference was not statistically different (Chi-square test, P=0.126) (Fig. 2). All the parasitized larvae were infested by *Cotesia* sp. (Hymenoptera Braconidae), a gregarious parasitoid which is a common biological control agent of this pest.

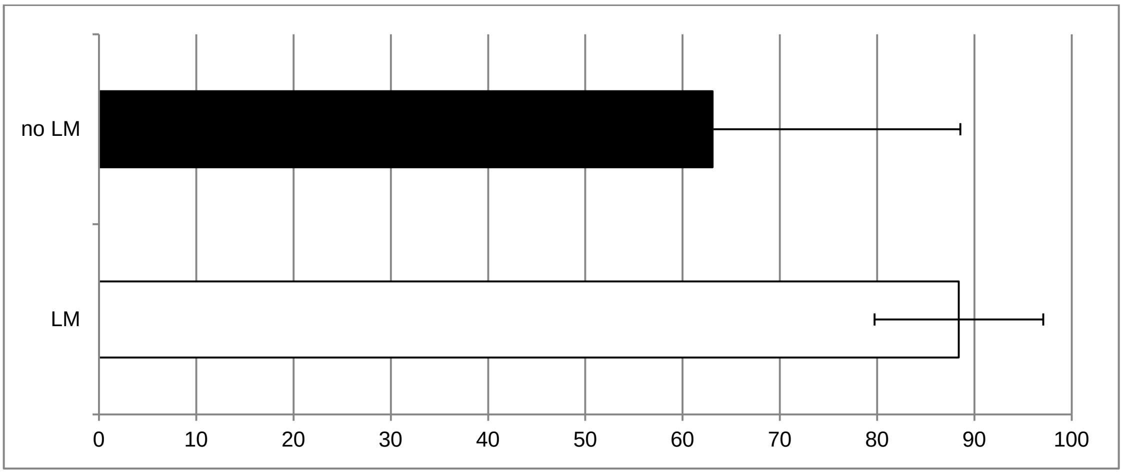

Figure 2 – Cumulative percentage of parasitized *P. brassicae* larvae (bars indicate standard errors of binomial distribution).

Concerning the soil bioindicators, an identification of the Carabidae to the species level is in progress, including a faunistic analysis of the trophic groups recorded in each treatment. The analysis in progress will state potential differences in species composition between the two treatments concerning the Carabidae. In Table 2 are reported the soil bioindicators divided in each trophic group. In general, all the groups showed similar activity densities in the two treatments, even if some slight differences was evinced (i.e Araneae or spiders and Staphylinidae or rove beetles density were higher on LM, and Collembola and Carabidae density were slightly higher on no LM).

Table 2: Bioindicators recorded per trap. The numbers show the mean activity density/per trap (±standard error)

	Carabidae	Araneae	Oniscidae	Staphylinidae	Collembola	Opilionidae
no LM	35.0±4.8	12.0±3.0	5.3±0.4	6.8±0.1	169.3±3.2	30.5±0.9
LM	22.5±2.3	22.5±4.7	4.5±0.4	25.8±2.2	136.8±6.8	27.0±5.3

Discussion

Small scale experiments were useful to focus each trophic system in the different countries, characterized by very different climatic and geographic situations. Moreover, the key-pest selection was a useful criterion to choose the suitable insect monitoring tool and the associated ecological services provided by beneficial fauna. For example, for the Italian scenario, the cabbage butterfly was selected as key-pest and the parasitization by the braconid *Cotesia* sp. was evaluated in order to determine if LM could affect biological control against the pest. The living mulch did not affect the infestation of *P. brassicae*, showing no detrimental effect of this technique on pest dynamics. A very high level of larval parasitization was detected in both treatments (Bryant et al. 2013); the percentage of parasitization was higher in LM (88%) *vs* no LM (63%). In general, a consistent regulatory capacity of the organic farm was detected in all the experiment. LM showed to increase the spider and rove beetle populations, while the carabid activity density was slightly higher in the no living mulch (Gill et al. 2011), although the low activity density of soil arthropod bioindicators in the autumnal season does not allow a definitive conclusion.

Acknowledgments

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Organic agriculture and sustainable practices: towards a typology of innovative farmers

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Key words: organic farming, conventionalisation, probabilistic model, innovation, certification,

Abstract

This paper aims to identify the factors that influence the choice of organic farmers to innovate for more sustainable practices that go beyond the strict limits imposed by the certification. Using survey data collected from 352 Italian and Portuguese certified organic farmers, a probabilistic model was estimated. The results show that farmers, in particular women, longest engaged in organic farming are more likely to adopt sustainable practices. They also indicate that farm size, landownership, the existence of some types of complementary activities and the sources of information used by farmers affect the adoption of such practices.

Introduction

Most definitions of organic farming emphasize a holistic approach that combines quality production with sustainable practices and positive impacts on resource conservation, biodiversity and animal welfare (e.g.FAO/WHO 1999, EU 2007). Its founding values were also connected to small-scale production, minimization of external inputs use, diversification and short market circuits. In the last decades, organic farming has grown very rapidly resulting in the subordination of their values to market forces. There was a greater specialization, an increase of scale, the involvement of large multinational corporations and the inclusion in global trade. This conventionalization process (Darnhofer *et al.* 2010) and the connected certification standards, primarily focused on banning the use of pesticides and chemical fertilizers, may weaken the vision of organic farming as a more sustainable alternative to conventional farming. Following the line of thought of Alrøe and Noe (2008), it cannot be said that the concept of organic agriculture is fully consolidated. There are several perspectives that offer different insights, may vary over time and are, in general, not easy to merge. Leaving aside more radical views, we are particular interested in the dialectic established between the protection of a system based on common values and the integration of it into the global market. The challenge remains to understand how to grow, to incorporate new actors and technologies and to integrate in global markets without losing the internal coherence and without deeply departing from the core values (IFOAM 2005). This lead to a huge debate in sustainability of organic farming, however we should recognize that sustainability is a moving target. In this sense it could be interesting to define innovations that goes in the direction of agricultural sustainability. In the case of EU SOLIBAM project (www.solibam.eu), in which this research is included, participation and diversity at different level are the main criteria to assess sustainability of innovations.

Material and methods

The main aim of this study is to identify the profile of organic farmers more likely to innovate and to adopt sustainable practices, drawing on the estimation of an empirical model based on a survey conducted in two European countries where this issue has not been addressed: Portugal and Italy.
The following analysis is based on a survey of 352 certified organic farmers, being 182 Italian and 170 Portuguese, held between 2010 and 2012, using a fully structured questionnaire. Several survey methods were applied. In Italy most of the data was collected by personal interviews, combined with telephone interviews. In Portugal, the data was mainly collected by mail, although some personal interviews took place. The questionnaire focused on different aspects of farmers, farm structure (including acreage, main crops and livestock), varieties and seeds, other activities besides farming and social network (market, main sources of information). Since the concept of sustainability is inherently multidimensional, covering at least economic, social and ecological issues, the dependent variable was also defined in a multilevel way to capture specialization, reliance on external inputs and type of marketing.

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Table 1: Variables

	Variable	Description
DEP.	Innovative	Dummy variable equal to 1 if yes; 0 otherwise
INDEPENDENT VARIABLES	*Characteristics of farmers*	
	Country Gender Experience	Dummy variable equal to 1 if Portuguese, 0 otherwise Dummy variable equal to 1 if male, 0 otherwise Experience in organic farming, in years
	Characteristics of farms	
	Total acreage (log acreage)	Logarithm of total cultivated area
	Percentage Area Owned	Categorical variable: own1 – 1 if 100% of total farm area owned by the farmer; 0 otherwise own2 – 1 if some part of farm area owned by the farmer; 0 otherwise own3 - if 0% of the total farm area owned by the farmer; 0 otherwise
	Labour	Categorical variable: lab1 –1 if 100% family labour; 0 otherwise lab2 – 1 if both types of labour; 0 otherwise lab3 – 1 if 100% hired labour; 0 otherwise
	Irrigation *Other activities on farm* Act *Main Information sources* 10 different sources considered.	Dummy variable equal to 1 if yes; 0 otherwise Dummy variable equal to 1 if there are other activities on farm; 0 otherwise Dummy equal to 1 if the source; 0 otherwise (family and friends, other farmers, private technical services, supply companies, org.farmers organizations, other producers organizations, universities/other public services, specialized press, others.

The possibility to innovate for sustainability was described by the following four criteria: 1) Crop diversity; 2) Presence of livestock; 3) On-farm reproduction of seeds; 4) Selling in local markets. A farmer was classified as able to innovate for sustainability if at least three of the late four criteria were met. The dependent variable – *Innovative* - is a binary variable, assuming the value 1 if the farmer is classified as innovative and 0 otherwise and a nonlinear probability model was specified relating several independent variables to the probability of an organic farm to innovate for sustainability (Long and Freese, 2006), described in table 1. The estimation method was logistic regression with 95% confidence intervals for estimated coefficients.

Results and discussion

The table 2 shows the result of the model estimation.

Table 2. Model estimation

Logistic regression				Number of obs =	299
LR chi2(20) =	71.23			Prob> chi2 =	0.0000
Log likelihood = -162.646611				Pseudo R^2 =	0.1796

Sustainable	Coef.	Std. Err.	dy/dx	z	P>z
country ***	-1.1982	0.4022	-0.2623	-2.98	0.003
Gender***	-1.0062	0.3229	-0.2079	-3.12	0.002
Experience*	0.0432	0.0262	0.0098	1.65	0.099
Logacreage**	0.2156	0.0937	0.0487	2.30	0.021
own2	0.4588	0.3489	0.0996	1.32	0.189
own3	-0.5289	0.3949	-0.1244	-1.34	0.180
lab2*	-0.5792	0.3475	-0.1313	-1.67	0.096
lab3*	-0.7429	0.4126	-0.1757	-1.80	0.072
Irrigation*	0.6555	0.3717	0.1544	1.76	0.078
act***	1.0528	0.2993	0.2313	3.52	0.000
inf1	0.0846	0.3303	0.0190	0.26	0.789
inf2	0.3506	0.2906	0.0794	1.21	0.228
inf3	-0.4189	0.3417	-0.0948	-1.23	0.220
inf4	-0.6725	0.4345	-0.1607	-1.55	0.122
inf5	0.0820	0.2923	0.0185	0.28	0.779
inf6	-0.4436	0.3221	-0.1017	-1.38	0.168
inf7 ***	1.0091	0.3790	0.2024	2.66	0.008
inf8	-0.2658	0.2973	-0.0604	-0.89	0.371
inf9	-0.1146	0.3205	-0.0259	-0.36	0.721
inf10	0.5198	0.4924	0.1084	1.06	0.291
_cons	0.6162	0.6454	0	0.95	0.340

***Statistically significant at *p*-value<0.01; **Statistically significant at *p*-value<0.05; *Statistically significant at *p*-value<0.1
For dummy variables dy/dx is for the discrete change from 0 to 1.

The main descriptive statistics show that 63.3% of the participant farms can be classified as innovative for sustainability, using the criteria previously defined. In relation to gender there is a predominance of men, as it happens in the population of organic farmers in both countries. The average age of participants is 46 years and average experience in organic farming is about 8 years, ranging between 0 and 36. Acreage has a great variability with values from 0.05 to 4000 ha. Most of the farmers are landowners and 34% of farms are typically household farms, employing only family labour. Marginal effects for all independent variable were evaluated at their mean. From the estimation results (success 72.3%) we can conclude that the dependent variables with significant effect on the probability of adoption of innovative sustainable strategies by organic farmers are: *country*, *gender*, *experience*, *acreage*, *lab2* and *lab3*, *irrigation*, *act* and *inf7*.

Looking at these outcomes in more detail, one may conclude that, other things remaining constant, Italian farmers are 26% more likely than Portuguese to adopt sustainable farming practices. The same applies to women who are significantly more likely than men to adopt such practices. Although in the limit of statistical significance, it is possible to conclude that earlier organic farming exerts a significant effect on sustainability practices. The coefficient is positive, confirming the dominant idea in the literature about conventionalisation of organic agriculture, but not large. For each year in organic farming, the probability of being "sustainable" increases less than 1%. Acreage is also significant, even though with an influence opposite of the expected. Ceteris paribus, the higher the acreage, the higher is the probability of sustainable practices adoption. Controlling for the other variables, the probability of a farm being sustainable is about 5% higher for each percentage point increase in the total agricultural area. In other words, large-scale producers are more likely than small-scale producers to apply diversity as a driver of farm management. Although opposing the conventionalization hypothesis, this result is not entirely unexpected, since traditional organic farming practices include, among other things, crop rotation, fallow and extensification, which requires additional agricultural area. In what concerns labour, results show that family farms are probably more innovative in sustainability. This probability reduces 13% when comparing farms that only rely on family labour to those that also employ hired labour and 17% when comparing the former with those that only employ hired labour. As expected, irrigation has a positive impact in the probability of innovate for sustainability, mainly because it allows diversification in spring-summer crops. The existence of other activities on farm also exerts a strong influence. Other things remaining constant, having such activities raises 23% the probability of an organic farmer to innovate with "sustainable" practices. To conclude, the model shows that farmers who have universities or other public services as one of their main sources of information have 20% higher probability of innovate for sustainability than others.

Conclusions

The model estimation gave important indication on the characteristic of organic farms that are more likely to innovate to increase their sustainability. A need to focus on the farmer much more than on the farm to look at value and principles emerge from the results. A particularly relevant result is related to the source of information that more influence the capacity to innovate of organic farmers. The role of universities and public advisory services represent a potential impact of innovation policies oriented to sustainability.

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Technical and economic feasibility of seabass fry production according to organic techniques

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Key words: economic feasibility, organic techniques, seabass fry

Abstract

Over the past few years, consumers have been increasing their awareness about environmental, health and safety concerns, gradually changing their habits in favour of organic food. In Europe, the organic aquaculture is legislated by Commission Regulation (EC) 710/2009. In Italy, only ten farms are involved in the supply of certified organic fish and only some pilot projects were carried out for organic farming of different species. Therefore, the purpose of this research was to evaluate organic technical feasibility and production costs, comparing them with conventional production. This study contains the first considerations about organic production and its relative costs for seabass fry, one of the most reared species of the country. Conversion to organic production naturally involves additional costs concerning the conversion process itself, the production of a new type of product and the lower output. In fact, results have shown that certification and feed costs represented the most significant difference between conventional and organic production..

Introduction

Over the past few years, consumers have been increasing their awareness about environmental, health and safety concerns and they have been gradually changing their habits in favor of organic food, controlled production chain and certified products. In aquaculture sector, the first legislative framework regarding the organic production in Europe was the Directive (EEC) 2092⁄91, which was replaced by the Directives (EC) 834⁄07 and (EC) 889⁄08 (EU 1991, 2007, 2008) and most recently by Commission Regulation (EC) 710/2009 (EU 2009). The Regulation aims to achieve a balance between the existing national rules and private schemes so as to give a minimum standard for organic aquaculture and seaweed products on the Community market. The chapter for aquaculture animals requires animal welfare conditions in husbandry and slaughter to be addressed (including maximum stocking densities). Total organic aquaculture production reached about 53,500 tons in 2009, accounting for about 0.1 percent of aquaculture production worldwide. Further production increases are foreseen. In the last five years market development has been slow because of a limited number of reliable organic seafood suppliers. This situation is changing right now for major products like salmon and shrimps. The number of certified organic aquaculture enterprises amounts to 240 in 29 different countries in 2009, most of them located in Europe where the lead product in organic aquaculture is Atlantic salmon, followed by the Mediterranean species seabass and seabream, freshwater salmonids (rainbow and brown trout, and charr species), and carp (IFOAM, 2010). In Italy, only ten farms are involved in the supply of certified organic fish and only some pilot projects were carried out for organic farming of different species (Castellini et al., 2012). On the other hand, Italy is a major producer of conventional seabass and seabream fry. In fact, in 2002 production was 95 million, of which 27 was exported mainly to Greece. Production is dominated by 3 large hatcheries which account for around 50% of production. There is an important sub sector in Italy which on-grows fry to fingerling size 10-15g (Final report, 2004). In addition, a number of companies have developed semi intensive methods of fry production, which give better quality at lower cost. Therefore, the purpose of this research was to define or verify the principal standards for organic seabass farming, evaluating technical feasibility and production costs, comparing them with conventional production. This study contains the first considerations about organic production and its relative costs for sea bass fry, one of the most reared species of the country.

Material and methods

The study was carried at Ittica Caldoli srl, a fish farm located in the Apulia region close to Lesina lake. The farm is able to cover the entire productive cycle for seabass and seabream species being characterized by a hatchery, pre-growing and on growing systems. For the project, the experiment was run using a breeding tank of a volume of 20 m³, at a stock density of 5 kg/m3 with an optimal ratio male-female, expressed in kg, of 3:7. The fertilized seabass eggs were then transferred into the collector placed outside the spawning tank

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having filters of 0.25 mm mesh. Egg incubation was carried out into a cylindro-conical hatching tank of 2 m³ volume for 48/72 h. Subsequently, larvae were divided and kept in 10 rearing tanks of 10 m³ volume for 58 days till weaning. Finally 6 circular tanks of 50 m³ volume were used as nursery and larvae kept at the maximum density of 15 kg/m3 till they reached the size of 2 g in order to be sold. Broodstock was feed with organic pellet twice a day for a total consumption estimated on a percentage of 1.5 of the body weight. Feeding protocol for larvae is characterized first by the use of rotifers (*Branchionus plicatilis*) in quantity of 5-10 organisms/ml and then by Artemia till they are transferred to the nursery. Here feeding rate on Artemia in the first 4-5 days is the same, since this is an adaptation period for the larvae to the new rearing environment. Artemia ration is linearly reduced until the fish is completely weaned over to the new diet on organic pellet.

Conversion to organic sea bass farming

In order to produce organic seabass fry, the farm has been certified by a private certification body (BIOS srl) on the basis of the guidelines established by Commission Regulation (EC) 710/2009. After an inspection to verify the rearing condition of the farm and analyzing all the documents, the farm passed through the conversion period of a length of 6 months. As required by specific regulatory framework, the farm applied low animal stocking density; use of good quality water with sufficient oxygen levels; use of temperature and light conditions in accordance with the requirements of the species; adequate flow rates and physiochemical parameters that safeguard the animals' health and welfare and provide for their behavioral need; use of organic feed products derived from sustainable managed fisheries; no preventive antibiotics or synthetic chemicals or hormones used; microbiological checking and applied organic fish processing process.

Production cost evaluation

Having ascertained the technical feasibility of organic fry production, the study went on to assess its economical feasibility. The cost-benefit assessment of conversion to organic fish production was carried out quantifying the costs of the different tasks (feeding, facilities, labour, broodstock, etc.). The cost of each task has been found with the direct costing technique by considering the effective use of resources and manpower at standard prices. Moreover, for each task we have considered and subsequently compared the costs of conventional production to the ones for the organic. Finally, considering the income from conventional sales obtained in 2012 from a production of 6,600,000 fry sold at a price of € 0.215, and estimating an approximated income from the organic sales at a price of € 0,256 we compared the profit between the two systems.

Results and Discussion

The percentage of spawned eggs was the 20-25% of female body weight with a percentage of fertilized eggs equal to 50%, thus the total number of produced eggs was 7,500,000. The survival rate of these items that reached the final size of 4 g was estimated at 20% resulting in an available quantity of 1,500,000 fry for sales. Conversion to organic production naturally involves additional costs concerning the conversion process itself, the production of a new type of product and the lower output. The analysis of the cost are shown in table 1, 2 and 3. The cost of maintenance and insurance for facilities and equipment as well as the depreciation charges did not show differences between the two systems (tab 1).Fuel and energy consumption are generally used for running seawater pumps, oxygenation and other machinery, vehicles and refrigeration plant. Labour costs in Italy mostly depend on characteristic of the level of labour required to manage the different production systems that are installed. Thus demands a high level of technical ability from the operators and often requires technical and engineering staff to be present or on stand-by 24 hours/day in case of mechanical failure, affecting total costs. Moreover, due to a longer production cycle in organic (200d vs 170d), fuel, labour, energy and oxygen cosnsumption resulted higher in organic production Certification and feed costs represented the most significant difference between conventional and organic production. Although the certification cost can be assumed as fixed price and total amount paid was only € 1,000 it should be taken into account that the certification body claims a percentage equal to 0.3% on the total sales of fry per year (table 2). Additionally, organic feed costs are mostly affecting the full production cost because world market prices of the raw materials are still high and only few feed companies sell organic aquafeed. Therefore, purchase conditions and discounts that might be negotiated with feed companies, are very limited. Analyzing the net margin in table 3, considering the output unit in order to have a realistic comparison, data shown a negative difference (-0.012€/fry) applying the organic system. Finally, the current market situation is characterized by a low demand for organic fish; an inadequate product differentiation from conventional (domestic or foreign) ones; a legislation still in progress; an unstructured and scarse offer for organic; which does not allow to consider organic aquaculture as an activity that today can assure adequate profitability for the most part of Italian aquaculture firms.

Table 1: Unit fixed costs of seabass management referred to a production of 6,600,000 fry (€)

Fixed costs	Organic and Conventional
Broodstock depreciation and insurance	0.000
Machinery and buildings depreciation	0.016
Machinery and buildings repairs and insurance	0.002
Interest rate	0.001
Total Fixed costs	0.018

Table 2: Unit variable costs of seabass larvae management referred to 2012 production of organic and conventional fry till a size of 4 g (€).

Variable costs	Conventional	Organic
Feeds	0.029	0.039
Energy, oxigen and fuel	0.085	0.114
Labour	0.031	0.043
Services	0.039	0.053
Certification	-	0.001
Interest rate	0.002	0.002
Total variable costs	0.187	0.252

Table 3: Conventional and organic fry unit costs and prices (€).

Variable costs	Conventional	Organic
Fixed costs	0.187	0.250
Total cost	0.018	0.018
Price	0.205	0.268
Net margin	0.215	0.256

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A functional agrobiodiversity approach to improve organic wheat production

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Key words: agrobiodiversity, composite cross population, cultivar, living mulch, organic farming, wheat

Abstract

Agrobiodiversity can improve organic and low-input wheat production, but a clear framework is necessary to translate scientific evidences into practice. Here we present results from a field experiment on common wheat, focusing on cultivar identity, genetic heterogeneity and on the inclusion of a legume living mulch. We conclude that selecting cultivar identities adapted to local macroclimate is crucial in enhancing yields, but this is not limited to modern pedigree cultivars. Old cultivars are, for example, better weed suppressors, and genetically diverse populations may better buffer climatic unpredictability. Living mulches do not always reduce wheat yield, but may reduce weed abundance

Introduction

Wheat is the leading crop for human nutrition in most temperate regions worldwide. Current yields are reported to be stagnating and dependent on external input supply (Brisson et al. 2010). In organic wheat growing, where environmental variation cannot be buffered through external inputs supply, changes in breeding and cropping systems design are necessary to ensure adequate and stable yields (Wolfe et al. 2008). The use of crop agrobiodiversity is thought to favour sustainable plant production (Newton et al. 2009) but there is an evident gap between scientific evidences and current agricultural practice (Ratnadass et al. 2012). This works aims at clarifying the impact of different categories of crop agrobiodiversity on wheat production and related agroecosystem services. These are (i) 'functional identity', i.e. the availability of adequate cultivars adapted to local environments and cropping systems, (ii) 'functional composition', i.e. the co-presence of complementary functional groups, and (iii) 'functional diversity', i.e. the use of genetically heterogeneous cultivars (Costanzo and Bàrberi, 2013).

Material and methods

As part of the SOLIBAM (Strategies for Organic and Low-input Integrated Breeding and Management) EU FP7 project, we compared common wheat (*Triticum aestivum* L.) cultivars and management systems representative of three categories of functional agrobiodiversity:

- Functional identity, represented by the identifying traits of cultivars with different geographic origin and breeding history;
- Functional composition, represented by the co-presence of wheat and a Subterranean clover (*Trifolium subterraneum* L. subsp. *brachycalycinum*) living mulch;
- Functional diversity, represented by the genetic heterogeneity of wheat crop population, increased by mixing cultivars or by sowing composite cross populations (CCPs), i.e. bulk progenies of half-diallel crosses between several parental genotypes, sown and re-sown season after season.

We carried out a field trial in 2010-11, 2011-12 and 2012-13 in the Centro Interdipartimentale di Ricerche Agro-Ambientali (CIRAA) of the University of Pisa (Italy). Experimental fields were part of a 5-year stockless rotation, with pigeon bean (*Vicia faba minor*) as preceding crop. Soil was an alkaline silty-loam at 5 m above sea level in the coastal plain of Tuscany (Italy), under a Mediterranean sub-humid climate with 900 mm average annual rainfall.

Wheat was sown either as a sole crop or with a subterranean clover living mulch. Living mulch was set up as an additive intercrop, by contemporarily sowing wheat and clover at the sole crop seed rates. Cultivars included a mixture of old Italian cultivars, an Italian pure line, a mixture of four Italian pure lines, a Hungarian pure line, two Hungarian and one British CCPs (Tab 1). CCPs were harvested and re-sown for the following season, upon an evolutionary breeding approach (Döring et al. 2011).

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Tab 1. Experimental factors and treatments

Factor 1: Wheat cultivar		Factor 2: Cropping system	
Cultivar Group	Cultivar name and provenance	Wheat only	Living Mulch
Old Cultivars	Mix of old cvs (IT)	450 seeds m^{-2}	450 seeds m^{-2} (Wheat) + 800 seeds m^{-2} (Subterranean clover)
Commercial Cultivars	Bolero (IT)		
	Mix of modern cvs (IT)		
	Mv Emese (HU)		
Composite Cross Populations (CCPs)	Elite CCP (HU)		
	Hungarian CCP1 (HU)		
	Organic YQ CCP (UK)		

We monitored wheat phenology and wheat canopy height periodically during the crop cycle. We assessed weed density in vegetative stages, weed biomass in vegetative and reproductive stages, grain yield and yield components. Data were analysed by ANOVA, as a completely randomised design in year 1 and as a randomised complete block design in years 2 and 3. Wheat cultivars were compared through orthogonal linear contrasts.

Sowing was delayed to mid-February in year 1 due to excessive autumn rainfall, resulting in suboptimal establishment and in a very short growing season. In contrast, in year 2 sowing was done in mid-October and climate was favourable to wheat growing. In year 3, the trial was also sown in mid-October, but continuous rainfall throughout almost the entire crop cycle caused severe diseases outbreaks and lodging.

Results

Mean wheat grain yield reflected the extreme climatic variability of the three trial years, being 1.04 t ha^{-1} in year 1, 4.04 t ha^{-1} in year 2 and 1.46 t ha^{-1} in year 3.

For functional identity, three main distinctions between groups of cultivars were possible: (i) old cultivars grew significantly taller than any other cultivar, (ii) Italian cultivars had an erectophile growth habit and faster growth during tillering stage, while foreign cultivars had a prostrate growth habit and slower growth, (iii) Italian cultivars had an earlier growth cycle than foreign cultivars. Italian pedigree cultivars were the best yielding in all three years, while the mixture of old cultivars was the least yielding in year 2.

For functional composition, presence of the living mulch reduced wheat yield by 30% in year 1 ($p = 0.008$) but had no significant effects in years 2 and 3. It also reduced early season weed density in year 1 ($p = 0.021$) and 3 ($p < 0.001$), and weed biomass at wheat flowering in year 3 ($p = 0.011$).

For functional diversity, CCPs showed a higher heterogeneity in plant height and heading time, compared to both pure lines and cultivar mixtures. Furthermore, CCP growth cycle was slightly longer than that of the Hungarian pure line. As all the tested CCPs were foreign, they tended to yield less than the commercial pure lines. However, except in year 2, the same pattern was also observed for the Hungarian pure line, suggesting that no important disadvantages in yield could be attributed to crop functional diversity (Tab 2).

Tab 2. Wheat grain yield: deviation of cultivar groups average from field average in each growing season

	2011	2012	2013
Italian commercial	+ 14%	+ 8%	+ 50 %
Hungarian commercial	- 6 %	+ 13 %	- 22 %
CCPs	- 7%	- 6 %	- 26 %
Treatments compared: significance of orthogonal linear contrasts			
Commercial vs CCP	ns	**	**
Commercial Italian vs Hungarian	ns	ns	**

* significant at P<0.05; ** significant at P<0.01; *ns* not significant

Moreover, considering within-field variation in yield of each cultivar, CCPs showed a consistently lower coefficient of variation across years than modern commercial cultivars (Tab 3). These evidences suggest that, despite their expected low fitness to the Mediterranean climate, functional genetic diversity of CCPs may result in an enhanced buffer capacity against environmental variation.

Tab 3. Within-field coefficient of variation (%) for yield of cultivar groups in each growing season

	2011	2012	2013	Mean
Italian commercial cultivars	41.1	15.8	26.2	27.4
Hungarian commercial pure line	39.5	17.9	62.6	40.0
CCPs	33.4	14.1	18.9	22.0

Discussion

This work allows to unravel the potential of different agrobiodiversity use strategies to improve organic wheat production. Cultivar local adaptation emerges as the most important determinant of yield performance. However, broadening cultivar choice and system management options would be crucial in the perspective of reducing external inputs, optimising ecological processes and adapting cropping systems to climate change. Our main outcomes are that (a) modern commercial cultivars adapted to local conditions are the highest yielding, while old, tall local cultivars are the best weed-suppressive, (b) including a certain amount of genetic heterogeneity can buffer unpredictable environmental variation, (c) including a legume living mulch can help suppressing weeds. However, the strategies analysed in this work need to be optimised. The use of different cultivar types, e.g. modern vs. old, should be embedded into local agroecosystems and societal needs. Functional diversity strategies, as the use of heterogeneous populations, need further testing, and the creation and wider distribution of CCPs for different climatic regions. This would in turn require innovations in seed regulation, which currently forbids trade and exchange of heterogeneous seeds. Functional composition effects, like those addressed by intercrops and living mulches, need improved component choice and technical optimisation of the system through adequate sowing densities and management tactics. We are currently working on optimising wheat cultivar mixtures through a functional composition approach, to facilitate the choice of component cultivars based on the combination of key phenotypic traits.

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Sustainability assessment of the farmers market - A case study in Tuscany

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Key words: Sustainability evaluation; agro-environmental and socio-economic indicators; farmer's market

Abstract

To assess the sustainability of the agricultural sectors of three farming systems of the Province of Massa (Tuscany, Italy) the analysis was performed on agro-environmental and economic aspects of 5 farms with different management systems: conventional and organic. The agro-environmental sustainability was measured through indicators of the soil, water, air and landscape-biodiversity. Economic indicators were carried out by detecting economic synthesis. The result shows that the analysed farms reach a good level of sustainability with regard to economic aspects and have positive impact on the environment in particular when managed as organic.

Introduction

In the 2011/12 University of Gastronomic Science conducted a rural development project named "Sustainability evaluation of agro-food products in the farmers market of Massa" (Tuscany, Italy). The general project objectives and UNISG role were the enhancement of agricultural and agro-food production and their connection with the short circuits of production/consumption. This farmers market has existed for 2 years, two days/week, 30 producers from the area, mainly organic, supported by the Province owner of the exposition space. In this paper we present the results of the first activities of this multidisciplinary project that consist in the sustainability assessment at farm level. We analysed the environmental sustainability by agro-ecological indicators and the socio-economic sustainability of the products sold at the market. Methodologies for assessing agricultural sustainability are many and use different matrices of indicators (Belle and Morse, 1999; OECD, 1999). Agricultural sustainability is a very complex issue as agriculture is multifunctional, multi scale and multi-issues terms and it need a multi-dimension and multi-criteria assessment and set of indicators. The results can be used by the policy makers in order to better plan the agricultural development of this area.

Material and methods

In order to fulfil the object of the research project, 5 farms have been identified among those participating in the farmers market in the centre of Massa (a small town in the north of Tuscany) representative of the area from three different production sectors potentially more interesting for the local development: 2 horticultural, 2 beekeeping, 1 livestock.

Agri-environmental evaluation

To assess the sustainability of farming systems with regard to agro-environmental aspect is adopted a methodology based on indicators of sustainability (Pacini et al., 2009; Migliorini and Scaltriti, 2012). The collection of farm information are captured through interviews with farmers, business documents and maps, estimates data during farm visits. To assess agricultural sustainability at farm level the following environmental subsystems have been identified: the soil system, the water and air system, the biodiversity and landscape system. For each subsystems different agro-ecological indicators are processed, aimed at evaluating a specific attribute of the system and its critical points. Each indicator is associated with a low (-1), medium (0) or high (+1) score which is derived from literature and adapted to the territorial context of reference (Table 2).

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Table 2: List of sustainability indicators identified for the various environmental systems, indicator description, unit measure (u.m.), low, medium and high levels of sustainability and relative weight (r.w.) (Migliorini et al. 2013)

ys te	Aspect	Indicator	u.m.	Low (-1)	Medium (0)	High (+1)	r.w.	%
Soil	Physical, chemical, biological fertility	Soil cover	%	<50	50-80	>80	16,67	100
		Crop rotation	year	<3	3-6	>6	16,67	
		Presence of meadows	%	<20	20-50	>50	16,67	
		Input of organic fertilizers	t/ha	<10	10-30	30<x>45	16,67	
		Green manure	n/year	<0,3	0,3-0,5	>0,5	16,67	
		Soil organic matter	%	<2	2-2,5	>2,5	16,67	
Water and air	Efficiency	Quantity	m3/m2	>3	3-2	<2	16,67	100
	Pollution	Pesticide	kg a.i./ ha	>20	5 - 20	<5	16,67	
	Alternative source	Recycling, rainwater utilisation	%	<30	30-50	>50	16,67	
	Quality	Nitrates in water	mg/l	>50	25-50	<25	16,67	
	Nitrous oxide (N2O)	Chemical nitrogen input	kg N/ha	>150	150-80	<80	16,67	
	Methane (Ch4)	Livestock intensity	LU/UAA	>2	1 - 2	<1	16,67	
Biodiversity	genetic	Local livestock breed	n	0	1	>1	16,67	100
		Local landrace of crop	n	0	1	>1	16,67	
	specie	crop specie	n	<6	6-20	>20	16,67	
		livestock specie	n	2	2-4	>4	16,67	
	Habitat and landscape	Wetlands	Mq	<500	500-1000	>1000	8,33	
		Hedges and rows	m/ha	<30	30-60	>60	8,33	
		Forest	% of UAA	<4	4-10	>10	8,33	
		recovery of dry stone walls	m	0	100-300	>300	8,33	

for beekeeping that do not have soil management, there is only one indicator of soil cover with 100% weight.

Socio-economic evaluation

We have analysed the economic aspects of same agro-food products present in the farmers markets of Massa (dairy, honey and horticultural). The parameters we analysed were production costs and gross income. The survey was conducted by visiting the farms and interviewing the farmers. The parameter "variable costs" concerns the costs of some farm inputs that are common to all the supply chains: pesticides, fertilizers, seeds, water and fuel; in the case of breeding we added costs for feed and pharmaceuticals products. The gross income is calculated by the simple multiplication of the amount of produce times the market price. The farmers markets include the shortening of the supply chain for the benefit of proximity between places of production and consumption.

Results

Figure 1 shows the overall result as the sum of environmental sustainability indicators in the three agricultural sectors (beekeeping, horticultural and livestock farms) and the two management methods (conventional and organic) converted to values -1 (bottom), 0 (medium) and +1 (high) multiplied by the weight percentage corresponding to the indicator. Please note that the extremes are -300 and + 300. The analysis shows that environmental sustainability of these 5 farms is medium strong (+56.66) with large differences for the environmental system (Fig. 1A). In particular, the sustainability of both soil system (+36.67) and water and air (+40.00) is positive, while it is slightly negative in the landscape and biodiversity system (-20). Among the three productive sectors (Fig. 1A), sustainability is strong in the honey (+139.16); medium in the livestock production (+6.65) and in the horticultural (-0.82). In particular, these results are influenced by the positive values on the soil and water and air systems by both beekeeping farms (organic and conventional). Discordant results are found in the two horticultural farms that get opposite values depending on the organic and conventional production method, respectively on the soil system (+33.33 and -50.00), on the water and air system (+60.00 and -20.00) and on the landscape and biodiversity system (-16.16 and -8.32) with an overall scoring of +76.67 and -78.32 in organic and conventional respectively. Results of the comparison between organic and conventional method, by adding the values of the farms (Fig. 1B), show that the first have a stronger environmental sustainability than the second (+75.55 vs +28.34

respectively). The data collected in the economic analysis shows a quite good situation. The dairy supply chain consists of small farms unable to develop economies of scale, but that takes advantage of the passion of part-time entrepreneurs, who use their time-off from their main occupation. Probably co-marketing actions could lead to economies in the distribution that is currently almost on time and carried out by the individual entrepreneur. The cost of production is found to 19.67 €/Kg which almost equals the selling price at the farmer market is about 20 €/kg. The production costs of honey are calculated as equal to € 10.88. Honey is on the market at different price (from 6 € a wildflower to the 10/11 € of acacia honey). For this reason, the only strategy for farmers is to pursue the highest quality, since only the quality can cover the production costs, which are particularly high due to the amount of manual labour required. The lettuce has been chosen as an example of the fruit and vegetable supply-chain, which is characterized by high level of products perishability. The production costs show that almost 70% of the costs to be represented by the manual operations (transplanting and harvesting). In the case of lettuce, profitability is quite interesting. The cost of production is in fact equal to 1.33 €/kg while the price, depending on variety, time and weather conditions may vary from 1,80 €/kg in rare cases up to 3 €/kg. Even in the case of lettuce direct selling is an exciting opportunity as it ensures the freshness of the product, but also provides an alternative to the large-scale distribution circuits.

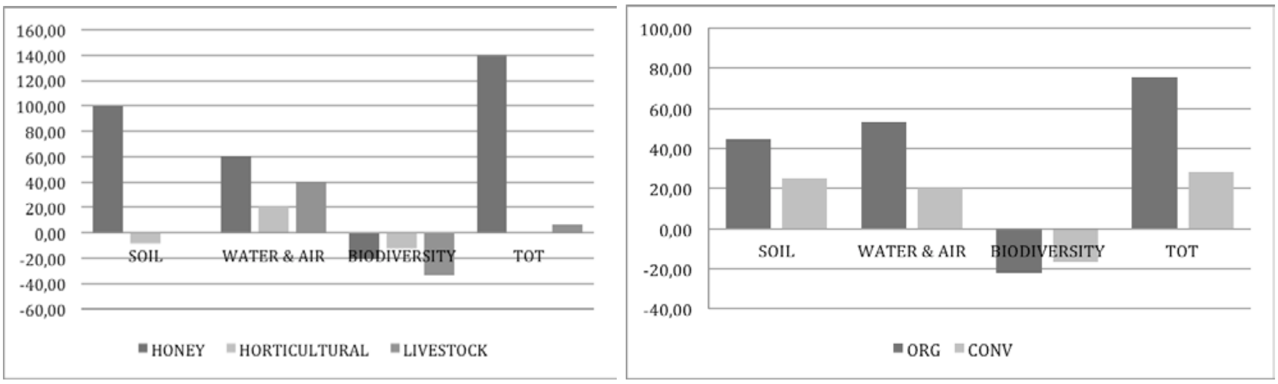

Figure 1. Sum of environmental sustainability indicators in (A) the three agricultural sectors (beekeeping, horticultural and livestock) and (B) in the two management methods. Con: conventional; Org: organic.

Discussion and Conclusion

The analysis of the environmental sustainability of agricultural farms of the farmers market of Massa showed good levels of environmental sustainability with differences depending on the system measured and on the production system. Beekeeping are better than livestock and horticultural sector and organic is better than conventional. The present work has shown that the profitability of agricultural food production is often threatened by market conditions that do not provide sufficiently remunerative prices of the factors of production, especially when it comes to labour intensive productions. Often this situation arises when the counterparty of agricultural producers is represented by large operators such as supermarket chains. In this framework an initiative as the farmers market of Massa represents a important alternative, which can be a place in which: a) producers are able to obtain an adequate price, with no mark-ups of the subsequent stages of the supply chain that are downloaded on to consumers; b) producers are able to communicate the quality of their product and to establish a direct relationship with its customers; c) consumers can enter into a relationship with the farmers and their products, overcoming information asymmetries and the criticality of long chain and very long.

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Organic in the local vs global antinomy

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Key words: organic, local, global, food chains, discourse analysis

Abstract

Increasing attention is paid by European citizens to food chain character, power relations and impacts. Distance travelled by food, its authenticity and identity, fairness in the value chain and information robustness on quality specifications tend to assume a growing relevance in both public perception and business organisation. A triennial multidisciplinary and multicriteria study, funded under the EU 7th Framework Research Programme, aims to assess the performance of local and global food chains against economic, environment, social, health and ethical dimensions.The present paper presents some results of the first part of the project, examining how organic foods and method of production fits in the local/global discourse, as emerging from an Italian literature review.

Introduction

Food is by definition ubiquitous as long as it accompanies the human being in his territorial colonization. Yet, its sourcing can largely vary depending on market structures and social, economic, environmental and political contexts and values. Food origins, both in geographic and value chain terms, can thus be hidden, mystified or glorified responding to peculiar interests and market pressures.

In modern societies purchasing habits give rise to an heterogeneous food basket with a miscellanea of (more) local and (more) global foods and ingredients (Bonanno and Constance. 2001; Coff et al, 2008; Holloway et al., 2007; Maye et al., 2007; Colombo and Onorati, 2013).Traditional agricultural societies, too, in their resilience strategies, have sometimes tilled crops in remote areas far away from villages (Diamond, 2012). Hence, the geolocalized food identity risks to become a spurious issue.

Every agricultural product is embedded in its farming system, but the whole value chain is at present questioned when meals reach the tables, as globalization is increasing awareness and concerns about anonymity of goods (Klein, 1999), including those who nourish the people. These aspects are highly debated in Italy where food cultures are notoriously loaded and verbally fed. The environmental and climatic "foodprint" adds additional topics in current narratives, as well as food affordability. The food industry and supermarket chains are thus beginning to operate new strategies, "relocalizing" foods, as these strategies also offer public relations opportunities.

The food business re-localization trajectory parallels a current of food-systems research holding that local food systems are preferable to systems at larger scales. This emerging narrative, termed by some authors as *the local trap* (Purcell and Brown, 2005; Born and Purcell, 2006), is countered by those arguing that scale is socially produced and that more attention should be paid to efforts aimed at pursuing the goal of social and environmental justice with a specific and more targeted agenda.

In this context, investigating the interaction between localness and models of production shows a particular interest.

As local is becoming not merely fashionable, but an effective market option for an increasing number of farmers and food businesses, the European Commission is eyeing at comparative impacts and efficiencies of local and global food system configurations[4], whose performance needs to be assessed against several criteria. The Glamur (*Global and Local food chain Assessment: a Multidimensional performance-based approach*) 3-year research project, ran by a Consortium of 15 partners of 10 European countries, addresses these issues with the aim to provide some evidence-based policy options and recommendations, based on comparative assessments of different food chain patterns in European and non-European countries.

Preliminary project results focus on perceptions in the public, scientific, market and policy arenas of local Vs global foods. To achieve some preliminary conclusion, several attributes, coding for emerging issues, expectations and key features around food systems, are identified in scientific and grey literature in association to each other.

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[4] EC FP7 Cooperation – Theme 2, Activity 2-2 Food, health and well being, KBBE-2-2-5 Environmental Impacts and Total food Chain; KBBE.2012.2.5-03: A comparative analysis of global versus local food supply chains

The present paper focuses on the attribute “organic”, highlighting frequencies of its occurrence, its interaction with other attributes and the related coalitions and dilemmas with the endeavor to explore how the “organic” character of food is addressed and framed in the Italian debate, within a local Vs global food chain perspective. Moreover, the paper aims at analyzing the relations as well as possible conflicts or contradictions that the organic “attribute” establishes with other relevant food chain features.

Material and methods

This study highlights how organic agriculture takes place in local/global narratives. An ample Italian literature review analyzes how the performance of food chains is perceived, defined and communicated in the public, scientific, market and policy spheres across a range of areas of impact, defined in the present study as dimensions (economic, social, environmental, health and ethical).
A desk-based analysis mapped 86 different suitable sources on the issues at stake, including media and potential stakeholders” house organs, each source being allocated to one sphere according to its prevailing profile. The public sphere mainly relates to mass media and web communication, the scientific focuses on peer reviewed articles on Italian food chains, the market sphere collects companies’ and product cartels’ statements, while the policy sphere gathers institutional communication or civil society organizations’ declarations and reports.
Sources were selected to ensure no worthless position duplications. Pertinent literature was analyzed through the screening of papers, documents and press releases to filter those focusing or addressing local and/or global food chains and issues. A total of 272 documents were examined and 50 attributes, organic being one of them, were finally retained and categorized.

Each attribute is classified within one of the five impact areas (the economic, social, environmental, health and ethical dimensions) and connotes characteristics relevant in terms of how global and local food chains performance is perceived. Attributes will be eventually translated into indicators with which the food chain performance can be assessed. At this stage of research, the whole set of attributes has been mapped enabling an in-depth analysis of each of them and their mutual relationship. In the present paper, the organic attribute is extracted and analyzed, highlighting frequencies of its occurrence, its interaction and coalition with other attributes, to determine how it fits in the Italian local Vs global food chains debate.

Results

The survey reveals a number of features arising from the local/global food chain comparison.

Frequency of the organic attribute

50 different attributes were mapped. Overall, they have been recorded 738 times across the five dimensions, as detailed in table 1.

Table 1: Frequency of attributes for each dimension

Dimension	Environmental	Ethical	Health	Economic	Social	TOTAL
Attributes frequency	180	172	137	130	119	738

A certain homogeneity in the distribution of the recorded attributes emerges among the various dimensions. The “environmental” dimension, where “organic” is positioned, prevails. The specific attribute “organic” has been recorded 27 times, accounting for 15% within the environmental dimension and for 3,7% in the overall set of attributes. “Organic” represents the third most recurrent attribute in the environmental dimension (following “GHG emissions” and “pollution”, and preceding “landscape preservation”). It is the eleventh most present the whole set of 50 attributes.

Interactions with other attributes and their dimensions

The interaction of “organic” with other attributes was further examined. There is a wide range of attributes to which “organic” has been related in the consulted literature. Yet, there is no frequent or constant combination among any of them: no strong pairs or twin attributes arise in the examination. The most frequent interaction “organic” shows with other attributes belongs to the environmental dimension, though this apparently contradicts existing literature on Italian consumers rationale in buying organic, more traditionally associated to health grounds (Bellini, 2011).

A map of interactions among attributes is given below, having "organic" as the core feature: attributes in the inner circle show stronger interface with "organic", as it emerges from the scrutinised documents.

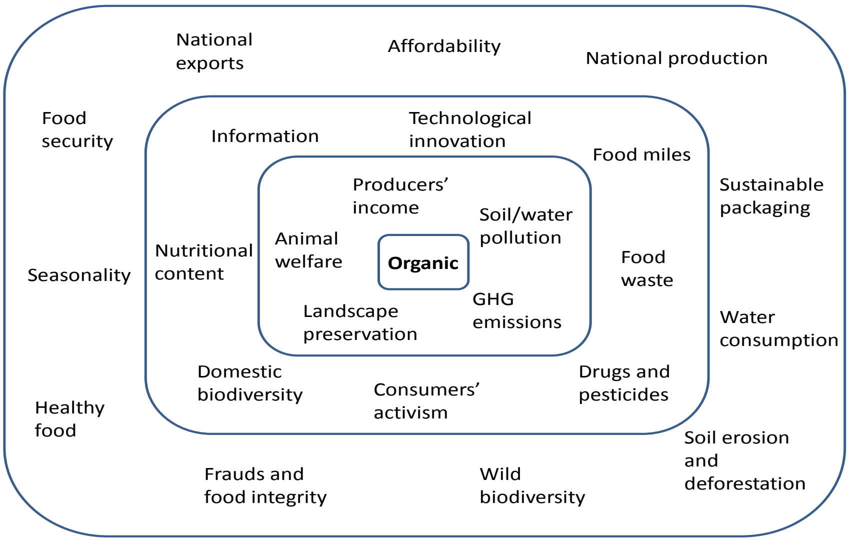

Figure 1. Map of interactions

Discourse analysis

A range of coalitions, dilemmas and contradictions with regard to the "local Vs global" food chain comparison arises from the textual analysis.

The "organic" attribute is highly associated to the local food chain configuration and the correlation always appears in a mutually reinforcing alliance. In the analyzed literature, local food chains are perceived as a synergic condition and a complementary option for marketing organic products. In this respect, local virtually always means short circuits, food activism and a thorough awareness among consumers, sometimes paralleled by farmers' consciousness and proactive involvement. Similarly, organic seems to ensure a further legitimacy to local foods and local food chains.

Various articles present or frame direct selling initiatives or similar short chain articulations associated to the organic production. They are regarded as the expression of a rich culture that cares about the environmental sustainability of food production and consumption systems, while ensuring affordability of organic foods (though the explicit association only emerges once). Overall, the duo local and organic comes forward as a strong alliance in the search of more socially just and environmentally friendly food chains. The increasing awareness of climate change impact and responsibilities provides additional relevance to this alliance, as shown by the liaison between "organic" and "GHG emissions" attributes, which often coexist in the same narratives. Their relationship is reinforced by considerations devoted to air freight and food miles concerns.

Environmental sustainability of the organic model of production is further highlighted by associations of the "organic" attribute with environmental, soil and water pollution alleviation or biodiversity protection. It is also assumed that consumers with stronger preferences for organic produce tend to reduce food waste in consideration of the higher overall value ascribed to organic products. The consulted literature, nevertheless, does not strictly associate these considerations to any local or global food chain configuration.

Local organic food chains are also seen as a viable economic alternative for farmers whose income is better secured in this sector than elsewhere, in a usually hostile market context.

The contexts in which organic production is discussed in relation to the global chains is maybe more complex and a weaker link between organic and global is found in the scrutinised Italian literature. Though limited, a liaison is observed when opportunities for organic Southern producers to earn a more decent living through a better remunerative export market are underlined. According to this perspective the increased attention paid in affluent countries to health and environmental sustainability issues could pave the way for developing countries and food chain actors to increase their exports.

Some scrutinised literature emphasizes consumers contradictory expectations. Naturality and typicality are incoherently looked for in conjunction with low prices, year-round availability and a-seasonality. In this sense, global chains and organic production can be seen as either conflicting or complementary features, when they meet demands by different consumers, or different demands by the same consumer groups. In a more hazardous dissertation, the organic method of production and GMOs are deemed as converging in scope and mutually supportive, though this is seen as a legitimizing trajectory for transgenic foods. In this very case, the narrative beyond this assumption can be described as technocratic when organic model of production is presented as suitable for sustainability, but unable to feed the world.

Health issues are regarded as highly important, though occurrences are relatively few. Exclusion of chemicals in the production method, no pesticide residues in the final product, higher nutritional value (though not necessarily substantiated with scientific references) and a generally improved attention to overall dietary patterns by organic consumers, ensure a positive trajectory to "organic" in literature. Yet, communicated health virtues of organic foods do not strictly suggest any specific link to local and global food chain differences in ensuring nutritional quality and safety. An exception is due to frauds occurring in the organic sector, potentially harmful for consumers, that are linked to longer and cross border value chains relying on (increasing) imports and weak certification rigour.

Ethical and social concerns seem to be well addressed by "organic", as shown by the positive correlation with animal welfare and food security, but no specific interaction is found with local or global patterns. A different consideration has to be made when the right to know and food activisms are considered: overall, issues related to certification credentials and trust among producers and consumers of local organic foods arise in the consulted literature.

Discussion

A strong coalition is found between organic, as a whole concept, and local/short food chains, often presented as binomial. Methods of production – and the organic sector as a development model, in particular – are reserved a place in the local Vs global antinomy, though not representing a dominant narrative.

The diverse length and complexity of food chains, their different and sometimes conflicting capacity to respond to public interests, or the dissimilar scale of their social and environmental impact, as perceived by media and stakeholders, are emerging discourses in Italy, with an increasing interest in the local-global food chain debate. At the same time organic, as a standalone topic, maintains its significant public and market trajectory, while also revealing an indicative positive correlation with the "local" narrative.

As the idea of "local foods" and/or "local food chains" have triggered mounting public interest, responding to various societal demands and anxieties, these aspects are only sometimes entwined with production techniques and processes worth and goals. Neglecting the socio-environmental link when it comes to choosing food and designing policies, the localized approach, *per se*, risks to be inconsistent with a genuinely sustainable and more socially-just agricultural model. Organic is thus sometimes seen as a potentially useful response to these contradictions.

Recalling the expression elaborated by the Italian politician Aldo Moro, the two distinct local and organic plots appear to be *converging parallels*.

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NOTE: the scrutinized literature is available at www.firab.it

Reduced tillage and cover crops in organic arable systems preserve weed diversity without jeopardising crop yield

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Key words: cover crops, green manures, ploughing, reduced tillage, weed abundance, weed diversity

Abstract

Environmental concerns are pushing organic farmers to substitute ploughing with reduced tillage but weed management under reduced tillage can be troublesome. One objective of the TILMAN-ORG Project is to improve weed management with reduced tillage ± cover crops without reducing weed community diversity. This paper reports results obtained in 2012 in 13 long-, mid-, and short-term trials scattered across Europe including winter cereals, maize, grain pea, potato, sunflower and grass/clover or legume leys. Long- and mid-term experiments showed higher weed abundance under reduced tillage but usually without reduced crop yield. Short-term trials showed that reduced tillage system may be troublesome to manage right after the conversion from ploughing, due to higher abundance of weeds and volunteer crops and reduced yield. Interestingly, there was no overall consistent relationship between weed diversity, always higher under reduced tillage, and crop yield.

Introduction

Organic farmers commonly keep weeds under control by ploughing and post-emergence mechanical methods. However, organic farming is facing increasing pressure towards substitution of ploughing with more environmentally-friendly methods like reduced tillage. Weed management, especially of perennial species, is expected to become more challenging in organic systems based on reduced tillage. Nevertheless, diversification in the cropping system based on targeted combinations between reduced tillage, cover crops and direct weed control should reduce weed abundance to a minimum.

One of the objectives of the TILMAN-ORG Project is to improve weed management under conservation agriculture (reduced tillage and/or cover crops) in organic arable systems while maintaining weed community diversity. This paper summarises the results on (1) weed abundance, (2) weed diversity and (3) crop yield obtained in the first year of the project (2012) in 13 trials scattered across Europe.

Material and methods

The 13 trials are based on different approaches (e.g. system *vs* reductionist trials), crops, factors, treatments and histories. They include 5 long-term (>7 years), 4 mid-term (3 to 7 years) and 4 short-term (<3 years) experiments, located in Austria, Estonia, France, Germany, Italy, Luxembourg, Spain, Switzerland, the Netherlands and the UK.

The crops included in the trials are winter cereals (barley, wheat, oats and spelt), maize, grain pea, potato, sunflower and grass/clover or legume leys. Some of the trials include both tillage (usually ploughing *vs* reduced tillage) and cover crop (species comparison) factors, whereas others include only one of the two factors.

Weed data (density and/or cover by species) are collected at key growth stages in both cover and cash crops. Crop yield and yield components are collected in all trials. Both weed and crop data are collected upon a commonly agreed sampling protocol.

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Data of the 2012 growing season are here summarised by typology of trial (long-, mid- or short-term experiments). Based on ANOVA results, trials were classified in three categories, regardless of their duration: those in which data in the ploughed treatment were significantly (a) higher or (b) lower than in the reduced tillage treatment(s), and those in which (c) there was no significant difference between tillage treatments. Attribution of trials to one of these three categories was done for weed abundance, weed diversity and crop yield data. A chi-square test for equivalence of sample distribution among categories was then performed. This analysis was not done on trials including only the cover crop factor due to their limited number.

Results

Long-term trials

In the Italian system comparison trial weed cover and/or biomass were generally higher in the organic system (including a green manure crop) than in the conventional system, although this difference was not always significant. Higher weed abundance did not turn out in lower wheat yield. The Italian cover crop trial showed no significant differences in weed abundance and composition at the termination date of cover crops but cover crop species influenced weed community composition. Total weed cover and biomass before harvest did not differ among treatments.

In the Austrian trial grain yield was very low irrespective of treatments due to seasonal drought, and did not differ between tillage systems. Before harvest, weed cover and biomass were low and nearly equal between ploughing and reduced tillage. The latter showed higher weed species richness with more perennials and grasses.

Dry weather also affected the Swiss trial, where establishment of the grass-clover ley was suboptimal. In the first two cuts, the proportion of clover in the sward was higher in the plough than in the reduced tillage treatment, where weed biomass was higher.

In the French trial very superficial tillage and reduced tillage had higher weed infestation and consequently lower undersown alfalfa biomass at wheat harvest. Weed diversity was also higher in these two treatments. Wheat yield was lower in the reduced tillage system and higher with shallow than deep ploughing.

Mid-term trials

In the Estonian system experiment weed presence was strongly influenced by green manure crop, rye being the most suppressive one and ryegrass the least. This had a carry-over effect on weed density in the next pea crop. Perennial weeds dominated in red clover.

In the UK trial reduced tillage significantly improved crop establishment. There was no grain yield difference between ploughing and reduced tillage (Ecodyn) in spring crops but 50% lower winter rye yield in the latter, probably because Ecodyn performed better under dry spring sowing conditions. Weed cover was higher in reduced tillage only at an early stage. Density of dicotyledonous species was higher in reduced tillage.

In the German trial the highest weed cover was found in the reduced tillage system (stubble cleaner). Alfalfa + plough was the treatment which had the lowest weed cover and biomass. *Lolium perenne*, *Sinapis alba* and *Vicia sativa* were the most suppressive green manure crops. Wheat grain yield was significantly higher in the alfalfa + plough system and after *V. sativa*. Instead, the *L. perenne* green manure reduced wheat yield.

In the Dutch trial there were hardly any perennial weeds, even in non-inversion and minimum tillage plots, likely due to the relatively high share of root crops in the rotation, leading to intensive soil cultivation. Tillage systems did not influence neither potato nor spring wheat yield. In spring wheat, weed density did not change upon tillage system. Undersown white clover did not establish well in the plough treatment compared with minimum tillage, whilst non-inversion tillage showed intermediate values. This was probably due to suboptimal working depth of the sowing implement under looser ploughed soil.

Short-term trials

In the Luxembourg factorial trial ploughing gave highest grain yield and better weed control compared to the stubble plough and the non-inversion system (disc harrow). No significant differences were found between the two reduced tillage methods.

In the Spanish trial spelt yield was enhanced (13%) by fertilisation with composted farmyard manure but was unaffected by tillage type. Total weed density early in the season was lower with ploughing. Later in the season, and without post-emergence mechanical weed control, weed biomass was only lower in fertilised ploughed plots.

In the German trial weed cover was lower in the plough system and higher in the direct drilling system. Direct drilling and mulching + drilling had less numerous but taller weeds than chisel and plough systems. However, weed cover was so high in direct drilling and mulching + drilling (from 60 to 90%) that all plots under direct drilling x common vetch (*Vicia sativa*) and mulching + drilling x common vetch treatments could not be assessed any further. Common vetch was the only green manure species capable to suppress weeds to some extent under reduced tillage. This was also the green manure treatment which gave the highest oat yield but yields were acceptable in all plots (from 4 to 6 t ha^{-1}). Chisel + common vetch resulted in the highest yields, whilst plough + white mustard and chisel + white mustard in the lowest.

Pooled results of all trials showed that tillage system influenced all three parameters but differently (Table 1). Reduced tillage increased weed abundance but did not diminish crop yield in a significant number of trials. Weed community diversity was also significantly increased by reduced tillage.

Table 1: Number of trials in which weed abundance, weed diversity or crop yield were significantly higher, equal or lower in ploughing (PLO) *vs* reduced tillage (RED), with observed chi-square (X_2) values, number of cases (n), degrees of freedom (d.f.) and probability (P) of equal distribution among the three categories

Parameter	PLO>RED	PLO=RED	PLO<RED	X_2 (n, d.f.)	P
Weed abundance	0	2	7	8.67 (9,2)	0.013*
Weed diversity	0	1	5	7.00 (6,2)	0.030*
Crop yield	5	11	0	11.38 (16,2)	0.003**

*, **significant at P≤0.05 and 0.01 respectively

Discussion

Long- and mid-term experiments showed a trend towards higher weed abundance under reduced tillage. However, this often did not turn out into lower crop yield. Overall, it was evident that proper weed management over the whole crop rotation can compensate for suboptimum results in one course. The German mid-term trial showed that consistent good results in both weed suppression and crop yield can be attained by optimum crop sequence/tillage system/ green manure combination. Wheat yield components often differed between ploughing and reduced tillage without influencing grain yield. This indicates high phenotypic plasticity and consequent buffer capacity of the cereal crop. There was no consistent relationship between weed diversity, always higher under reduced tillage, and crop yield. Short-term trials showed that reduced tillage system are often troublesome to manage right after the conversion from ploughing, resulting in higher abundance of weeds and volunteer crops and reduced yield.

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The organic aquaculture sector in Italy: a Delphi evaluation of the market potentialities

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Key words: organic aquaculture, market survey, Italy, Delphi method.

Abstract

The paper draws out the possibilities of development and increase of organic farmed fish in Italy, evaluating both technical and economic aspects, for breeding, market, political, regulatory and environmental issues. The survey has been conducted using a well-known foresight methodology, the Delphi technique, with a panel of national experts. The analysis offers interesting insights and useful suggestions addressed to the organic aquaculture sector. Authors chose Delphi methodology according to the paper's objective: the study is in fact aimed at exploring the evolution dynamics (positive or absent) for a less-developed market like the one of the Italian organic fish. This method allows to create a forecast by collecting and evaluating experts' opinions about the organic fish market; these experts are divided in homogeneous groups and selected as privileged observers of the phenomenon. Expert panel suggestions are worthy of consideration as a contribution to improve and to subsidize organic aquaculture, that may be further sustained by scientific research and technologic innovation.

Introduction

It is a relatively common and shared opinion that aquaculture will have an important role in satisfying a steadily increasing demand of fish, since quantities potentially caught in the wild have nearly reached their absolute limit. Aquaculture seems therefore to promise abundant resources for the production of food and may also play a key role in reducing the current exceeding pressure on overburdened wild fisheries.
The paper draws out the possibilities of development and increase of organic farmed fish in Italy, evaluating both technical and economic aspects, for breeding, market, political, regulatory and environmental issues. The survey has been conducted using a foresight methodology as the Delphi technique, in three rounds with a panel of national experts.

Material and methods

The Delphi method has an exploratory approach towards a subject and for its nature it can be ascribed to the category of semi-quantitative foresight methods. Into this wide methodological framework, Delphi technique is placed in the sub-category of methods based on information coming from rational judgements and viewpoints of experts and commentators (Popper, 2008). It is mainly used for surveying the potential of a well-defined market or demand.

Authors chose this methodology according to the paper's objective: the study is in fact aimed at exploring the evolution dynamics (positive or absent) for a less-developed market like the one of the Italian organic fish. This method allows to create a forecast by collecting and evaluating experts' opinions about the organic fish market; these experts are divided in homogeneous groups and selected as privileged observers of the phenomenon (Molteni et al., 2007). Due to this feature, Delphi technique is characterized for being subjective but in some cases this aspect can be limited by weighting experts' opinions.
Information are collected through an iterative procedure. Three rounds were carried out with the aim of collecting judgements and viewpoints; it was developed an appropriate questionnaire for each round. The first questionnaire is used to define boundaries of the field of study and some general characters; the second one explores in depth the central theme drawing information and elements from the 1st round questionnaire, following the analysis of the answers; the last questionnaire should allow to complete the forecast whose examination should offer suggestions and indications to outline strategies for this sector.

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Contemporarily the experts panel necessary for the survey has been composed. It included 5 categories for a total experts number equal to 20; this is the precise composition: producers, fish chain operators, technologist, policymakers and market scholars.
Regarding producers group, it should be said that some of them had to forcibly be removed because they have recently given up on this production, mainly due to the scarce economic returns obtained.
It was not made any attempt to reach a consensus, conversely it has been respected any case of polarization, because it requires more investigation being in constant evolution and it is not possible to give a clear definition of it. Diverging issues can be studied in the future by the use of different techniques and methodologies.

Survey coverage has been at national level, choosing witnesses working in several areas of Italy.
The first questionnaire included six broad open questions requiring narrative response about: 1) hurdles/strengths of the organic fish production process; 2) market potentialities of organic aquaculture products; 3) consumers' behaviour towards organic fish; 4) firms' marketing strategies 5) hurdles/strengths of the regulation framework; 6) the role of the Italian Institutions in organic aquaculture value promotion. The obtained responses have been registered and analyzed and the results will represent a useful feedback in order to prepare the questionnaire for the second round. This will be different since the first one and it includes a set of closed questions.
At the end of the second round, the Authors will evaluate the need of a third round of the survey.

Results

In Italy, in spite of economic crisis and the drop in spending in food sector in general (ISMEA), in recent years production and consumption of organic products have shown a rapid growth. ISMEA emphasizes that the expansion of organic sector is confirmed by the increasing of certified operators: 49,709 in 2012 among producers, processors and distributors, an increase of 3% on annual basis; there has also been a growth of organic sales shops (BioBank), for a total amount of 1,270 in 2013 (more than 5% compared to 2012).
According to Nomisma data, in 2012 the weight of organic food consumption was 1.45% of the total food consumption expenditure while the total organic food expenditure stood at €2 billion (+6.7% compared to 2011.

Moreover, the performance of Italian export of organic products in 2011 shows a positive trend: more than € 3 billion that represent more than one third of Italian organic turnover (ISMEA).
In 2009, the whole production stood around 53,500 tonnes, mainly concentrated in some European countries (Germany, Great Britain, France and Switzerland). This quantity represents about 0.1% of the global aquaculture production and about 0.26% at European level (IFOAM 2010). Species that are most commonly bred through organic processes are salmon, trout, crayfish, sea bass and sea bream. In Italy this market is basically nonexistent: in 2012 there were 21 organic aquaculture companies mainly located in the north central part of the country (SINAB, 2012). Furthermore, the import/export organic fish products proved to be irrelevant or nonexistent.

The Italian organic aquaculture sector, pointed out by the results from the first round of the Delphi methodology, is still confuse and not so advanced and, moreover, full of difficulties and unsolved hedges; for more detailed information on them, Authors push back to the edited paper.
Below is a synthetic framework of the results:

- **productive process**. The principal hedges are linked to: the reproduction phases of some species; the technical management of the farm; the application of organic production basics and requirements); the organic fry and feed supply issues; production economic competitiveness achievement and maintenance

- **regulation and legislation**. Still recent and to be refined; Regulation (EC) No. 710/2009 shows some technical difficulties and contrasts: conversion rules have to take in account the extreme diversification of the sector, in terms of breeding species, and link them to the entire biomass and not to the animal age; organic fry use is considered a strong constrain due to the lack and inconsistency of availability in domestic market;

- **firm profitability**. The overload of bureaucracy in authorization issues added to the process difficulties strongly weighted on the productive costs; animal density is particularly felt as a problem and it is linked to low profitability;

- **market opportunities**. There are opposite opinions among interviewed: some consider there are no or scarce chances for market development due to the high prices in the consumer's market for both fresh and processed organic fish, due to the mark-up in the final phases of the supply chain. Moreover the situation is affected by problems in the post-capture management (differences in capture and processes tools; commitment of different transport platform for organic products; low diffusion of specialized and fresh fish equipped shops. Some other consider that organic fish may have good market opportunities because it fights the consumer's opinion on farmed fish (fat, unsafe, etc.) and may be perceived as substituted product of captured fish, especially in a long period view, where the decreasing wild fish stock will cause an increase of its price, leaving market possibilities to organic fish product closer to it than the farmed one. Nevertheless producers assert the quality of the Italian conventional reared products and so consumers don't feel the usual organic products appeal and buy them only according their sensibility for environment and animal welfare;

- **marketing strategies.** About marketing strategies that have to be implemented we have to underline the convenience for producers to choose direct sales channels, to adopt price policy, to enforce accurate and complete communication plan to inform and make consumers aware about organic fish environmental and ethic value, and about its special characteristics and brand awareness. Further strategies may be represented by chain agreements to perform "ready to eat" products and to foster competitiveness through innovations. The distribution net represents a nodal point: it has to be competitive, to contribute to organic fish valorisation and sometime it consists of a small number of operators;

- **Institutions.** A basic role is attributed to Public institutions (PI); PI have: to improve organic fish knowledge level at a starting phase , and, than, according to new PCP mandate, promote aquaculture; to focus national policies on diffusion of organic aquaculture and, on the other side, address regional policies to drive local development and strengthening of the sector. PI may work on several level: downsize bureaucracy for producers, improve quality check to protect consumers, control external audit authorities' amount and quality, fulfil new actions for organic aquaculture sector development by conversion of FEP subsides towards organic aquaculture, foster cooperation among producers, promote organic fish image and its use in school dining hall.

Discussion

Even if organic sector represent a market segment of limited size, it is possible to say that it is no more a niche. The reasons for this expansion lie either in a better organization of supply, and in the growing attention of consumers to issues linked to welfare and food safety.

Within that general frame, the production of food through organic aquaculture seems to be a very important tool in order to supply a market segment which consists of safe and certified products, since the main purposes of organic practices are namely the improvement of food quality and of its safety, by implementing environmental friendly processes.

It is important to reflect on the fact that some interviewed experts emphasize the importance to promote scientific research and studies focused on organic aquaculture in order to favour the sector development from a technical point of view and the consumers' knowledge. Furthermore, reflecting on the survey's results, the experts appear quite worried for EC Reg. 710/2009 application: in fact it could cause higher costs for the producers and trade expenses. The difficulty of placing the products on the market is related to packaging and the compliance with organic certification standards along the supply chain.

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The Level of Trust and the Consumer Attitude toward Organic Vegetables: Comparison between Japanese and German Consumers

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Key words: consumer attitude, consumer characteristics, buying behaviour, trust, organic vegetables

Abstract

This study examined the differences in the consumer's attitude toward and the buying behaviour of organic vegetables in Japan and Germany through two online questionnaire surveys, and tested if the level of trust was related to such differences. The study found that the average level of trust was higher for the German samples when trust was measured by the question items related to organic vegetables (OVT), while the Japanese samples exhibited higher trust when it was measured by the scales of "general trust" (GNT). Both scales of trust were confirmed to be related to the attitude and buying behaviour of organic vegetables including purchase frequency, consumption intensity, and benefit evaluation. OVT was also shown to be associated with the consumer's choice of the channel by which they shop for organic vegetables.

Introduction

It has been a puzzle that the Japanese organic market grows at a much slower rate than in the Western industrialized countries, despite the strong purchasing power. One possible reason for the difference is the gap in the intensity of the sales of organic foods by supermarket chains that have played a major role in expanding the organic market in Europe (Padel and Midmore 2005). When considering the factors that affect the consumers' choice of the channel by which they purchase organic foods, we need to pay attention to the factors related to the credence attributes of organic foods in addition to the factors that applies to foods in general. Since the information that the consumers receive is imperfect, organic foods requires greater efforts to build trust between sellers and buyers than conventional products. Where consumers favour to form trust through transaction experience rather than via certification, there is less possibility of success for a supermarket's entry into the organic business. This study examined how the level of trust was related to the consumers' attitude and buying behaviour of organic foods.

Material and methods

Traditionally, trust between consumers and producers is formed through past transaction experience, but the introduction of the certification system of organic products has enabled the parties to externalize the trust-formation process from their business relationship. In so doing, conventional supermarkets can now handle organic foods by "purchasing" the trust formed through certification, as Zucker (1986) put it, which has probably lowered their transaction costs.

However, whether the certification system to work effectively depends on the preference of consumers on the method of trust formation. If the certification system fails to provide consumers with the sufficient degree of assurance, such market would have to rest on the traditional trust-formation methods, preventing the society from wider adaptation of labelling and subsequent expansion of organic food market. Therefore, it would be natural to consider that the difference in the way consumers form "trust" plays certain roles in the consumers' channel choice.

In this study, two online questionnaire surveys, one in Japan and the other in Germany, were conducted in March 2012 to see the situation of the consumer's attitude and the buying behaviour of organic vegetables, and to measure the level of trust. Some 1,500 and 1,000 samples were collected in Japan and Germany, respectively. All respondents were household food shoppers including singles and non-organic consumers, and were urban residents.

The level of "trust" was measured by asking: 1) five arbitrary questions related to organic vegetables (OVT); and 2) five questions suggested by Yamagishi (1999) as the scales to measure a person's general tendency to trust (GNT). Respondents were asked to rate the degree of agreement by 7-point Lickert Scale, and greater points in positive questions were interpreted to be "more trusting" tendency, and greater points in negative questions were taken as "less trusting (=suspicious)" tendency. When comparing the sum, points in negative questions were reversed; i.e., points 1, 2, 3 were replaced with 7, 6, 5, and 5, 6, 7 were replaced

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with 3, 2, 1; so that the greater sum indicates the higher level of trust. Having “higher level of trust” means that the person makes an assumption that he/ she can trust others in general, under the circumstances that he/ she does not know who are the others and cannot observe others’ actual behaviour ex ante.

Based on the collected data, several comparisons between the Japanese and German samples were made. Firstly, to examine there is truly the difference in the degree of market penetration of organic foods, consumer’s attitude toward and buying behaviour of organic vegetables in each country were compared. Secondly, to see if German samples shows higher level of trust than the Japanese samples, average points of 7-point Lickert scale, as well as sums of the points of the question items included in the level of trust (OVT and GNT) were compared. Finally, the respondents were categorized into three groups according to the level of trust: “high,” “medium,” and “low,” and the results were cross tabulated to see the relationship between the level of trust and the consumers’ attitude and buying behaviour of organic vegetables. Results were tested by the test of independence and were compared between Japanese and German samples.

Results

a) Consumers’ attitude and buying behaviour of organic vegetables

As indicated in Table 1, organic vegetables were more easily available, and the proportion of regular buyers was greater in Germany than in Japan. While 89.9% of German consumers could access to organic vegetables at the retail stores that they usually make their grocery shopping, only 43.4% of Japanese consumers reported that they could do so. The proportion of respondents who purchase organic vegetables at least once a month (hereinafter called “organic consumers”) is 62.9% (n=629) for Germany, and 46% (n=683) for Japan. However, the ratio of the amount of organic vegetables in the entire vegetable consumption in a month did not differ much and the difference was not statistically significant. In both countries, more than half of the organic consumers chose supermarkets as the most important channel to source organic vegetables, but what came in the second place significantly differed: it was farmers market and specialized stores in Germany, whereas it was home deliveries in Japan.

German respondents showed more favourable attitude toward organic vegetables. When compared by the average points of the 7-point Lickert scale with which respondents evaluated the benefits of the organic vegetables, German samples showed significantly higher average in three of the four items. However, Japanese samples showed significantly higher average for the evaluation on “safety.” Although caution is required when comparing stated data based on the subjective interval, the tendency that the Japanese consumers pay attention to “food safety” more than other aspects of organic vegetables would deserve attention.

Table 1: The attitude and buying behavior of organic vegetables

Category		Germany		Japan		
		n	%	n	%	
Availability of organic vegetables at the stores where the respondents use for the daily grocery shopping [a]		899	89.9	651	43.4	**
Ratio of organic vegetables consumed in a month [a]	Less than 40%	783	78.3	1,238	82.6	-
	40% or more	217	21.7	262	17.4	
Frequency of purchasing organic vegetables [b]	Less than once a month	629	37.1	683	55.0	**
	Once a month or more	371	62.9	817	46.0	
Most important channel to purchase organic vegetables [b] (organic consumers only)	Supermarkets	403	64.1	402	58.9	**
	Specialized stores	82	13.0	88	12.9	
	Home deliveries	11	1.75	99	14.5	
	Farmers Market	82	13.0	23	3.7	
	Other	51	8.1	71	10.4	
		average points of 7-point Lickert scale				
Benefits of organic vegetables (average points of 7-point Lickert Scale) [c]	Protect environment	5.03		4.65		**
	Improve health	5.32		4.60		**
	Safe to eat	4.74		5.21		**
	Tasty	5.37		4.70		**

** significant at P<0.01, * significant at P<0.05, - not significant.
[a] tested the difference by Z-test, [b] tested the difference by Chi-squared test, [c] tested the differnce by t-test

b) Comparison in trust levels

As shown in Table 2, average aggregated points for trust related to organic vegetables (OVT) were higher in German survey, and those for General Trust (GNT) were higher in Japanese survey, and it was hard to determine which population were more trusting. Out of five questions, average points for some questions were higher in German survey, and others were higher in Japan.

With regard to OVT, German consumers were appeared to be more suspicious at the honesty and selflessness of producers and/ or sellers. In contrast, more Japanese consumers doubt the fact the organic production was technically possible. As for GNT, Japanese consumers tend to think themselves have trusting characteristics and believe most people were basically honest. German consumers, on the other hand, considered most people were friendly and kind, more than the Japanese consumers did.

Table 2: Comparison of the level of trust between Japan and Germany (t-test)

	Question items	Average points		
		Germany	Japan	
Trust related to organic vegetables (OVT)	1. It's impossible to produce vegetables without pesticides or chemical fertilizers	2.54	3.67	**
	2. Many vegetables in market are falsely labelled as organic	5.05	4.68	**
	3. Organic vegetables are sold at unreasonably high prices	4.94	4.17	**
	4. Most people would purchase organic vegetables if they are sold in the nearest stores	4.08	4.01	-
	5. It is foolish to buy organic vegetables	2.99	2.59	**
	Sum of the points	23.34	22.58	**
General Trust (GNT)	1. Most people are basically honest	3.75	4.10	**
	2. Compared to average person, I tend to trust others more	3.72	4.53	**
	3. Most people are friendly and kind	4.40	4.29	*
	4. Most people trust others	3.90	3.98	-
	5. Most people are trustworthy	3.79	3.87	-
	Sum of the points	19.56	20.77	**

** significant at P<0.01, * significant at P<0.05, - not significant.

c) Relationship between the level of trust and attitude/ buying behaviour or organic vegetables

Sum of the points for OVT and GNT was normalized so that each scale has zero mean and the variance of 1. Each individual was categorized into three groups: "high" if $x \geq 0.5$, "medium" if $-0.5 \leq x < 0.5$, and "low" if $x < -0.5$ (Table 3). Number of respondents for each category was summarized in Table 3.

As shown in Table 4, trust levels measured by OVT and GNT were significantly related to the consumption ratio, purchase frequency, and benefit evaluation. Respondents with high level of trust in both scales tend to consume more organic vegetables, purchase more frequently, and evaluate the benefits of organic foods highly. Also, as shown in Table 5, higher level of OVT was related to the consumers' choice of the retail channel for organic vegetables. As against the expectation, however, the ratio of respondents who chose supermarket as their main channel to purchase organic vegetables was greater for the "low" OVT category; i.e. the higher the OVT, the greater the possibility of farmers market, specialized stores and home deliveries to be chosen as the main channel to source organic vegetables.

Table 3: Categorization by the level of trust

	OVT				GNT			
	Germany		Japan		Germany		Japan	
	n	%	n	%	n	%	n	%
high	347	34.7	478	31.9	297	29.7	428	28.5
medium	334	33.4	471	31.4	445	44.5	679	45.3
low	319	31.9	551	36.7	258	25.8	393	26.2
n	1000	100.0	1500	100.0	1000	100.0	1500	100.0

Table 4: Relationship between the level of trust and the attitude/ buying behavior of organic vegetables (Chi-squared test)

		OVT		GNT	
		Germany	Japan	Germany	Japan
Ratio of organic vegetables consumed in a month		**	**	**	**
Frequency of purchasing organic vegetables		**	**	**	**
Benefits of organic vegetables	Environmental protection	**	**	**	**
	Health improvement	**	**	**	**
	Safe to eat	**	**	**	**
	Tasty	**	**	**	**
Most important channel to purchase organic vegetables		**	**	-	-

** significant at P<0.01, * significant at P<0.05, - not significant.

Table 5: The most important channel to purchase organic vegetables by OVT category

	Germany						Japan					
	low		medium		high		low		medium		high	
	n	%	n	%	n	%	n	%	n	%	n	%
Supermarkets	79	77	158	71	166	55	119	71	130	61	153	59
Specialized stores	10	10	23	10	49	16	20	12	19	9	49	13
Home deliveries	0	0	4	2	7	2	16	10	36	17	47	14
Farmers market	10	10	23	10	49	16	3	2	7	3	13	3
Other	4	4	16	7	31	10	10	6	20	9	41	10
Total	103	100	224	100	302	100	168	100	212	100	303	100

Discussion

This study attempted to explore a possible explanation for the slow growth in organic food market in Japan, by employing the theory of "trust." The study found that the average level of trust was higher for the German samples when trust was measured by the question items related to organic vegetables (OVT), while the Japanese samples exhibited higher trust when it was measured by the scales of "general trust" (GNT). Both scales of trust was confirmed to be related to the attitude and buying behaviour of organic vegetables including purchase frequency, consumption intensity, and benefit evaluation. OVT was also associated with the consumer's choice of the channel by which they shop for organic vegetables, but contrary to what trust theory tells us, higher level of trust was associated with lower importance of supermarket. This was probably due to the fact that people with higher level of trust tend to consume more organic vegetables and therefore direct and specialized channel was more convenient channel to shop than supermarket with possibly decreased search cost. Though further research is needed to exclude the effect of consumption intensity to reveal the pure effect of trust on channel choice, this study clearly showed that the ability to trust is one of the important factors that explains the consumers' buying behaviours of organic vegetables.

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Traceability among Smallholders in the Organic Fresh Produce Value Chain: Case of Nairobi

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Key words: traceability, information flow, organic, value chain

Abstract

Traceability enhances information sharing and disclosure thereby increasing trust among stakeholders along value chains. This research assessed information flow along organic fresh produce value chain using a participatory study of certified organic farmers and outlets around Nairobi in February, 2012. Traceability was limited since majority of stakeholders were smallholders who had no functional traceability system. There were two main drivers of traceability; organizational activities and personnel perception. Variables in the organizational activities were interrelated and included documentation, certification by other quality management standards, training on food safety and traceability and quality systems monitoring. In addition, group activities increased trust among value chain actors. Extension services emphasizing on documentation, quality management systems certification, employee training, group activities and system monitoring should be conducted to improve traceability.

Introduction

Organic production is a dynamic and rapidly-growing sector of the global food industry (Ponti et al., 2012). Information flow is vital for food safety and quality management along value chains. Inadequate credible product information flow can compromise safety and quality of food (Souza-Monteiro and Caswell, 2010). Linking traceability with information flow and documentation improves operational efficiencies, safety and quality (Ruiz-Garcia et al. 2010). This is important for credence attributes; those which consumers cannot detect either prior or after consumption of food (Hall, 2010). Food traceability systems record information during production and distribution using paper or electronic systems. This study describes information flow among actors in the organic fresh produce value chain. Specifically, the study assessed presence of product traceability and factors that contribute to traceability among smallholders in developing countries with Nairobi City as the case study.

Material and methods

Study design

Survey was designed to get specific information on the given population. A two step study approach was used; mapping the organic fresh produce value chain then evaluating traceability along this chain. The study was conducted around Nairobi since most of the local organic markets are found around the city where majority of the consumers are foreigners and affluent higher middleclass persons (Kledal et al. 2008).

Sampling procedure

Stakeholders in the organic fresh produce value chain around Nairobi were identified using snowball sampling technique. Since the total population was small, complete census of identified actors was done.

Data collection

A total of 38 organic kales farmers, 10 traders and 2 organic farmers' market officials were interviewed between February, 2012 and June, 2012. Data was collected through interviews using three sets of semi-structured questionnaires specifically designed for the target respondent (farmers, farmer groups' officials and traders). The questionnaire provided a guide to the interviewer, covering details of the traceability systems used, employee perception on chain traceability, documentation, training, monitoring and review of

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traceability systems, and the challenges faced during tracing and tracking organic fresh produce. Five-Point Likert scale was adopted as the basic scale for ranking questions.

Data analysis

Descriptive data from interviews was used to present the data, content analysis used to analyze qualitative data while exploratory factor analysis used to uncover the underlying variables which influence traceability. The Kaiser-Meyer-Olkin (KMO-test) and Bartlett's test were used to check adequacy of the factor analysis. Extraction of factors was done using the Eigen values of the correlation matrix (Rietveld and Van Hout, 1993). Since some factors could be interrelated, oblique rotation was used. SPSS version 17 was used to run the analysis.

Results

Most organizations certified as 'organic' had adopted product and information traceability systems as demanded by the certifying organic standards. Organic fresh produce traceability was limited mainly because of the small- scale nature of most farmers. There were also differences in the information traced in terms of the precision, depth, breadth, and accessibility to information by other members in the supply chain. These negatively affected chain traceability along the supply chain. There were several reasons for tracking and tracing organic fresh produce with most respondents using the traceability system as a means to gain competitive advantage, for organizational sustainability and to convey information on the product characteristics along the chain.

More than 75 percent of the actors had a positive perception on traceability. Certification by quality management systems was not mandatory although as indicated by Maldonado-siman et al. (2012), organizations operating under these standards had better traceability and quality verification systems. From the study, 35.7 percent of respondents perceived that certification by other quality management systems had a great impact in their traceability systems; however, only 23 percent had been certified with these quality management systems.

Traceability was influenced by two drivers, that is, organizational activities and the perception of traceability by the personnel. These accounted for 60 percent of the variance with the first driver accounting for 38.3 percent while the second one accounted for 22.9 percent. Variables in the first driver were monitoring, documentation, certification and training. These represented the organizational drivers that positively contribute to traceability. The second driver represented variables that affect employees' perception to the traceability system. Variables in these two drivers were interrelated. These results were similar to previous research; personnel perception (Pouliot and Sumner, 2008; Heyder, 2012), organizational drivers such as certification by other quality management systems and documentation (Gawron and Theuvsen, 2009) and labelling (Raynaud et al. 2009).

The organic sector was dominated by small scale actors with minimal assess to finances for implementing a functional traceability system. There was also lack of an appropriate and rapid traceability system capable of tracing organic fresh produce that can account for losses as a result of spoilage, withering and dehydration. Seasonality of fresh produce also affected the tracing system. Employees had inadequate knowledge on record keeping and documentation which affected their perception in traceability.

Discussion

There were two main drivers of traceability; organizational activities and personnel's perception. Variables in the first driver were presence of a quality management systems, documentation and record keeping, certification with a quality system and personnel training. Variables in the second driver affected employees' perception on traceability. Variables in both drivers were interrelated.

Traceability along organic fresh produce chain was limited. Use of labels and documentation was limited. Only part of the information was traceable; basic primary production and processing characteristics and identity of immediate actors both upstream and downstream the supply chain being traceable. Majority of the actors did not have functional chain traceability strategies to access and share information with others along the chain. At primary production, group affiliation and regular checks on the verification and monitoring systems by group members increased trust along the value chain.

Suggestions

The study recommends capacity building of smallholder actors through training on documentation of the basic production and process characteristics and use of identification tags and labels. Design of a system which enhances information flow and information retention with rapid access by other actors is necessary. Group activities such as chain traceability, group certification, training, monitoring and documentation should be encouraged to reduce cost in setting up a traceability system.

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Ability of commercially available soybean *Bradyrhizobia* inoculants for cool growing conditions in Central Europe

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Key words: Soybean, Nitrogen-fixation, inoculation, *Bradyrhizobium japonicum*

Abstract

In Central Europe the inoculation of soybean (Glycine max (L.) Merr.) with different Bradyrhizobia inoculants has led to unsatisfying nodulation results under low temperature conditions. The aim of this study was to test the capacity of commercially available inoculants under cool growing conditions in Central Europe. In 2011 and 2012 four Bradyrhizobia inoculants were tested on three early soybean varieties in a field trial in Germany. The number of nodules, yield and protein content were assessed. Two years data showed a successful nodulation of Product 4, Product 3 and Product 2 while Product 1 cannot be recommended. Independently of soybean variety, all of the three successful inoculants can be advised regarding grain yield. Protein content and protein yield depend on the combination of inoculants and soybean variety. Over the years Product 4 was the most reliable inoculant.

Introduction

Soybean is able to produce high quality protein for human and animal consumption. Under low temperature conditions in Central Europe the inoculation with different *Bradyrhizobia* inoculants, which were mainly developed for the conditions in USA, has led to unsatisfying nodulation results. The aim of this study was to test the ability of commercially available inoculants for cool growing conditions in Central Europe.

Material and methods

A field trial was carried out under organic farming conditions, at the "Hessische Staatsdomäne Frankenhausen", the research farm of the University of Kassel-Witzenhausen (51,4 N; 9,4 E), located 230 m above sea level. Soil type was a Haplic Luvisol and soil texture a silty loam.

The field trial was conducted in two consecutive seasons (2011 and 2012), on fields, on which no soybean has been cultivated previously. Three early mature soybean varieties (Variety 1, Variety 2, Variety 3) were tested in combination with four different *Bradyrhizobia* inoculants (Product 1, Product 2, Product 3, Product 4) and non inoculated controls. Soybeans were sown on the 28.04.2011 and 08.05.2012, respectively, with 65 kernels per m^2 and a distance of 37,5 cm between rows and harvested the 05.10.2011 and 19.10.2012, respectively. Seeds were inoculated according to the recommendations of the manufacturer of the inoculants, except Product 1 which was applied in 20 fold concentration in 2012, because of the unsuccessful nodulation observed in 2011.

The factorial treatments were arranged in a split-plot design with inoculant (I) as main plot and variety of soybean (VS) as subplot with four replications (REP) and a subplot size of 1,5 m x 10 m.

Six weeks after sowing (Nodulation 1) and at flowering (Nodulation 2) 2 x 3 plants per subplot were harvested. Number of nodules, size of nodules (mm) and colour of nodules as well as shootlength (cm) were assessed. Grain yield (dt ha^{-1} at 86 % DM) was determined at harvest. Crude protein content (%) was determined by NIRS and protein yield (dt/ha) was calculated.

Analysis of variance and comparison of means were analysed using the MIXED procedure of the software package SAS 9.2 (SAS Institute 2002-2008) and Tukey's honestly significant difference test.

Results

Due to unsuccessful nodulation of Product 1 applied at recommended concentration in 2011 and at 20 fold concentration in 2012 all the assessed traits did not differ significantly from the not inoculated controls.

Nodulation 1 was significantly affected by the interaction of inoculant and year. Highest number of nodules per plant was determined on soybeans inoculated with Product 4 in 2012 and in 2011 (Fig. 1). Nodulation 2 was significantly affected by inoculant. Over two years, three soybean varieties and four replications, the significant highest number of nodules per plant was also observed in combination with Product 4, followed by Product 2 and then by Product 3 (Fig. 2).

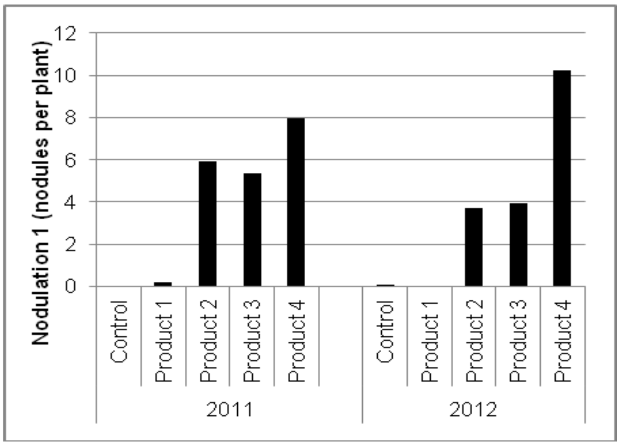


Fig. 1: Nodulation 1 (nodules per plant) in Frankenhausen as a function of inoculant and year. Average across three varieties of soybeans and four replicates.

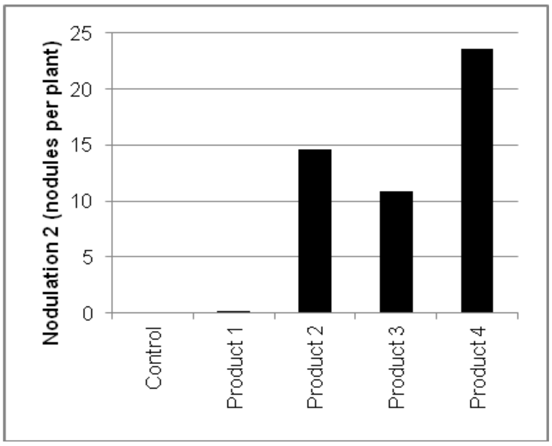
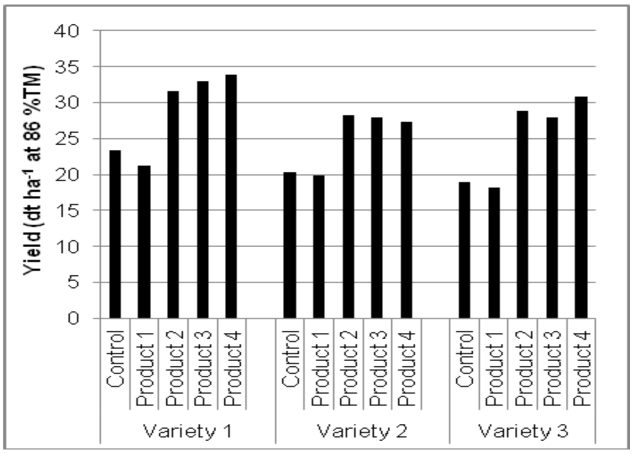
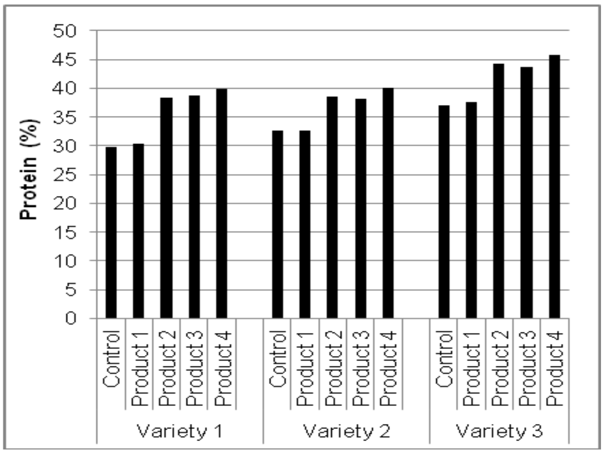


Fig. 2: Nodulation 2 (nodules per plant) in Frankenhausen as a function of inoculants. Average across three varieties of soybeans, two years and four replicates.

Grain yield was significantly affected by the interaction of year * variety of soybean. Grain yields of soybeans inoculated with Product 2, Product 3 or Product 4 were significantly higher than the non-inoculated control and Product 1 (Fig. 3). For all three varieties the combination with Product 2, Product 3 or Product 4 resulted in similar yields which did not differ significantly from each other. Mean yield was significantly higher in 2012 than in 2011.





Protein content was significantly affected by the interaction of inoculant * variety of soybean. For Variety 2 and Variety 3 the protein content was significantly highest in combination with Product 4, followed by Product 2 (Fig. 4). Variety 1 obtained the highest protein content in combination with Product 4 and with Product 3. These two combinations were statistically at par.

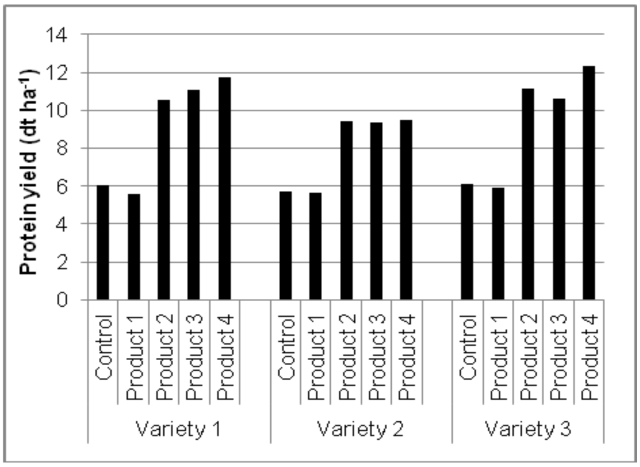


Fig. 5: Protein yield (dt ha^{-1}) in Frankenhausen as a function of inoculant and variety of soybean. Average across two years and four replicates.

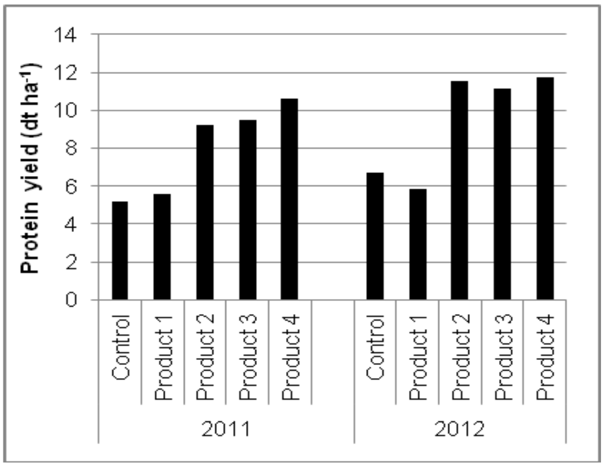


Fig. 6: Protein yield (dt ha^{-1}) in Frankenhausen as a function of inoculant and year. Average across three varieties of soybean and four replicates.

Protein yield was significantly affected by the interaction of inoculants * variety of soybean. Highest protein yield was determined for Variety 3 in combination with Product 4 and in combination with Product 2, and for Variety 1 in combination with Product 4 and in combination with Product 3 (Fig. 5). For the above named combinations protein yield was significantly higher than that of Variety 2, independent of the inoculant. Protein yield was also affected by the interaction of inoculants * year. Over three varieties of soybean and four replications soybeans inoculated with Product 4 had the highest protein yield in 2011 and in 2012 and were at par with the protein yield of soybeans inoculated with Product 2 and with Product 3 in 2012 (Fig. 6).

Over two years nodulation at flowering correlated positively with grain yield (r_s=0,74), with protein content (r_s=0,71) and protein yield (r_s=0,78) (Spearman rank correlation p<0,0001).

Discussion

Nitrogen uptake has been identified as the limiting factor of soybean grain yield. On average 50-60% of soybean nitrogen demand can be covered by biological N_2 fixation (Salvagiotti et al. 2008).

It is therefore necessary to select for proper *Bradyrhizobia* inoculants for cold growing conditions in Central Europe to improve soybean yield and quality. The experiment confirmed the successful nodulation of Products 2, 3 and 4 while Product 1 cannot be recommended. Regarding grain yield, all the successful inoculants can be advised, independently of soybean variety. Concerning protein content, Product 4 was especially profitable in combination with Variety 2 and 3. For the Variety 1, Product 3 or 4 can be chosen to obtain high protein content, whereas Products 2 and 4 are recommended for Variety 3 to target high protein content and protein yield. Variety 2 showed the lowest yield and protein yield independent of the inoculant. Over the years Product 4 was the most reliable inoculant.

Acknowledgment

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Dynamic composting optimization through C/N ratio variation as a start-up parameter

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Key words: compost, organic waste, phytotoxicity, C/N ratio, maturation

Abstract

Different organic wastes (tomato, melon, olive mill wastes and sheep manure) were mixed to make better use of tomato waste. The objective of this study was to evaluate the effect of C/N ratio on the quality of the produced compost. The four studied C/N ratios (treatments) were: C/N=25; 30; 35 and 40. Results revealed that the treatment C/N=35 has resulted in the highest oxygen consumption and also, the longest thermophilic phase. Treatments C/N=25 and 35 have reached optimal C/N ratios at the end of the process (respectively 11.88 and 14.71). The effect of compost on Cresson and phytotoxicity test showed that treatment C/N=35 has produced the most mature compost. The amendment of compost has reduced the pH, increased the EC, and enriched soil with organic matter as far as the rate of the amendment is increasing (10; 20 and 30 Tonnes.ha-1). The quality of the produced compost depends largely on the level of C/N startup ratio and also the quality of its constituents within the mixture.

Introduction

In Souss Massa region, the production of plant by-product has reached 1 307 465 tons in 2011. The analysis of organic wastes macro elements (NPK), reveals that the economic loss to win has been evaluated to more than 6 M€ with about 4000 tons of nitrogen, 1000 tons of phosphorus and 9200 tons of potassium per year; what constitutes for soils a source of important fertilization backup. Compost quality is closely related to its stability and maturity, and their indicators that have been used in composting studies include C/N ratio, microbial activity, germination index, cation exchange capacity (CEC), humic substances content etc. Generally, composting could be carried out under a wide range of initial C/N ratios, namely, 11 to 105, depending on the starting materials. Therefore, the aim of this study was to investigate the influence of different C/N ratios on dynamic composting piles of horticultural wastes in terms of compost quality tests and its agronomic performance.

Material and methods

Experimental site and raw material preparation

Experiments were carried out at the Centre of Technology Transfer (APEFEL professional Association) in Souss-Massa region (Morocco) 25 km to the south of Agadir city. The choice of wastes to be composted was based on their availability and the adoption of logic of recovery and the use of their additional carbon and nitrogen content. Four types of wastes were selected: end cycle tomato plants; melon wastes; olive mill wastes and sheep manure. Raw materials were ground using silage brewer, and representative triplicate samples were taken for physical and chemical analysis (table 1) prior to mixture using formula below given by Soudi (2005).

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Table 1. Physical and chemical characteristics of raw materials

Organic wastes	Total Carbon (%)	Total Nitrogen (%)	C/N ratio	Moisture content (%)
Tomato wastes	39.20 ± 0.65	0.78 ± 0.19	50.25 ± 0.68	26 ±1.98
Melon wastes	30.46 ± 0.53	1.47 ± 0.23	20.72 ± 0.79	17 ± 1.56
Sheep manure	38.00 ± 0.76	2.00 ± 0.27	19.00 ± 0.84	32 ± 1.78
Olive mill waste	34.62 ± 0.45	0.87 ± 0.14	39.79 ± 0.97	36 ± 2.21

$$\frac{C}{N}(mixture) = \frac{\sum_{n=1}^{\infty}(Q_n\,[C_n(100 - M_n)])}{\sum_{n=1}^{\infty}(Q_n\,[N_n(1 - M_n)])}$$

C/N (mixture): C/N ratio of the resulting materials to compost
Q_n: Quantity of the fresh materiel (n)
C_n: Total carbon content of the dry materiel (n)
M_n: moisture content of the fresh materiel (n)
N_n: Total nitrogen content of the dry materiel (n)

Experimental design & Treatments description
Using the previous formula has resulted in the composition (fresh weight/ fresh weight) of the following four treatments:

Table 2. Proportion of raw material used to constitute the treatments

Treatments (C/N ratio)	Proportion (% w/w of fresh matter)			
	Melon waste	Sheep manure	Olive mill waste	Tomato waste
25	10	55	5	30
30	10	30	20	40
35	5	20	20	55
40	5	10	15	70

Moisture content was adjusted to 55 % initially and maintained approximately between 50 to 60 % using fresh water. Aeration of the compost piles was done through periodic turning every 7 to 10 days, in addition to daily forced ventilation (2 hours per day). Samples were collected from at least 70 cm depth at the shaded pile side at 1, 11, 21, 53, 73, 109 and 172 days, through a composite 3 subsamples of 2 kg of each. All the samples were put in a plastic bag, weighted for moisture content after its drying at 105°C during 48 hours in the oven (Pétard, 1993) prior to laboratory analysis.

Monitoring parameters and quality of compost
Temperature, moisture content and oxygen percentage inside the pile were measured daily using multiparametric probes (Green Mountain Technologies, USA) at 1 meter depth in three point of each treatment pile. Samples were sieved (Ø= 2 mm) and analysed for following parameters; pH; EC; Total Organic Matter; NTK; Mineral nitrogen (N-NO3 and N-NH4); Phosphorus; Potassium; Calcium; Magnesium; Humic and fulvic acid content. The quality of compost was evaluated with three methods (i) germination assay (ii) cress test and (iii) green bean growth bioassay.

Statistical analysis
All statistical analyses were performed using Minitab 13.0 Fr software. The multiple comparisons of means were confirmed by Tukey's test (at $P < 0.05$).

Results

The evolution of the temperature at the beginning of the composting process shows that the temperature is different depending on the composition of the pile (Figure 1). Thus the temperature is higher for the lowest C/N ratio with 65, 56, 54 and 47 °C respectively for C/N 25, C/N 30, C/N 35 and C/N 40. Thermophile phase (T°>60 °C) lasted 5, 7, 11 and 7 days respectively with C/N 25, C/N 30, C/N 35 and C/N 40.

After windrowing, a drastic decrease of C/N ratio is observed for the all the treatments till the 20th DAW. During the composting process, the C/N ratio decreases slightly in all the treatments to 11.88, 17.93, 14.70 and 18.84 respectively for initial C/N ratios C/N 25, C/N 30, C/N 35 and C/N 40. All the evolution patterns conserve their order with respect to their initial C/N ratio.

Germination assay (Table 3) has shown that C/N 35 compost has resulted in the highest percentage of germination among all the treatments with 60 % of germinated seeds. Similarly, C/N 35 has resulted in the highest germination percentage of the cress test with respect to the other treatments with about 90 % after 7 days culture of watercress seeds.

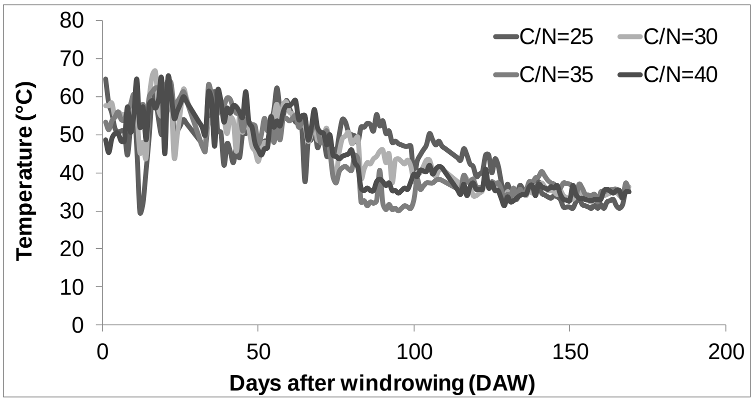

Figure 1. Temperature evolution at piles center

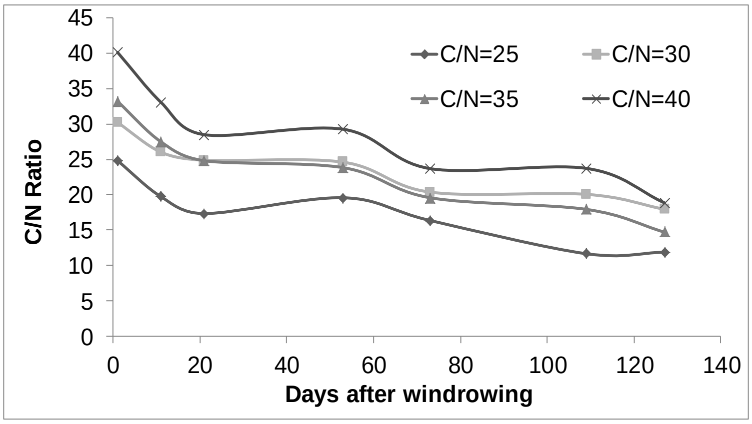

Figure 2. C/N ratio evolution

Table 3. Percentage of cress seeds germination after 3 and 7 days seeding

Treatments	3 days after seeding	7 days after seeding
Control (peat moss)	62 ± 2,31 **ab *****	86 ± 2,31 **a*****
C/N 25	61 ± 3,83 **b**	74 ± 9,52 **ab**
C/N 30	69 ± 3,83 **a**	82 ± 5,16 **a**
C/N 35	69 ± 5,03 **a**	90 ± 8,33 **a**
C/N 40	44 ± 4,62 **c**	54 ± 9,62 **b**

Discussion

The difference in piles temperature can be explained by the ratio of manure that increase while initial C/N decreases. Manure contains high nitrogen level and already fermentable what promotes early microbial activity with lowest C/N ration. The decrease of the C/N ratio observed during the first 20 DAW is in conformity with Mustin (1987) who stated that C/N ratio decrease due to the release of carbon as CO_2. The treatments of initial C/N ratio 40 has kept his order as the highest C/N ratio after windrowing, and this can be explained by its high value of recalcitrant organic matter in comparison with the other treatments. Treatments C/N 30 and 35 has resulted in the highest germination percentage, and were comparable to the control, this effect is maybe due to the high level of stability reached after composting.

Suggestions to tackle with the future challenges of organic animal husbandry

The economic growth and the rising of consumption demand in the world, have led to more and more important production of manure due to an important of the animal husbandry intensification. This unmanaged manure, can lead to serious sanitary and environmental complications. Composting is a type of waste processing that has gained increasing acceptance over the years thanks to the carbon sequestration to the depleted soils. Consequently, compost maturity is the most essential criterion in recycling animal manure, as well as its marketing and utilization in agriculture as organic amendments.

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Participatory development as a way to innovations: five key elements for success

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Key words: participatory research, sustainability, organic farming, innovation, operational group, co creation

Abstract

In the participatory development of the organic sector five elements appear to play a key role: ownership, heterogeneity, sharing knowledge and experience, value driven and a system approach. It is recommended to identify these five key elements in each research based on a participatory development and handle consciously according to them.

Introduction

In the development of an integrated sustainable agriculture of the EU much new knowledge and innovation is needed (EU, 2012). In the Netherlands, the organic sector gained much experience with a partnership focusing on innovations. Farmers, industry en knowledge institutions worked closely together within a demand-driven context. The partnership is characterised by a high degree of active participation. Practice and research participated actively and contributed to the development. The aim of the partnership is to contribute to growth, innovation and the strengthening of the sector. We therefore call this approach a participatory development.

Organic farming is the fasted growing agricultural sector in the Netherlands. The sector strives towards an integrated sustainable development with a focus on a healthy environment, animal welfare, natural production, biodiversity, transparency, fairness, health and safety, regionalism, and the relationship with consumers and society. In an international perspective this is embedded in the principles of the International Federation of Organic Agriculture Movements (IFOAM, 2005).

Material and methods

Participatory development plays an important role in the design and concept of the research. The establishment of a structural cooperation between research and practice was possible through a knowledge network. The knowledge network organizes the exchange between practice and research. The network collects and prioritizes research questions. The knowledge institutions translate the questions into research projects. In conducting the research, research and practice work closely together. In recent years much has been learned about the different aspects of this cooperation.
The participatory model is quite unique in research (Koopmans *et al.*, 2011). In this model research is characterized by a strong connection between partners in the supply chain. It uses the knowledge and experience of farmers. The farmer brings in his practical experience and links them with the complex business environment. The interaction between the farmer and the researcher often leads to surprising new insights.

Which elements can be considered as key elements to the intensive cooperation of research and practice to be successful? In a series of expert meetings five key elements could be extracted and elaborated: ownership, heterogeneity, sharing of knowledge and experience, value driven and systems approach.

Results and discussion

Figure 1 shows a schematic overview of the five key elements distinguished in a participatory approach. From a base of 'ownership', the development is launched. The development will be more successful, as the group of people involved is or becomes more heterogeneous in composition and if the group wants to share experience and knowledge. It is crucial to commute back and forth between a focus on parts and the context of the larger system, in which the development must fit.

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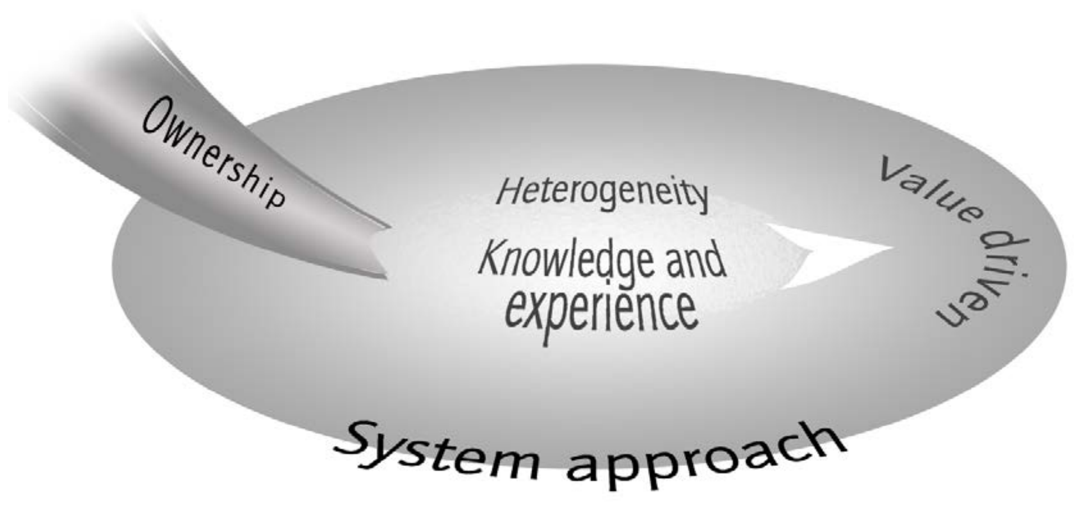

Figure 1. Schematic representation of the key elements of participatory development

Ownership is the key to a successful development and a precondition for knowledge transfer and utilization. Ownership is the extent to which a group or person considers himself owner of the problem and the development of the problem to solve. A development process often has four phases: articulation of demand, knowledge generation, dissemination and knowledge utilization (Kolb, 1984). The result of the development cycle is that the solutions are implemented. The more ownership is felt in all steps of this process, the more applicable the solutions are.

The research can be formulated by individuals or by a group of stakeholders. This process is called 'articulation of demand'. From the moment the question is converted into a research question, the researchers themselves feel more responsible for answering the question. Importantly, the stakeholders are closely involved in the implementation and also in guiding the research. Sufficient attention to the applicability will then also lead to a continued feeling of ownership of the stakeholders.

The dissemination and discussion of results can best be linked to meetings and the sector itself. Think of meetings of farmer's networks, businesses or buyers etc. Good communication also requires professionals, exceeding the industry alone. In the knowledge dissemination and knowledge utilization phase networks are an important link to maintain ownership.

Heterogeneity refers to differences in views and perceptions of problems and their causes and possible solutions. Heterogeneity is often guaranteed when parties come from different professional domains or have different interests.

Reform and innovation are often stimulated if several stakeholders talk to each other each with its own vision on the challenges and possible solutions. Different perspectives arising from different underlying ways of looking to the world (values and norms, interests) call for new approaches. By that, a learning process is initiated on all levels that can lead to new perspectives. This creates a larger space for new and surprising solutions. Also, this leads to a greater commitment of stakeholders and more effective participation in creating solutions based on own responsibility and capabilities. Often this process arises if the parties are new to each other, with an unusual mix of stakeholders. Partners can trust each other, if there is a common goal and if there is a proper process management. Farmers themselves indicate that such cooperation is inspiring.

The chance of success and finding solutions is enhanced through sharing **knowledge and experience** with all stakeholders. Moreover, it is a good basis for a further flow of knowledge. By linking science and practice and practical experiences with science, more applicable solutions are created.

Formal scientific knowledge consists of abstract concepts, falsifiable and verified scientific knowledge. Experiential knowledge from practice is often implicit knowledge of the actors, personal, situational and time-bound. Experiential knowledge can be made more explicit and general by asking critical questions, reflection, measuring, review and integration with formal (scientific) knowledge. As a result, it is more broadly applicable.

Bringing together these different kinds of knowledge and experience is essential for boosting innovations. In a participatory development, the collective knowledge and experience of all partners are brought into workable methods and techniques for optimization and innovation. For specific situations in practice, feasible and effective solutions and innovations come into place. This is also called knowledge construction or co-creation. In these, often lengthy processes an upward learning circle of 'learning by doing' arises.

Value driven. Participatory development looks ahead and is proactive. A common direction is only possible if there is a degree of consensus on the desired development, a common image of the future. Values are the basis. IFOAM (2005) uses four guiding values in the form of principles from which organic agriculture grows and develops: health, ecology, fairness and care. In the Netherlands, playing alongside these more general IFOAM values are social values, animal welfare, natural products, healthy and safe as well as regional production and the connection with consumers in a socially responsible chain. The concept of 'naturalness' is an important integrative value of organic farming (Verhoog *et al*., 2007).

Values also play a role in the development of research projects. The problem being investigated is central and roles that values play in identifying this problem are not always made explicit. The underlying values determine to a large extent the perception of the problem or challenge and potential solutions. The objective pursued already, refers to a realizable ambition. Science is not value free, but where and when are values made explicit in the research process? According to Alrøe and Kristensen (2002) a scientific way of dealing with values, is made possible by 'reflexive objectivity'. Analysing, clarifying and communicating values are a part of that. Reflexive also refers to questioning the own underlying values. By bringing together different stakeholders it is important that through a good process, principles, perceptions and worldviews are addressed and made explicit.

A final key element in the participatory development is the **system approach**. This approach is rooted in the realization that the context in which farmers, researchers and other partners come to decisions and control their processes, is always the whole system. Moreover, stakeholders within organic farming strive towards several, often potentially conflicting, objectives. A decision on one item of the business affects another item. In business there are items that lead to synergy and strengthening of goals and items that work antagonistic towards goals*, i.e.* the strength of one item means a decline of another item. Questions and solutions always deserve to be studied and solved in a system context.

Working under a system approach also requires a good analysis of the total system in which the change has to take place. The social system and the agro-system or parts thereof, can teach us a lot about the opportunities and obstacles associated with it and provide targets for the desired development.

If we consider the wider context: different ideas about the future are imaginable in a participatory development. It is not one, but there are several possible solutions. Each sector, each industry, each area requires its own elaboration. In this the cooperation of many stakeholders is needed. Moreover, the context might also change: the formal and informal rules (institutions) and the methods being used. In this way, working on technological solutions becomes more embedded in socio-economic and institutional innovation and several innovations come together. We call that a system innovation.

Conclusion

Participatory development has been shown to be an effective tool to sustain and innovate the organic sector. The sector is closely involved in the research and determines the research agenda. A real impact on the research direction is imposed. Researchers do more practice-related research resulting in innovations that are also more relevant for practice.

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Soil and water salinization and the development of organic saline crops

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Key words: salinization, saline crops, seabeet, seakale

Abstract

Saline water and soils present an increasing problem for agriculture. Adaptation strategies include selection of existing crops for salt tolerance, and development of new salt-tolerant or halophyte crops. As saline areas are often located near sensitive nature conservation areas, the development of saline crops represents a challenge to sustainable and organic agriculture.

In small field plots we tested the salt tolerance of two wild plant species that have some potential as saline crops: seakale and seabeet. We also tested the crop performance of seakale, on larger field plots.

Our results show that seakale can be classified as salt-tolerant and seabeet as halophyte. In the larger field tests the performance of seakale was poor on soils saturated with (fresh) water, showing the need for adapted crop management.

We conclude that the development of new saline crops has potential. However, there is still a long way to go before these crops can be produced on a larger scale.

Introduction

Worldwide, salinization of soils and water bodies and agricultural use of and competition for scarce freshwater resources are increasing problems (Rozema & Flowers, 2008, Pimentel et al., 1997) . According to current estimates, about 7% of the global land area (including 20% of irrigated land area) is salt-affected (Figure 1A; De Vos, 2011).

In the Netherlands, large areas of the country are situated below sea level and include historical tidal zones. In these areas salt water is present in the subsoil (e.g. Post et al., 2003).

During summer droughts, the freshwater lens on top of this salt water is depleted, leading to capillary rise of salt water and damage to topsoils and crops (De Vos, 2011; Figure 1B). Furthermore, in various parts of the country near coastal areas, irrigation becomes impossible due to saltwater intrusion into surface water bodies.

In the Netherlands, current efforts of agriculture to adapt to these conditions are focusing on two main strategies: firstly to test existing crops and cultivars for their salt tolerance in order to minimize damage, and secondly to search for new, highly salt-tolerant crops in order to reclaim salinized/salt-affected areas that are already lost for agriculture. For organic and sustainable agriculture the development of saline crops presents a particular challenge, as salinized soils are often located near (coastal) nature conservation areas that are sensitive to eutrophication.

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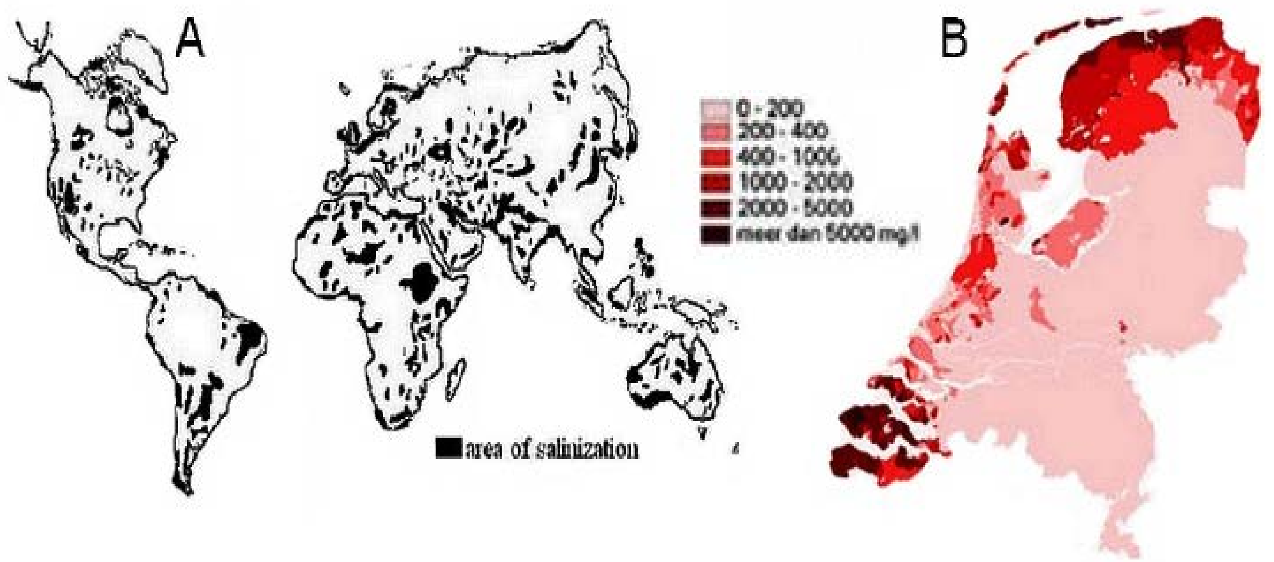

Figure 1: A: World map of soil salinization; B: Average chloride concentration (mg/L) of surface water in July during a dry year in the Netherlands. Figures adapted from De Vos (2011).

Salt tolerance in crops, whether existing or new, can be characterized by two parameters: firstly, the level of salinity above which plant damage occurs (where damage is often expressed as a decrease in yield or some growth parameter), and secondly the slope of the regression line between soil salinity and plant damage.

In our study, we measured the salt tolerance of two wild plant species that have potential as saline crops, seakale (Crambe maritima) and seabeet (Beta vulgaris subsp. Maritima), in small field plots at different salinity levels. Secondly, we tested the performance of seakale grown on a larger scale as an agricultural crop.

Material and methods

At a unique experimental field facility of an organically managed farm in the north of the Netherlands, we grew seakale and seabeet at 4 levels of salinity, applying saline waterby drip irrigation during the growing season. Salinity levels (measured as EC in saturated soil paste) were around 0 dS/m, 12 dS/m, 20 dS/m and 35 dS/m, and plot size was 1.25 by 1.25 m, with 4 replicate plots for each treatment. At various times during the 2013 growing season, we conducted non-destructive and destructive measurements, including plant height measurements on 31 July as presented in Figure 2.

In a second experiment, performed in 2011 and 2012, seakale was grown in larger field plots (1.2 x 15 m), with saltwater spray or sweetwater spray to simulate coastal conditions, and different levels of manure application (0, 70 and 100 kg N per ha applied as organic pellets, with and without compost, four replicates per treatment, data not shown), to test its performance as an agricultural crop. All plots were located an organic farm and managed organically. Plant numbers were counted at 52, 71 and 112 days after planting (DAP). The whole season had high rainfall, and 25 May and 13 June, soil moisture content was measured by sampling the top 10 cm of the soil and drying the samples in a stove at 70oC for 48 hours.

Results

Our field tests showed that seakale can be classified as salt-tolerant: up to an EC of 10 dS/m (during the entire growing season), seakale plants performed reasonably well (Figure 2). At higher salinity levels average plant height decreased, but the slope of this effect was relatively shallow, compared to the slope of salt-sensitive crops (Figure 2). Seabeet performed even better: this species did not show any damage (or even performed better than at 0 dS/m) up to ECs of 20 dS/m. At higher salinity levels only a slight decrease in growth performance was observed.

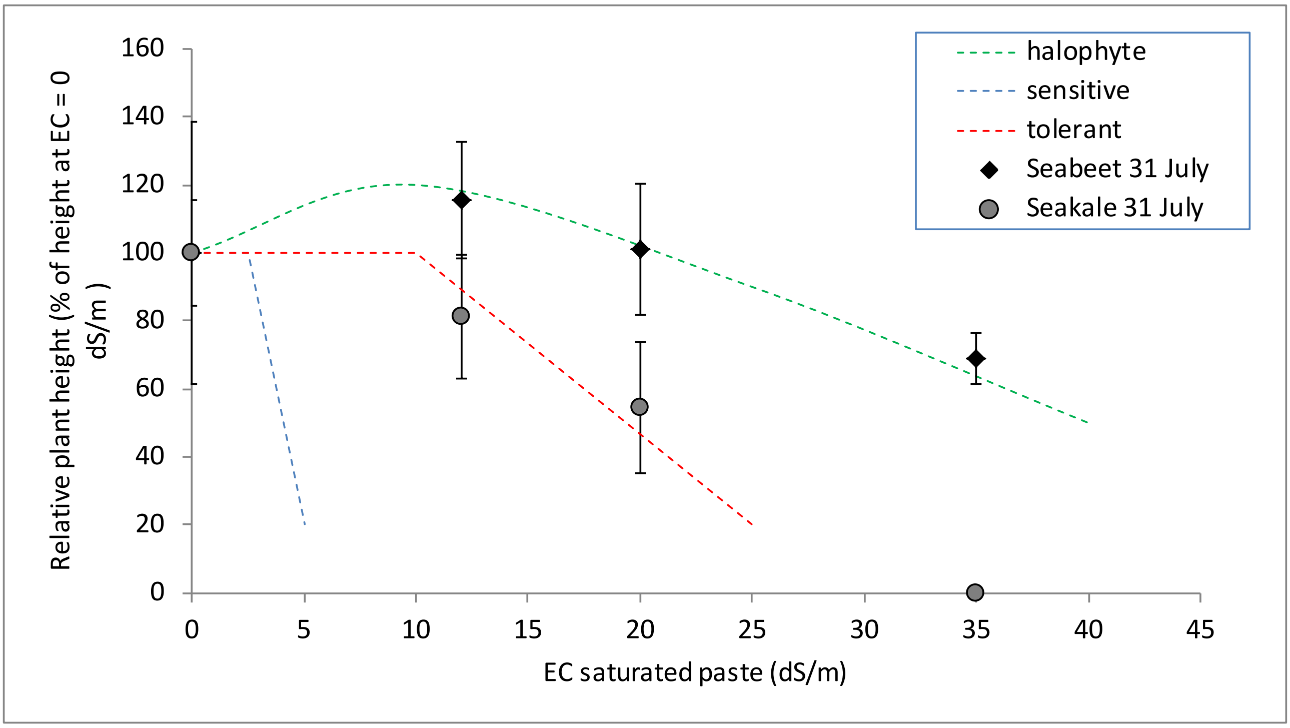

Figure 2. Relative plant height of seakale and seabeet at different soil salinity levels, as measured on 31 July 2013. The dotted lines are the theoretical curves for salt-sensitive , salt-tolerant and halophyte plants (after De Vos, 2011). Error bars indicate standard error of the mean. Seawater around the Netherlands ranges in salinity from ~30 to 55 dS/m.

Testing the crop performance of seakale in larger field plots showed surprising new problems: in the second year we tested this species (2012), a large number of plants died (Figure 3A) or showed very slow growth (3B), even though general growing conditions seemed to be good. Salt or manure treatments did not show a clear effect on plant performance. Both plant number and plant height were negatively correlated to soil saturation with fresh water during periods of heavy rainfall (e.g. the first two weeks of June, 2012). The occurring plant death seems to be associated with a disease that needs yet to be identified. There are indications that this disease is caused by a complex of fungi and occurs under specific environmental conditions (saturation of the soil with fresh water);

Discussion and conclusions

Our first results show that there are prospects for the development of new saline crops. For example seakale was shown to be quite salt-tolerant; this species could be grown in many salt-affected areas in the Netherlands. Seabeet showed to be a real halophyte. At 35 dS/m, almost as saline as seawater north of the Netherlands, seabeet showed a decrease in plant height of only about 30%, whereas it meant a certain death for most other tested plants (including most weeds).

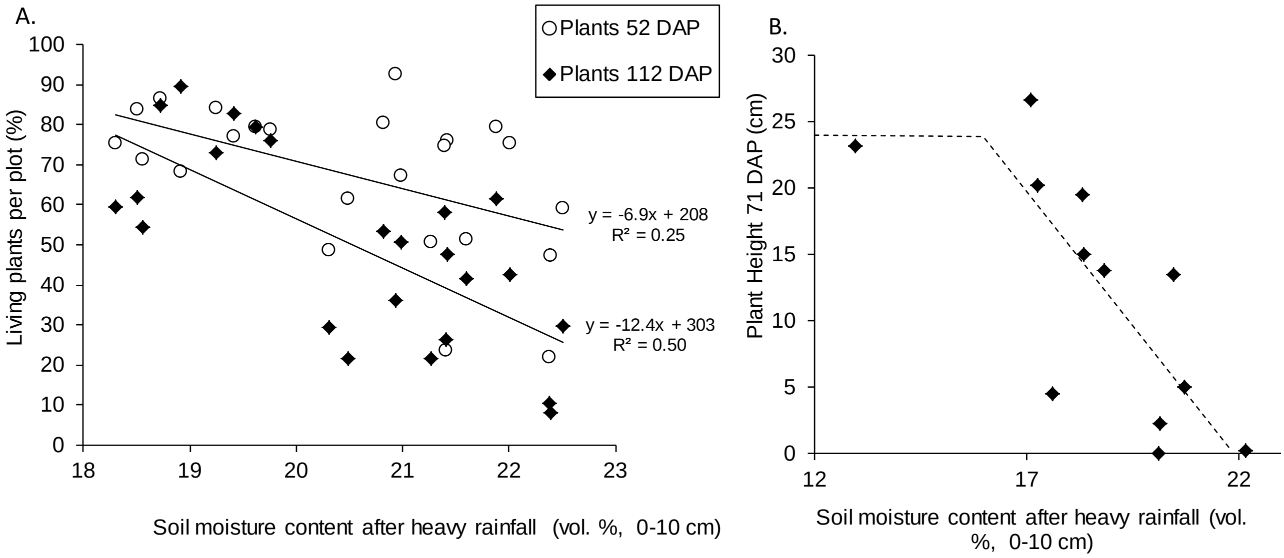

Figure 3. The performance of Seakale as an organically grown crop. Left: Correlation between plant number and soil moisture content (significant with p=0.012 at 52 DAP and p<0.001 at 112 DAP). Right: Correlation between plant height and soil moisture content. The dotted line indicates the theoretical relation, significant above 16% soil moisture (p=0.011).

Secondly, our results show that there is still a long way to go between identifying salt-tolerant and halophytic wild plants, and achieving stable crop production with these species. We selected seakale for the larger-scale field tests because there already is a market for seakale, and on a small scale it has been grown for some years already. The massive plant death observed in 2012, also observed by growers some years ago, is an example of the risks associated with growing new crop species.

In conclusion, the development of saline crops has potential, but still some problems have to be overcome. As saline areas are often located near vulnerable coastal nature areas, the production of saline crops presents a particular challenge for organic and sustainable agriculture. Some wild species, such as Salicornia, are already being produced organically on a commercial scale, but for other potentially suitable species, there is still a long way to go.

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Organically grown grassclover in nature areas to remove soil phosphate for development of specious rich grasslands

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Key words: biodiversity, nutrient cycles, soils, species richness, *Trifolium repens*

Abstract

Worldwide the current reserves of phosphate rock are being exhausted. In The Netherlands many former agricultural soils have been enriched by large quantities of phosphorus as a result of fertilization. It is thought that this phosphorus prevents development of target-nature types. Nature organizations currently seek ways to remove it. We tested grassclover, organically managed by local farmers, as a tool to extract excessive soil phosphate from nature areas and reimport it into the mineral cycle agricultural farms. In a small scale experiment we have shown that grassclover with potassium fertilization can remove more than twice the amount of soil phosphate compared to mowing alone. We tested the methodology on 60 ha of grasslands in nature areas and measured large decreases in soil phosphate. We conclude that organically managed grassclover could form an elegant way to solve problems with excessive soil phosphate in nature areas and recycle phosphate.

Introduction

Large areas of Dutch agricultural soils have been enriched by phosphorus (P) (Schoumans, 2004). Causes are high levels of fertilization. This results in high losses of P to surface and soil water (Schoumans & Groenendijk, 2000). Dutch nature policy has led to the conversion of large areas of agricultural land to nature areas. In such areas, the high P levels associate with low species diversity (Janssens et al., 1998; Critchley et al., 2002). The current way to remove P is either removal of the top soil or cutting of perennial grass swards. Removing the top soil is expensive and irreversible. The cutting management is very slow in lowering P due to a restricted availability of other nutrients. Specific management can help to remove P from such nature areas. Our objective was to test the an organically grown grassclover sward with potassium fertilization under cutting management as a tool to remove P from nature areas on sandy soils, and to quantify the amount of P thus removed.

Material and methods

Grassclover swards were sown in 2007 on 60 ha of former agricultural lands with sandy soils in in the south of The Netherlands. The grass/clover was planted with a seed mixture of grasses (Lolium perenne, Phleum pratense, Festuca pratensis and Poa pratensis) and clovers (Trifolium repens). The grassclover was organically managed and mown by 12 local farmers in 2007, 2008 and 2009. The management included intensive mowing (4 to 5 cuts annually) and fertilization with potassium fertilizer (Patentkali, 240 kg K2O per ha annually, 100 kg for the first cut, 80 kg for the second cut and 60 kg for the third cut). On one of the fields, located in "Nieuwkerk", two treatments were realized by marking 9x9 m plots with metal plates. Two marked plots were left unfertilized by potassium, and two marked plots were fertilized with potassium as mentioned above. In the plots, shortly before each cutting, a strip was mown and clover percentage, dry matter yield, potassium content and fodder value (including crude protein content) were determined. In the overall area of 60 ha, a total of 20 plots of 5x5 m were marked with iron plates, with a maximum of 1 plot per field. In each of these plots, soil measurements were done at the start of the experiment (early 2007) and at the end of the experiment (autumn 2009), in the layers 0-10 cm and 0-30 cm depth. Soil P contents were measured as P-total (soil destruction) and P-Al (plant available P) by a commercial soil analysis laboratory (AgroXpertus, Wageningen, The Netherlands).

Results

In "Nieuwkerk" in the first year after sowing, clover percentages in both treatments were high (maximal 70-80%, Figure 1A). The clover, that acted as the source of nitrogen, resulted in high yields (12 to 14 tons of dry

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matter per ha) in both treatments (Figure 1B) and over 80 kg of P_2O_5 ha^{-1} was removed in the mown crop the first year (1C).

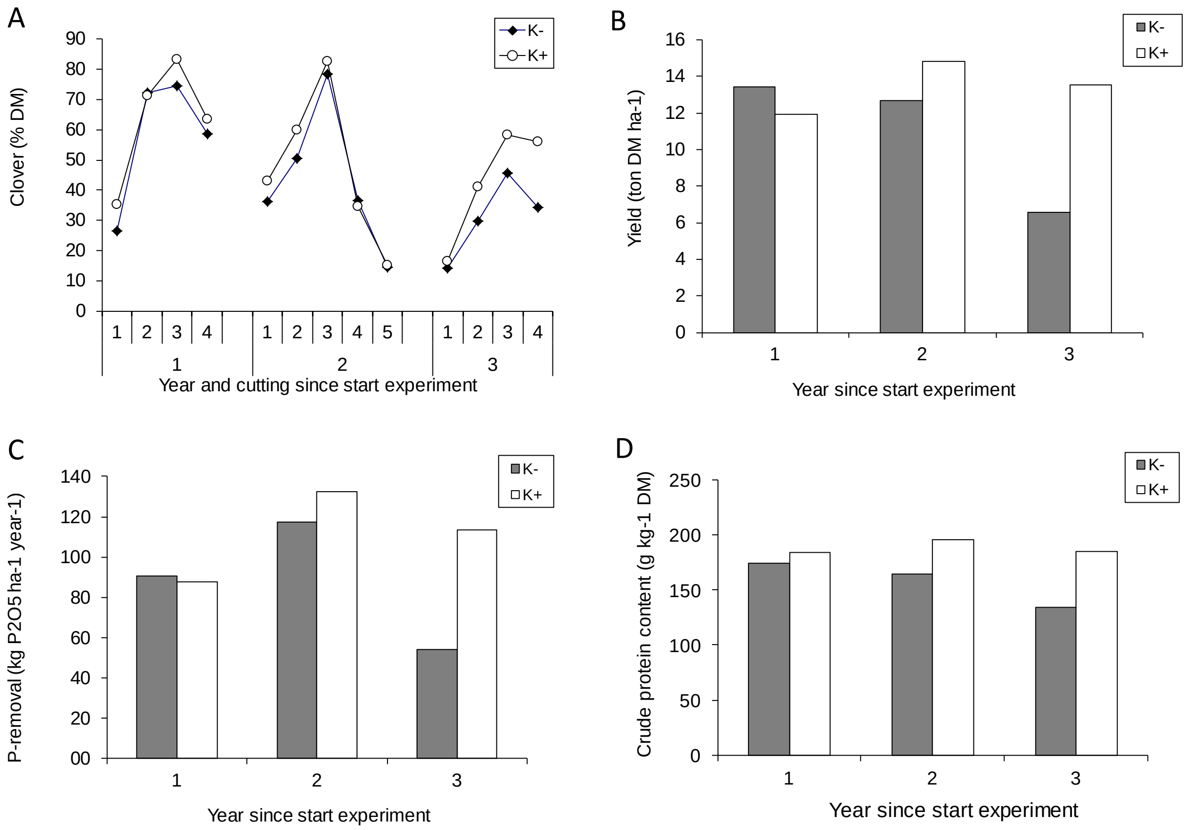

Figure 1. Results of the experiment in "Nieuwkerk" for grasclover with (K+) and without (K-) potassium fertilization: A. Clover percentage in the dry matter. B. Yields of mown grassclover (4-5 cuttings a year) . C. P-removal by the mown crop. D. Crude protein content of the grassclover.

During the course of the experiment, especially in the third year, the clover percentage of the plots without potassium fertilization decreased. As a result, the dry matter yield and phosphorus removal dropped even more, being less than halve the yield and phosphorus removal of the plots with potassium fertilization. Finally also the crude protein contents were measured: they were quite high (about 180 g kg^{-1} DM) for both treatments in year 1, and stayed about 180 g kg^{-1} for the treatment with potassium fertilization, but dropped to 134 g kg^{-1} DM in the treatment without potassium fertilization.

Soil measurements for phosphate in the 20 plots on the fields with grassclover and potassium fertilization ranged from low (P-total of 38 mg P_2O_5 per 100 g^{-1} dry soil) up to high (244 mg P_2O_5 100 g^{-1} dry soil) soils at the start of the treatment, with an average of 129 mg P_2O_5 per 100 g^{-1} dry soil in the top layer (0-10 cm) of the soil. After three years of P removal with the grassclover and potassium fertilization, an annual average decrease of 113 kg P_2O_5 ha^{-1} $year^{-1}$ dry soil was measured in the layer of 0-10 cm, and an annual decrease of 130 kg P_2O_5 ha^{-1} $year^{-1}$ in the layer of 0-30 cm (Table 1A). The annual decrease in plant available phosphorus for both layers was 2.9 and 2.6 mg P_2O_5 per 100 g^{-1} dry soil respectively (Table 1B).

Table 1. A: decrease of total soil P concentration (mg P_2O_5 $100g^{-1}$ soil) and annual reduction per ha (kg P_2O_5 ha^{-1} y^{-1}), averages of 20 fields in nature areas managed with grassclover and potassium fertilization during 3 successive years. B: decrease in plant available P in the soils (mg P_2O_5 $100g^{-1}$ soil) and average annual reduction (mg P_2O_5 100 g^{-1} soil).

A.

layer:	year 1	year 3	average reduction	SE	(p-value)	average reduction per ha
0-10 cm	129	115	14.2	5.5	0.019	113
0-30 cm	139	123	16.3	6.0	0.014	130

B.

layer:	year 1	year 3	average reduction	SE	(p-value)	average annual reduction
0-10 cm	53	45	8.6	2.3	0.001	2.9
0-30 cm	58	51	7.9	4.0	0.063	2.6

Discussion

Our field test showed that organically managed grassclover with potassium fertilization offers an alternative way to lower soil P levels. Quite a high production was maintained during the three years of measurements, resulting in high decreases of soil P levels. An extra was the high protein content of the mown material, caused by the presence of the clover in the sward: this made the mowing worthwhile for local farmers, and ensured a successful collaboration between farmers and nature organizations. Although these first results are positive, the methodology presented here is currently being tested in long term experiments to test whether high production and P removal levels are maintained also on a longer time scale, and at lower soil P levels to start with. In the long term, it could be an elegant way to reimport soil P that is bound in soils in nature areas back into the mineral cycle of an agricultural farm, and redirect/replace at least part of the imported P fertilizer that comes from mines abroad.

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Species identity important to achieve benefits of diverse grassland mixtures

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Key words: *Dactylis glomerata*, overyielding, diversity, species identity

Abstract

In semi-natural grasslands, plant diversity has shown to increase primary production and reduce weed invasion. To investigate whether such positive effects also apply to low input agricultural grasslands, a commercial grassland was sown with seven non-leguminous grassland mixtures. Diverse mixtures proved less susceptible for invading species three years after sowing. Yields were 11% higher for mixtures with two functional groups of grassland species compared with mixtures with only one functional group. Though overyielding was significant, transgressive overyielding was not apparent, due to the strong effect of one specific functional group: mixtures containing tussock grass had a 14% higher production than mixtures without tussock grass. Tussock grass also had a major effect on botanical composition. However, ground cover by invading species was mainly influenced by the number of functional groups present in the sown mixture. The results suggest that diverse grassland mixtures can improve agricultural production and reduce the susceptibility of sods for invading species, but that the specific composition of mixtures has a strong influence.

Introduction

In the last decades of agricultural intensification, species diversity has been largely ignored. In the Netherlands the main focus was on favouring and improving the most suitable, economical species, *Lolium perenne*. However, fertilization rates are increasingly limited, due to environmental legislation and the increased grassland area under nature conservation and organic production rules. Under these circumstances other grassland species might become more suitable. Mixing high productive species of leguminous herbs with grasses has been shown to increase primary production (Nyfeler *et al*, 2009). However, this effect is strongly related to increased N-availability, thus potentially conflicting part of the goals of environmental legislation and nature conservation, while grass-legume mixtures are rather unstable over years. Therefore, we tested the hypothesis that species diversity will improve grassland production (Hooper *et al*, 2005), with commercially available species of two different groups of grasses and one group of non-leguminous herbs.

Material and methods

In April 2009 an experiment was started with seven grassland mixtures (table 1) and three replications, as part of a larger trial (de Wit *et al*, 2013). We selected two groups of commercially available species (tussock grass and herbs) besides the standard sod grass (*Lolium perenne*), with two species in each functional group as we were uncertain which alternative grass and herb would be best suited for the agro-environmental conditions. A species rich mixture was added to assess the effects of higher species diversity. The trial was sown on a commercially used grassland with a shallow sandy soil in the south of the Netherlands. Plot size was 7 * 4 m. The plots were harvested four times in 2010 and 2011, but yield data of one replication in 2011 were lost. In both years weather conditions were rather unfavourable with severe drought periods during the first half of the growing season. Dry matter yield was determined by cutting a strip of 0.81m x 5m with a two-wheel tractor. After weighing the fresh biomass, a sub-sample was dried for 48h at 70°C and analysed for dry matter. In 2010, 2011 and 2012 the plots received cattle slurry in early spring (80, 61 respectively 75 kg total N ha^{-1}). In May 2011 and 2012 all sown and invading species were listed per plot and the percentage of cover by each species at the upper side of the biomass was visually assessed. This assessment of cover percentage is used as an indicator for the contribution of each species to the biomass production of the (fairly homogeneous) grass sod, though it may overestimate tall growing species slightly.

For the analysis of the diversity effect, the mixtures were clustered according to the number of functional groups. L (sod grass), DP (tussock grasses) and PC (non-leguminous herbs) were categorised as having one functional group, LDP and LPC as having two functional groups, and LDPPC and RICH as having at

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least three functional groups. Overyield was defined as the difference between the yield of the plot and the average yield of the constituent single functional groups (L, DP and/or PC), while transgressive overyield was defined as the difference between the yield of the plot and the highest yield of the constituent single functional group. The effects of mixture, number and type of functional groups on production and species presence were tested by an ANOVA using GENSTAT software.

Table 1. Composition of tested grassland mixtures.

Mixture	L	DP	PC	LDP	LPC	LDPPC	Rich
Number of functional groups	1	1	1	2	2	3	3
Species	--- seeding rate (kg ha^{-1}) ----						
Lolium perenne	40			20	35	19	15
Dactylis glomerata		10		5		5	4
Phleum pratense		30		15		14	8
Cichorium intybus			5		1,5	1,5	1
Plantago lanceolata			5		1,5	1,5	1
Festuca rubra							4
Festuca arundinacea							4
Festuca pratense							4
Daucus carota							1

Results and discussion

In autumn 2009 the newly sown grass mixtures were well established, though the establishment of *Phleum pratense* and *Festuca arundinacea* was disappointing, while *Festuca pratense* was virtually non-present. In spring 2011 the presence of the sown species was only slightly changed, except for a clear reduction of *Phleum pratense*. More importantly, unsown species invaded the plots (on average 10% of the ground cover), particularly the PC plots (42% of the ground cover). This process accelerated after the drought period of 2011. In spring 2012 *Cichorium intybus* had sharply decreased and nearly 29% of the soil was covered by invading species, mainly *Plantago lanceolata* (spreading rather evenly around the plots), *Poa annua* and *Trifolium repens* (see table 2). The successful invasion of species was significantly affected by the number of functional groups present in the mixture (table 3), but not by a single functional group. However, tussock grass (mainly the tall growing *Dactylis glomerata*) did affect the successful invasion of *Trifolium repens* ($P<0.05$): without tussock grass 19% of the surface was covered by *Trifolium repens*, while with tussock grass this was only 6%.

Table 2: Presence of species related to the mixture sown (May 2012; note: [a] is a species invaded from other plot).

Mixture	% of ground cover of most common species						Total number of different species
	Lolium perenne	Dactylis glomerata	Plantago lanceolata	Trifolium repens	Poa annua	Total by invading species	
L	52	0	23 [a]	17	2	46	16.0
DP	0	68	20 [a]	4	0	28	14.7
PC	12 [a]	0	45	23	7	49	19.3
LDP	22	43	23 [a]	7	0	33	14.7
LPC	38	0	30	17	5	28	15.3
LDPPC	18	44	30	5	0	6	14.3
RICH	20	37	28	9	0	11	19.7

Table 3. Presence of invading species related to the number of functional groups in grassland mixture. Values with different letters are significantly different (P<0.05) within each column.

Number of functional groups in mixture	% of ground cover (of species >1% of cover)	Number of different invading species
1	41.2 ^{b}	14.8 ^{b}
2	30.3 ^{b}	11.5 ^{a}
3	8.7 ^{a}	11.2 ^{a}

Average aboveground biomass production was limited to only 5.9 respectively 5.2 ton dry matter ha^{-1} in 2010 and 2011. Production was significantly affected by the mixture sown (table 4), related to the number of functional groups sown: mixtures with two functional groups were 11% more productive than mixtures with one functional group (table 5). Adding more diversity to the mixtures, however, did not further increase production. Besides this general diversity effect, there was one single functional group with a large individual effect: mixtures that included tussock grass (mainly the drought tolerant *Dactylis glomerata*) were more productive than the other mixtures (+0.7 ton DM ha^{-1}; P<0.05). Overyield is apparent (table 5) but relatively small compared to the results of e.g. Nyfeler *et al* (2009) and Finn *et al* (2012), possibly because in this current experiment no N-fixing herbs were included. Transgressive overyield was not achieved, even though the yield variation among the mixtures with one functional group was relatively small: the mixture DP was as productive as LDPPC and RICH. Thus, the agronomic value of species diversity in terms of production seems limited. However, the results do indicate that adding more palatable species, like *Lolium perenne,* is possible without decreasing the yield of the highest yielding species.

Table 4. Yields of mixtures (ton DM * ha^{-1} * year^{-1}), averaged for both years. Values with different letters are significantly different (P<0.05).

Mixture	L	DP	PC	LDP	LPC	LDPPC	RICH	Average
Yield	4.84 ^{a}	5.56 ^{ab}	4.83 ^{a}	5.99 ^{b}	5.29 ^{ab}	5.88 ^{b}	5.93 ^{b}	5.47

Table 5. Average yield and overyield per number of functional groups present in mixture. Values with different letters are significantly different (P<0.05).

Number of functional groups in mixture	1	2	3
Yield (ton DM* ha^{-1}*year^{-1})	5.08 ^{a}	5.64 ^{b}	5.90 ^{b}
Overyield (ton DM* ha^{-1}*year^{-1})	0 ^{a}	0.56 ^{b}	0.76 ^{b}
Transgressive overyield (ton DM* ha^{-1}*year^{-1})	0 ^{a}	0.34 ^{a}	0.18 ^{a}

The large effect of *Dactylis glomerata* on both yields and invasion rate by *Trifolium repens*, underlines the importance of species identity as indicated by Huyghe *et al* (2012). On the other hand, each species has a rather unique combination of functional characteristics and relevant agro-environmental conditions vary over years, making it difficult to select grassland mixtures with only few species. This was not only illustrated by the low presence of the drought tolerant (but also low productive) *Festuca rubra,* but also by the wide spreading of *Plantago lanceolata* simultaneously with the nearly disappearance of *Cichorium intybus*.

Conclusion

In this experiment diversity effects on productivity were modest. However, results indicate that possibilities exist to improve agricultural production and decrease weed invasion by using grassland mixtures with a diversity of species with functional types likely adapted to specific agro-ecological conditions.

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Improving nitrogen management in reduced tillage systems by use of green manures and appropriate off-farm inputs: results of TILMAN-ORG

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Key words: green manure, reduced tillage, nitrogen, NDICEA

Abstract

For a successful integration of reduced tillage techniques and green manures in organic cropping systems, a better understanding of nitrogen dynamics and management is essential. We present data of several long- and medium-term European experimental field studies from the TILMAN-ORG project. Nitrogen dynamics and crop performance were investigated in an Estonian and a Spanish trial. A Dutch and a Swiss trial were simulated with the NDICEA-model. The Estonian trial shows that the effect of green manure on yield of the subsequent crop is dependent on green manure and crop type. The Estonian and the Spanish trial indicate that effects of fertilization on crop performance are larger than those of green manure or soil cultivation. The results of the Dutch trial give no reason to assume that soil nitrogen availability is negatively affected by minimum tillage in organic or conventional systems. However also in the ploughed systems, low nitrogen availability in spring warrants attention.

Introduction

Reduced tillage and green manures are efficient conservation agriculture tools that can be applied to further improve organic crop production systems. For a successful integration of those techniques in organic cropping systems, a better understanding of nitrogen dynamics and management is essential. The adoption of reduced tillage and/or green manures strongly affects nitrogen quantity and availability during the vegetative period and throughout the crop rotation (Peigné et al. 2007). Specifically, changing soil and water conditions may affect the availability pattern of nitrogen, notably in spring (Berry et al. 2010). To date, few results on this issue have been presented in the scientific literature. We present data of several long- and medium-term European experimental field studies from the TILMAN-ORG project. In those field studies green manures and reduced tillage techniques are used in organic cropping systems.

Material and methods

Effect of grass-clover ley, green manure and off-farm inputs on nutrient dynamics and crop performance under reduced tillage

Nitrogen dynamics and crop performance were investigated in an Estonian and a Spanish trial. The Estonian trial aimed at evaluating the effect of green manure with or without cattle manure on crop yield and nutrient dynamics in an organic crop rotation. The crop rotation included (green manure crops between brackets): winter wheat – (ryegrass) – peas - (winter oilseed rape) – potato – (winter rye) – barley – (red clover) – red clover. The crop rotations with green manures run since 2007, the crop rotation without green manures started in 2011. In the Spanish trial three factors with two levels each were investigated: soil tillage (conventional (ploughing) and reduced (chisel), fertilization (with or without fertilization) and green manure (with or without green manure). The crop rotation consisted of cereals and legumes for both human consumption and livestock forage. Green manure consisted of a mixture of oat (*Avena sativa* L.*),* white mustard (*Sinapsis alba* L.*),* bitter vetch (*Vicia ervilia* L. willd*)* and common vetch (*Vicia sativa* L.*)*.
Nutrient budgets were made by considering the following inputs: N in (kg/ha) in seed or seedlings; manure/compost/cut-and-carry fertilizers; and aerial deposition. N removal by crop harvest was the sole

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output considered. Nitrogen use efficiency was calculated as N in harvestable product (kg/ha)/N inputs in manure, compost and/or cut-and-carry fertilizer (i.e. external N-inputs, kg/ha).

Calibration of NDICEA model for nitrogen and carbon
Within the TILMAN-ORG project, the decision support tool NDICEA (Van der Burgt et al. 2006) is calibrated for reduced tillage systems with the incorporation of green manures and off-farm inputs in The Netherlands, Belgium and Germany and also for different pedo-climatic zones across Europe. This will support farmers to make more rational use of green manures and off-farm inputs and to assess the effects of reduced tillage on soil water and nitrogen dynamics. Here, NDICEA-simulations of two European trials are being presented and discussed.

Nitrogen and water dynamics was simulated by NDICEA for a Swiss and a Dutch long-term trial. The Swiss trial had two factors with two levels: soil cultivation (ploughing and rototilling) and fertilization (slurry only or manure and slurry). The crop sequence consisted of spring wheat – sunflower – spelt – clover-grass – silage maize – winter wheat. In order to be able to differentiate the pace of organic matter decomposition between the lay phase and the arable phases, modeling was done for three separate periods: 2003-2005 (wheat-spelt), 2006-2007 (clover-grass) and 2008-2009 (silage maize – winter wheat). Scenarios were calibrated on soil organic matter content, and by doing so, a soil cultivation factor was included and adapted for the rototilled scenario's, indicating a slower decay of soil organic matter and freshly added organic materials.

Within a six-year organic and conventional rotation, the Dutch trial covers three types of soil cultivation: ploughing, reduced tillage and minimal tillage. The organic crop rotation consisted of seed potato – clover grass – cabbage – spring wheat, undersown with clover – carrots – peas. The conventional crop rotation consisted of spring barley – onion – seed potato – sugar beet. The experiment has four replicates and started in 2009. NDICEA scenarios were built for ploughing and minimum tillage. Regular soil mineral nitrogen measurements were used to assess the quality of the simulation.

Results

Effect of green manure and off-farm inputs on nutrient dynamics and crop performance under reduced tillage
In the Estonian trial, potato yield was highest in the treatments without fertilization, and green manure did not affect yield. Mean wheat yield increased in the order no green manure < green manure without fertilization < green manure with fertilization – however red clover was preceding wheat in all treatments including those without green manures. Nitrogen budgets (Table 1) were negative for all winter wheat treatments including the one with fertilization (- 45 kg N/ha for the latter). In potato, nitrogen budget showed a small surplus (17 kg N/ha) for the treatments with fertilization. The budget was negative for the treatments without fertilization (-91 kg N/ha and -87 kg N/ha for the treatment without and with green manure, respectively). Nitrogen use efficiency could only be calculated for the trials that included the use of cattle manure, thus a comparison of the systems with or without green manures wasn't possible. Nitrogen use efficiency was 1,9 for winter wheat and 0,81 for potato in 2011/2012, reflecting differences in fertilization and in nitrogen use efficiency between crops.
In the Spanish trial, spelt grain yield was enhanced by fertilization but unaffected by cultivation. Nitrogen surpluses were larger in systems with fertilization than in systems without fertilization, but crop yield was negatively affected in systems without fertilization. These results indicate that nitrogen surpluses alone may not give an adequate impression of agronomic feasibility when crop performance is not taken into account. A slightly higher crop nitrogen harvest in the treatments with reduced fertilization resulted in a slightly lower nitrogen use efficiency in those systems (0,38) compared to systems with conventional tillage (0,36).

Table 1. Nitrogen budget in kg * ha^{-1} for two crops and three treatments in 2011/2012 in the Estonian trial. Output values are means ± standard deviation, n=4. NF: no fertilizer, NG: no green manure, F: fertilizer, G: green manure.

Crop	**Winter Wheat**			**Potato**		
Treatment	NF NG	NF G	FG	NF NG	NF G	FG
Inputs						
Seed or seedlings	2,93	2,93	2,93	5,5	5,5	5,5
Manure			43,46			86,91
N-deposition	3	3	3	3	3	3
Total inputs	5,93	5,93	49,39	8,50	8,50	95,31
Outputs						
Crop harvest	70,28 ±12,37	81,82 ±9,26	93,90 ±10,55	99,82 ±13,93	95,25 ±11,45	77,42 ±9,98

Calibration of NDICEA model for nitrogen and carbon

In the Swiss trial, both simulated and measured data showed an increase of soil organic matter content in the rototilled treatments compared to the ploughed treatments (Figure 1), and a slight increase in the treatments with slurry and manure compared to the treatments with slurry (not shown). However, given the limited number of soil organic carbon measurements, the results should be interpreted with care. These results indicate that reduced soil tillage enhances soil organic matter content, as does the addition of solid manure.

In the Dutch trial, little differences were found in both measured and simulated soil mineral nitrogen dynamics between ploughing and minimal tillage (Figure 2). Simulated soil organic matter content decreased in both conventional and organic systems irrespective of soil cultivation, but the decrease was less in the organic systems.

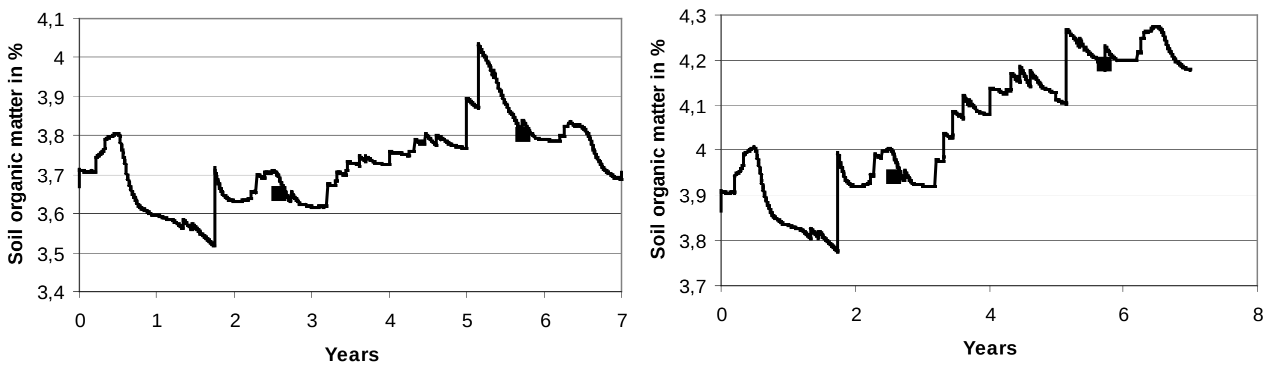
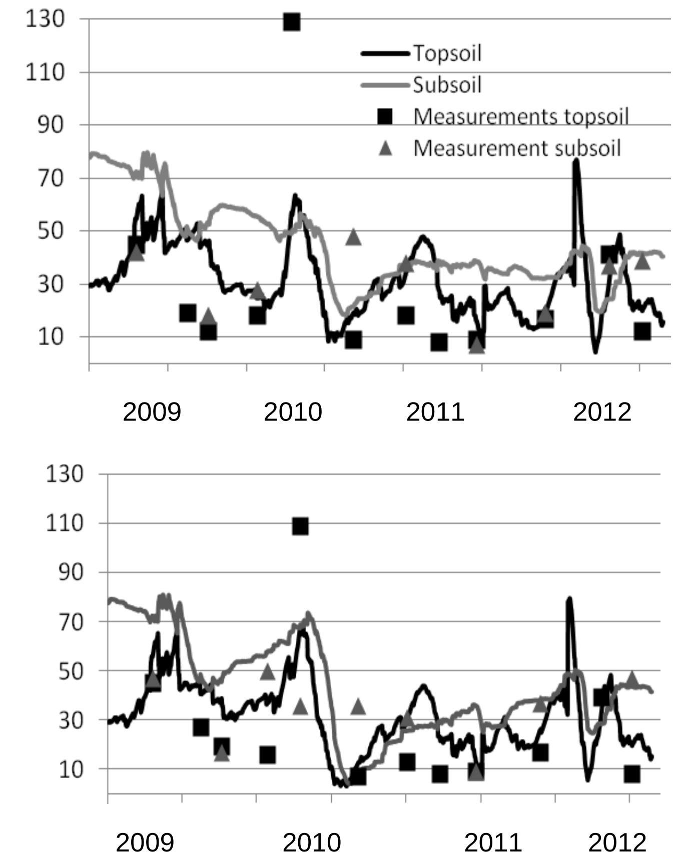


Figure 1. NDICEA-simulated (line) and measured (squares) soil organic matter % in rototilled (right) and ploughed (left) treatments of the Swiss trial. Years indicate time lapse since the start of the experiment, year 0=2003.



Mineral nitrogen (kg ha^{-1})

Figure 2. Measured and NDICEA-simulated soil nitrogen content in topsoil (0-30 cm, black line) and subsoil (30-60 cm, grey line) for the Dutch trial, in the minimal tillage (left) and ploughed (right) treatments of the organic crop rotation.

Discussion

The Estonian trial shows that the effect of green manure on yield of the subsequent crop is dependent on green manure and crop type. Moreover, the Estonian and the Spanish trial indicate that effects of fertilization on crop performance are larger than those of green manure or soil cultivation.

No conclusive effects of reduced soil tillage on soil carbon content were found across the different trials. In order to increase the validity of the modelling, a better understanding of soil carbon dynamics under reduced tillage in organic systems is desirable. Including a soil cultivation factor in NDICEA seems to be an adequate measure to capture the effects of no-till on organic matter decomposition when this decomposition is reduced.

The results of the Dutch trial give no reason to assume that soil nitrogen availability is negatively affected by minimum tillage in organic or conventional systems. However also in the ploughed systems, low nitrogen availability in spring warrants attention.

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Renewed interest for silvopastoral systems in Europe – an inventory of the feeding value of fodder trees

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Key words: tree leaves, digestibility, crude protein, minerals, CAP, greening measures

Abstract

The reform of the EU's Common Agricultural Policy (CAP) has created renewed interest in the implementation of agroforestry and silvopastoral systems. The multifunctional use of trees for energy and wood production, nutrient cycling, carbon storage, biodiversity, landscape quality and -last but not least- fodder makes trees a potential third crop next to grass and maize on dairy farms. To decide which trees to use for planting, it is important to have insight into the feeding value of the different species. Therefore we created a database on feeding values of leaves and twigs, using data from the literature. These data show that, compared to grass, the in-vitro organic matter digestibility of tree leaves is relatively low. However, crude protein and mineral levels of some species are relatively high, which shows the potential value of tree leaves as an additional feed source.

Introduction

The reform of the EU's Common Agricultural Policy (CAP), has created renewed interest in agroforestry and silvopastoral systems. The CAP includes several "greening measures" aimed to enhance biodiversity on farmland, such as creating Ecological Focus Areas (EFA) and requiring farmers to grow at least three crops on their farms. The multifunctional use of trees for energy and wood production, nutrient cycling, carbon storage, biodiversity and -last but not least- fodder, makes trees an interesting candidate to grow as a third crop on Dutch dairy farms, next to grass and maize. Theintroduction of fodder trees on dairy farms requires insight into the cultivation, harvest, production and feeding value of different species. The objective of this survey was to create a database of feeding values (energy, protein and mineral levels) of common tree species, and compare these data to the feeding value of grass (*Lolium perenne* L.).

Material and methods

Based on a literature review, records about the feeding value of leaves and twigs from temperate tree species were collected in a database (www.voederbomen.nl). The database includes studies from Germany (Becker and Nehring 1965, Rahmann 2004), the UK (Smith et al. 2012), the Netherlands (Van Eekeren unpublished), France (Trémolières 1999), Finland (Saramäki and Hytönen 2004), Greece (Papachristou and Papanastasis 1994) and studies from outside Europe (Burner et al. 2005, Chen et al. 2011, Roder 1992, Singh et al. 1997). The database includes records of tree leaves, twigs, and twigs with leaves of 40 different temperate tree species (620 records in total). Using this database, we compared the nutritive value of the leaves of a number of temperate fodder trees: alder (*Alnus glutinosa* L. Gaertn.), birch (*Betula pendula* Roth), hazel (*Corylus avellana* L.), beech (*Fagus sylvatica* L.), ash (*Fraxinus exelsior* L.), robinia (*Robinia pseudoacacia* L.), large-leaved lime (*Tilia platyphyllos* Scop.), and willow (*Salix alba* L.). The nutritive values for grass (*Lolium perenne* L.) are shown for comparison.

Results

The literature study showed that there are ample data available on feeding values of temperate fodder trees. Compared to grass, the in-vitro organic matter digestibility (OMD) of the different tree leaves is generally low (averages ranging from 30.6 to 57.8% for tree leaves, compared to 79% for grass) (Table 1). This is probably related to the high lignin and fiber content of tree leaves and/or the presence of secondary plant compounds such as tannins. Crude protein levels of the different tree species range from 15.7 to 21.4% of DM (Table 2). Some species, particularly lime tree (*T. platyphyllos*) and robinia (*R. pseudoacaccia*) have a higher average crude protein content than perennial rye grass in the Netherlands (16.5%). Average copper levels in tree leaves range from 7.7 to 15.3 mg kg-1 for the different species, compared to 8.9 mg kg-1 in grass (Table 3). Particularly hazel and beech leaves contain high levels of copper. This mineral is of interest because in the

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Table 1: In-vitro Organic Matter Digestibility (%) of tree leaves. Average (av), minimum (min), maximum (max) values and number of records (n) found in the literature.

Species	Common name	Av	Min	Max	n
Alnus glutinosa	Alder	48.1	10.4	69.1	6
Betulus pendula	Birch	37.6	5.9	63	3
Corylus avellana	Hazel	47.7	46.4	50.0	3
Fagus sylvatica	Beech	30.7	7.4	59.0	5
Fraxinus excelsior	Ash	34.1	12.8	55.3	2
Robinia pseudoacacia	Robinia	56.7	37.3	77.4	7
Salix spp.	Willow	57.8	4.5	70.5	5
Tilia platyphyllos	Large-leaved Lime	30.6	15.0	46.2	2
Lolium perenne	Grass	79.0			

Table 2: Crude protein levels in tree leaves (% of DM). Average (av), minimum (min), maximum (max) values and number of records (n) found in the literature.

Species	Common name	Av	Min	Max	n
Alnus glutinosa	Alder	19.2	14.4	26.2	6
Betulus pendula	Birch	17.5	14.0	22.9	5
Corylus avellana	Hazel	16.1	14.1	20.4	7
Fagus sylvatica	Beech	18.0	14.3	23.3	18
Fraxinus excelsior	Ash	15.7	5.9	26.8	8
Robinia pseudoacacia	Robinia	20.4	11.6	27.0	16
Salix spp.	Willow	15.9	9.8	23.1	10
Tilia platyphyllos	Large-leaved Lime	21.4	15.3	28.0	13
Lolium perenne	Grass	16.5			

Table 3: Copper levels in tree leaves (mg kg-1 DM). Average (av), minimum (min), maximum (max) values and number of records (n) found in the literature.

Species	Common name	Av	Min	Max	n
Alnus glutinosa	Alder	12.3	6.0	20.0	4
Betulus pendula	Birch	10.0	10.0	10.0	1
Corylus avellana	Hazel	13.1	8.5	18.0	4
Fagus sylvatica	Beech	15.3	6.5	24.0	2
Fraxinus excelsior	Ash	10.0	10.0	10.0	1
Robinia pseudoacacia	Robinia	7.7	7.0	8.3	2
Salix spp.	Willow	8.3	5.5	12.9	5
Tilia platyphyllos	Large-leaved Lime	8.0	8.0	8.0	1
Lolium perenne	Grass	8.9			

Discussion

Our analysis shows that various tree species are very interesting in terms of feeding value for livestock. Tree leaves could serve as alternative source of proteins, minerals and spore elements. However, the records in the database show a considerable range in feeding values for the same tree species. This range is probably due to seasonal differences (Smith et al. 2012), local soil conditions (Saramäki and Hytönen 2004, Wroblewska et al. 2009) and the ability of tree species to adapt to local conditions (Robinson 2005). Unfortunately, most studies did not record the soil conditions. Therefore we are now conducting a follow-up study to investigate the relation between feeding value of fodder trees and harvest date, soil type and soil fertility.

Suggestions to tackle with the future challenges of organic animal husbandry

Trees deliver a range of ecosystem services. The challenge for modern organic farmers is to make optimal use of the multi-functionality of trees, fine-tuned to the specific farming system and local conditions. The use of tree leaves as an alternative fodder crop is just one of the functions of trees on farms. Optimising this function with other uses (such as energy and wood production, and stimulation of functional biodiversity) could make trees a profitable crop for organic farming systems.

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Grass silage in diets for organic growing-finishing pigs

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Key words: pigs, grass silage, roughage, growth, performance

Abstract

In this study, organically raised pigs received an increasing proportion of grass silage up to 10 and 20% dry matter in the daily ration in the grower and finisher period, respectively, to determine the effects of grass silage on feed intake and growth performance. The pigs receiving a mixture of grass silage and compound feed ingested 0.3 kg DM/d (13% of their daily ration) as grass silage and realised a similar daily net energy intake as pigs fed compound feed only. However, the silage fed pigs realised a lower daily gain (37 g/d) and a lower calculated net energy utilisation (1.6 MJ/kg) for gain and a lower dressing percentage (1.1%) of the carcass. The optimal feeding system and the nutritive value of grass silage for growing pigs requires further investigation to improve the silage intake and clarify and minimise the loss in animal performance.

Introduction

In organic pigs farms in the EU, roughage must be added to the daily ration (Commission Regulation 889/2008). Inclusion of early harvested grass silage in the diet of growing finishing pigs may reduce the need for import of protein rich feed ingredients and contribute to the closure of regional nutrient cycles. However, information on the nutritive value of grass silage, the potential inclusion level in the diet and consequences for growth performance is scarce. Growing pigs with free access to both compound feed and silage, showed a high preference for compound feed and have a low silage intake (Van der Peet et al., 2006). Studies in sows suggest that silage intake is improved when cut at an early stage of maturity and ensiled with a relatively low dry matter (DM) content (Van der Peet-Schwering et al., 2010). Thus the present study was conducted to determine the effect of early harvested grass silage in a completely mixed ration, on performance and nutrient utilisation of growing pigs.

Material and methods

Animals, housing and design

This study has been conducted at the Research Farm for organic pig production in Raalte, the Netherlands from July 2011 to January 2012. The experiment comprised two dietary treatments:

1) control, pigs fed compound feed only
2) silage, pigs fed a mixture of compound feed and grass silage.

Each treatment comprised 8 pens with 16 pigs each, females and castrates mixed, in total 256 pigs (Pietrain x (Dutch Landrace x GY)) from 26 to 119 kg body weight. At a mean age of 11 weeks and a mean body weight of 26 kg, the pigs were blocked on the basis of offspring litter, gender, age and body weight and allocated to the two treatments. The pigs were housed in two naturally ventilated rooms with 8 pens each. Pen dimensions were 4.4 x 4.7 m of which 4.4 x 1.6 m was concrete slatted floor. Straw was used as bedding material in the closed area. In addition, each pen was connected to an outdoor area of 4.7 x 3.2 m, half of which had concrete slatted floors.

Diets and feeding

The aim of this experiment was to include grass silage in the daily ration of growing finishing pigs without substantial loss in performance. A completely mixed ration was used to avoid selection of compound feed. The proportion of grass silage was gradually increased in order to minimise selection and feed refusals. The pigs of each treatment received a similar amount of calculated net energy (NE) on the basis of a generous feeding scheme to allow (near) maximum feed intake. The compound feed and the mixture of compound feed and grass silage were supplied in a dry feeder with three eating places per pen. Water was freely available from nipple drinkers. Pigs of the control group received a grower diet (9.7 MJ NE, 8.8 g apparent ileal digestible (AID) lysine/kg) during the first 4 or 5 weeks, depending on the initial BW of the pigs per block, and a finisher diet (9.3 MJ NE, 7.0 g AID lysine/kg). The pigs in the grass silage group received a

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similar daily amount of calculated net energy from a mixture of these compound feeds and grass silage. The proportion of grass silage gradually increased from 0 to 10% on DM basis in the grower phase and from 12 to 20% DM in the finisher phase.

Grass silage was harvested from 4.6 ha of organic pasture, first cut on May 11, 2011 at an estimated yield of 3 tonnes of DM per ha and ensiled on the same day in large (350 kg) plastic covered bales. Six weeks later samples were taken from a representative number of bales and proximate composition was determined. The grass silage contained 32% DM, 192 g crude protein (CP) and 205 g crude fibre per kg. Based on digestibility studies with grass silage in sow diets (Van der Peet-Schwering et al., 2010) we estimated the NE value at 7.9 MJ/kg DM. Prior to feeding, the grass silage was cut in a mixer feeder wagon, weighed, mixed with concentrate and supplied to the pigs in a dry feeder in each pen. The daily feed allowance was supplied in 3-4 servings because of the large volume of the grass silage mixture. Each morning only a small amount of grass silage was left over in the trough.

Management and observations

Feed allowance and feed refusals were registered on a daily basis. The pigs were weighed at start of the experiment, at change-over from grower to finisher diets, four and eight weeks later and prior to slaughter. The animals were routinely controlled for any health disturbances and required medical treatments and death of animals was registered. The pigs were slaughtered at a minimum target carcass weight of 86 kg, as required to obtain a premium price for organic pigs. Pigs in each pen were slaughtered in two or three batches. Data of live weight and body gain of individual pigs were used to determine the optimal slaughter date. At slaughter, carcass weight was registered, dressing percentage was calculated from body weight prior to slaughter and carcass weight, and muscle and backfat thickness and lean meat percentage were determined using the HGP-method.

Statistical analysis

Feed intake, growth performance and carcass data were analysed with ANOVA for a randomised block design with pen as experimental unit, using Genstat statistical software. P<0.05 was regarded as significant.

Results

In the control treatment one pig died during the experiment and one pig was removed because of tail biting. Two pigs in the control group and one pig in the silage group were qualified as outliers with extremely poor growth and removed from the dataset. A summary of results for pig performance and carcass characteristics is presented in Table 1. The maximum inclusion of 10 and 20% grass silage was realised in week 4 of the grower period and week 3 of the finisher period, respectively (data not shown). Due to the gradual increase in the proportion of silage, and due to leftovers of grass silage, the mean ingested proportion of grass silage was 6 and 15% from the grower and finisher ration, respectively. Overall, the silage intake was 0.3 kg dry matter/day, being 13% of DM and 10% of NE of the daily ration.

The pigs were fed according to a feeding scheme. The reduction in compound feed intake was similar to the calculated energy intake from grass silage, corrected for leftovers. Despite a similar energy intake of 23 MJ NE per day, the daily gain was substantially lower (37 g/d, P=0.002) and the energy usage per kg of body gain substantially higher (1.6 MJ NE/kg body gain, P=0.02) in silage fed pigs. The carcass weight and dressing percentage of the silage fed pigs was significantly lower whereas the lean meat percentage, corrected for carcass weight, was similar for the two treatment groups. Daily gain corrected for dressing percentage was 50 g/d lower (P<0.001) in silage fed pigs. Several reasons may have contributed to this reduction in feed utilisation. The actual intake of feed, especially silage may have been lower than calculated because of feed spillage. Indeed some grass silage was observed in de bedding material of the pen. Furthermore, the digestibility and net energy content of the grass silage may have been lower than 7.9 MJ/kg dry matter as calculated on the basis of proximate composition and previous digestibility studies in sows. Digestibility of fibrous ingredients may be higher in sows than in growing pigs (Shi and Noblet,1993). A digestibility study in growing pigs should further clarify this aspect. It seems unlikely that the amino acid supply was limiting in the grass silage diet since the muscle thickness and lean meat content were not reduced in silage fed pigs. Finally, pigs receiving the grass silage may have used more energy for maintenance processes, In our facilities with three eating places per pen of 16 pigs, observations of farm staff indicate that inclusion of grass silage increased time required for eating and competition at the feeder. In addition, the increased visceral mass due to ingestion of fibrous feed, as indicate by the lower dressing percentage, may have increased the energy expenditure of the metabolic organs (Jørgensen et al., 1996). A further reduction of the particle size of the grass silage may improve digestion and reduce spillage of the feed material. Further studies are required and planned to elaborate these aspects.

Table 1: Effect of supply of grass silage in a completely mixed ration on growth performance and carcass characteristics in organically raised growing finishing pigs.

	Control	Grass silage	SEM[1]	P-value
Number of pigs	124	127		
Number of pens	8	8		
Initial body weight (kg)	26.1	26.1	0.02	0.69
Final body weight (kg)	119.4	118.7	0.57	0.38
Variation in final body weight (kg)	5.8	4.6	0.38	0.06
Days to slaughter	104.1	107.8	-	-
Feed intake				
Compound feed (kg/d)	2.44	2.24	0.026	<0.001
Grass silage (kg DM/d)	-	0.29	-	-
Proportion of silage (DM-basis)	-	12.8%	-	-
Compound feed (MJ NE/d)	22.9	20.9	0.26	0.001
Grass silage (MJ NE/d)	-	2.3	-	-
Complete ration (MJ NE/d)	22.9	23.2	0.27	0.34
Daily gain (g/d)	897	860	5.3	0.002
Corrected daily gain (g/d)[2]	890	841	4.9	<0.001
Feed conversion (MJ NE/kg)	25.5	27.1	0.40	0.02
Corrected feed conversion (MJ NE/kg)[2]	25.7	27.6	0.38	0.007
Carcass characteristics				
Carcass weight (kg)	93.1	91.2	0.40	0.01
Dressing percentage	78.0	76.9	0.28	0.03
Lean meat (%)[3,4]	56.7	57.2	0.27	0.26
Muscle thickness (mm)[3,4]	61.0	61.1	0.93	0.96
Back fat thickness (mm)[3,4]	16.5	15.9	0.24	0.12

[1] SEM, pooled standard error of the mean
[2] Corrected for differences in dressing percentage, i.e. based on carcass gain
[3] Determined with the Hennessy Grading Probe (HGP) between the 3rd and 4th rib
[4] Analysed using carcass weight as covariate in the statistical model

Discussion

Grass silage in the ration of growing pigs may increase the use of locally produced feed materials. We used a completely mixed ration to avoid selection of compound feed. The realised silage intake in the grower period may be too low in relation to costs of labour and equipment for feeding grass silage. In late finisher pigs a higher proportion of grass silage can be included in the ration since leftovers were small and the realised portion of ingested grass silage was close to 20%. Further increase in the proportion of grass silage may be possible provided that the feeding system allows adequate time and space for feed consumption. Our feeding system with dry feeders limited the silage intake; the optimal feeding system requires further attention. In addition, daily gain, energy utilisation for gain and dressing percentage were lower in silage fed pigs. Thus, the nutritive value of grass silage for growing pigs requires further investigation to clarify and minimise the loss in animal performance. A reduction of the particle size by chopping the grass may improve digestion and reduce spillage of the feed material.

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Silage in diets for organic sows in gestation

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Key words: sows, roughage, grass silage, mixed silage, feed intake

Abstract

This study was conducted to determine whether the supply of grass silage or grass silage mixed with barley or CCM to organically raised gestating sows allows a reduction of compound feed allowance. Sows fed grass silage or mixed silage compensated for a pre-set reduction of 1 kg or 1.5 kg compound feed, respectively. However, the variation in silage intake between individual sows was large, with a number of mainly young sows consuming less silage than the required amount. These sows showed a net back fat loss during the experimental period from d 7 of gestation to weaning. More feeder space than 1 place for 8 sows is required to allow adequate silage intake in group housed sows. It is unclear whether this would also allow young sows to realise an adequate silage intake. In conclusion, it seems possible to replace 1 kg compound feed by free access to grass silage and 1.5 kg compound feed by mixed barley or CCM silage, provided that variation between sows is reduced and young sows also ingest an adequate amount of silage.

Introduction

The daily ration of organically raised pigs in the EU needs to contain roughage, fresh or dried fodder or silage (Commission Regulation 889/2008). In the Netherlands, during the winter period, pregnant sows kept on organic farms generally are provided with grass silage. In order to reduce feed costs and avoid excessive fatness, the supply of compound feed should be reduced accordingly. However, because the silage intake of individual sows is not well known, it is difficult to establish the amount of concentrate that is additionally required to meet the nutrient standards in gestation. Moreover, by mixing grass silage with cereal grain or corn cob mix (CCM), the silage supply may further reduce the requirements of compound feed. Therefore, this study was conducted to determine the intake of two types of grass silage and grass silage mixed with barley grain or CCM, to determine how much the compound feed allowance could be reduced and and the consequences on body condition of the sows.

Material and methods

Animals, housing and design: This study has been conducted in 38 primiparous and multiparous reproductive sows (Dutch Landrace x GY) at the Research Farm for organic pig production in Raalte, the Netherlands. The experiment comprised five dietary treatments:

1. Grass silage, first cut, harvested in an early stage (early grass silage)
2. Grass silage, first cut, harvested in a late stage (late grass silage)
3. Grass silage, early harvest, ensiled after mixing with barley (barley silage)
4. Grass silage, early harvest, ensiled after mixing with CCM (CCM silage)
5. Control treatment with compound feed only

Each treatment comprised one pen of 7-8 group-housed sows from 7 to 105 days of gestation. All pens were located in one naturally ventilated room for gestating sows. Each pen comprised 8 feeding stalls to temporarily restrict the sows for individual supply of compound feed. The remaining of the pen was a deep litter area with straw bedding. In addition, each pen was connected to a partly covered outdoor area of 4.25 x 4.4 m, half of which had concrete slatted floors. At day 105 of gestation, the sows were placed in farrowing rooms with six pens (2.0 x 3.75 m) each with straw bedding and an outdoor area of 3.5 m^2. Each pen had a covered and heated area for the suckling piglets.

Diets and feeding: Sows in treatments 1 to 4 had free access to silage during daytime between 7 and 105 days of gestation. Silage was provided in a trough with electronic identification of sows, electronic weight registration (RIC, Roughage Intake Control), and one eating place per group of 8 sows, to register silage intake of the sows. This trough was in the covered outdoor area of the pens. Based on prior experience (Van Krimpen et al., 2006), it was assumed that grass silage and mixed CCM or barley silage could replace 1.0 and 1.5 kg of concentrate per day (8.8 and 13.2 MJ net energy (**NE**)), respectively. Therefore, the standard daily allowance of compound feed was adjusted accordingly (Table 1). The compound feed was supplied in

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one meal in the morning while sows were confined in feeding stalls for max. one hour to enable individual feeding. Water was freely available from nipple drinkers.

Table 1: Daily allowance of compound feed in gestation (kg/d)[1)]

Treatment	Early grass silage	Late grass silage	Mixed barley silage	Mixed CCM silage	Control, no silage
Until day 7[2)]	2.5	2.5	2.5	2.5	2.5
Days 0 – 84	1.5	1.5	1.0	1.0	2.5
Days 85 – 105	2.2	2.2	1.7	1.7	3.2
Dag 105 – 112[3)]	3.2	3.2	3.2	3.2	3.2

[1)] In addition, all sows received 0.7 kg/d winter allowance from December to March
[2,3)] sows in mating stalls and in the farrowing rooms, respectively, no silage in the ration

Early and late grass silage was harvested from organic pasture, first cut at May 1 and 21, respectively, at an estimated yield of 2.0 and 3.5 tonnes of dry matter (**DM**) per ha, respectively, and ensiled on the same day. Part of the early cut grass was mixed with approximately 30% ground CCM or barley prior to ensiling to increase the starch and energy content of the silage and allow the replacement of a larger amount of compound feed. A standard organic compound feed (8.8 MJ NE, 4.9 g digestible lysine/kg) for gestating sows was supplied to sows of the control treatment. Because of the lower daily allowance of compound feed in silage fed sows, the vitamin and mineral content was increased accordingly to allow the same daily intake of these micronutrients in all treatments. In addition, the protein and amino acid content was increased in the compound feed (8.8 MJ NE, 6.4 g digestible lysine/kg) for mixed silage fed sows to compensate for the low amino acid content in barley and CCM.

Management and observations: Feed allowance, feed refusals of compound feed and intake of silage during gestation were registered daily. Body weight (**BW**) and backfat (**BF**) of the sows was registered on day 7, 42, 77, and 105 of gestation, after farrowing and at weaning. Reproductive performance of the sows was registered, i.e. litter size, still birth, birth weight, cross fostering, mortality, number of weaned pigs and intake of creep feed. Cross fostering was allowed within treatment group and piglets were weaned at 42 days of age. The animals were routinely controlled for any health disturbances and required medical treatments and death of animals was registered.

Statistical analysis: Feed intake, BW and BF, and reproductive performance were analysed with ANOVA for a randomised block design with sow as experimental unit, using Genstat statistical software. $P<0.05$ was regarded as significant.

Results

Silage composition: The composition and estimated NE content of the silages is presented in Table 2. Late cut grass silage had a lower crude protein content and higher crude fibre content than early cut silage. Barley and CCM silage had a higher starch and NE content than early and late grass silage. The calculation of NE intake of the sows was based on the values in Table 2.

Table 2: Analysed composition of grass silage and barley and CCM silage (g/kg DM)

	Early grass silage	Late grass silage	Mixed barley silage	Mixed CCM silage
Dry matter (as fed)	258	259	346	326
Crude protein	165	129	170	145
Crude fat (HCl)	45	45	37	44
Crude fibre	227	287	171	173
Crude ash	131	108	100	93
Starch	< 10	< 10	136	134
Sugar	70	25	70	35
Net energy (MJ/kg)[1)]	7.5	7.0	8.5	8.8

[1)] NE calculated on the basis of CVB (2007) and digestibility of grass silage in sows according to Van der Peet-Schwering et al. (2010).

Silage intake: The mean daily NE intake (Table 3) was 10-12 MJ from grass silage, 18 MJ from barley silage and 26 MJ from CCM silage. The higher energy intake from mixed silage was caused by a higher DM intake and a higher NE content per kg DM. Consequently, the silage fed sows were able to compensate for the reduction in compound feed supply as described in Table 1. However, results per sow in Figure 1 show a large variation in individual silage intake of the sows, from less than 0.1 to over 6 kg DM/d.

Table 3: Effect of type of silage on feed intake of sows in gestation

	Early grass silage	Late grass silage	Mixed barley silage	Mixed CCM silage	SEM[1]	P-value
Number of sows	8	7	8	7		
Time spent eating silage (min/d)	42	54	42	66	17	0.72
Silage intake/visit (kg)	0.31[ab]	0.22[a]	0.44[c]	0.36[bc]	0.04	0.008
Silage intake (kg/d)	6.1	6.1	6.1	8.9	2.1	0.72
Silage intake (kg DM/d)	1.57	1.52	2.12	2.90	0.62	0.45
Silage intake (MJ NE/d)	11.8	10.6	18.1	25.5	5.1	0.19
Total feed intake (MJ NE/d)	32.2	28.8	34.3	40.3	5.1	0.48

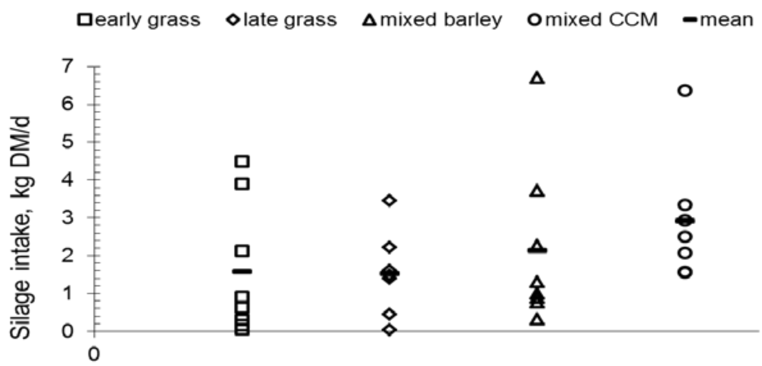

Figure 1. Mean daily silage intake of individual sows during gestation

Body condition of sows: The mean body weight gain of the sows in gestation (days 7-105) was 68 kg and was not affected by dietary treatment. The increase in BF was higher (P<0.001) for sows fed CCM silage (5 mm) as compared to the sows of the other silage groups (2-3 mm) (Figure 2). During the full cycle of gestation and lactation, the sows of the grass silage group tended to loose BF whereas the sows fed CCM silage gained in BF thickness.

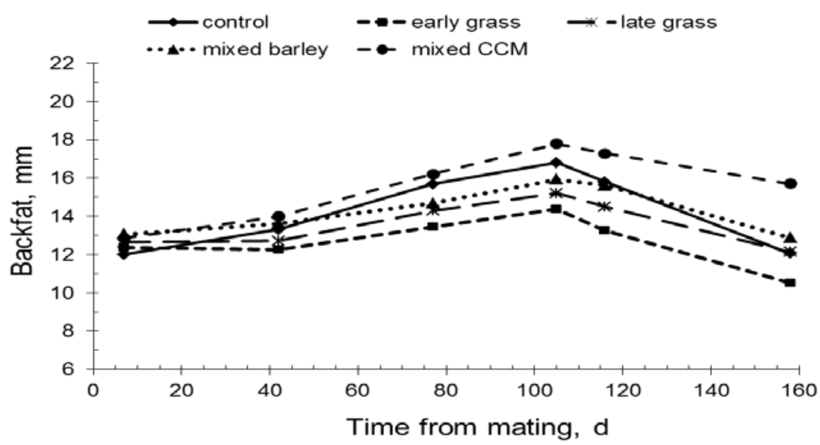

Figure 2. Effect of silage intake on development of BF in gestation and lactation

As illustrated in Figure 3, the development in BF was largely affected by the individual NE intake from silage of the sows. Results in Figure 3 illustrate a significant relationship between energy intake from silage and BF gain (or loss) from day 7 of gestation to weaning.

Reproductive performance

The mean litter size was 16.2 live born and 1.1 still born piglets. The mean birth weight of live born piglets was 1.21 kg and the weaning weight 11.4 kg. Reproductive performance was not significantly affected by dietary treatment, although the weaning weight of piglets tended to be lower (10.4 kg, P=0.07) for sows receiving CCM silage in gestation.

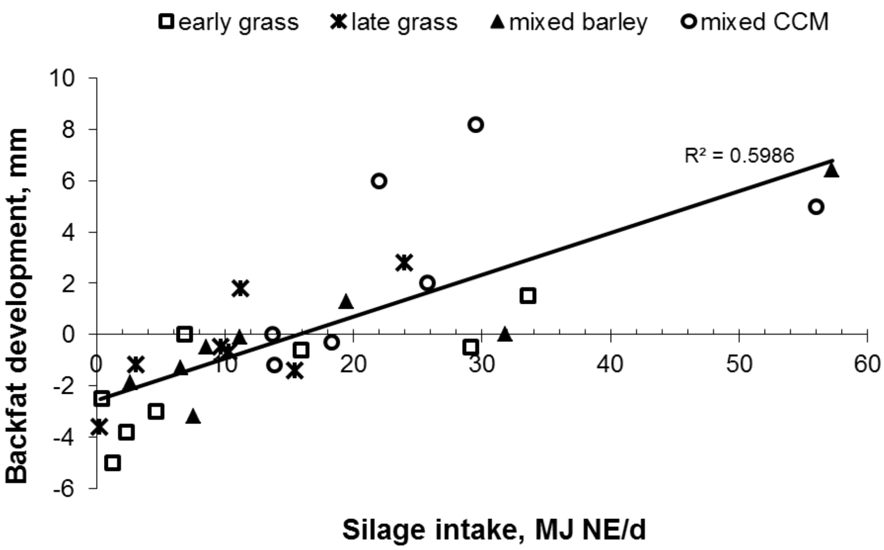

Figure 3 Relationship between NE intake from silage and BF gain from d 7 of gestation to weaning

Discussion

This experiment was conducted to determine whether the supply of grass silage alone or mixed with CCM or barley could replace a proportion of the compound feed in gestating sows. The allowance of compound feed was reduced for silage fed sows to stimulate silage intake. The mean daily intake of grass silage, mixed barley and CCM silage confirmed that on average the sows were able to compensate for the reduced compound feed allowance. Nonetheless, the individual silage intake of sows drastically varied between individual animals with a lower mean intake in young sows than in older sows. This may have been caused by competition between sows because of limited feeder space and/or because of a lower ingestive capacity of young sows. As a result, a number of sows was not able to consume an adequate amount of feed required for a constant BF thickness. More feeder space is required to allow adequate silage intake in group housed sows. We cannot derive whether that would also allow young sows to realise an adequate silage intake. In conclusion, it seems possible to replace 1 kg compound feed by free access to grass silage and 1.5 kg compound by mixed barley or CCM silage, provided that variation between sows is reduced and young sows would also be able to ingest an adequate amount of silage.

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A Study Of Subclinical Mastitis in Two Herds, One Managed Organically, the Other Conventionally, and the Effect of Different Management Strategies

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Key words: mastitis, organic, bulk milk somatic cell count, management

Abstract

Mastitis in two herds managed as a comparison between organic and conventional dairy farming systems was monitored for 9 years utilising regular bacterial culture of milk samples, individual and bulk somatic cell counts and observation by farm staff. The most important isolates in pure cultures were coagulase-negative staphylococci, Staphylococcus aureus, Streptococcus uberis, and the common contaminant Bacillus spp. Positive cultures were generally not associated with subclinical mastitis. The aim of the project was to develop strategies for the control of mastitis in organic cows without the use of antibiotics. Within a set of key control measures, two management strategies were trialled, one of which reduced the prevalence of subclinical mastitis to very low levels.

Introduction

Between 2001 and 2011, Massey University set up its Dairy Cattle Research Unit (DCRU) as a system comparison between organic and conventional farming. The farm was a seasonal producer with calving from late July until mid-October. All cows were dried off by the end of May, the exact date depending largely on pasture availability.

The DCRU was split into two similar units. The organic unit carried typically 44 cows (2.27cows/Ha) and the conventional 51 (2.39cows/Ha), respectively. From August 2006, all organic dairy suppliers to Fonterra NZ Ltd were required to meet the standards set by the USDA National Organics Program. Each of the two units was managed individually according to "best practice" for its particular type of management system. The project has been described in detail by Kelly *et al* (2006).

Mastitis control for the conventional herd was based on New Zealand's Seasonal Approach to Managing Mastitis (SAMM) Plan, a nationwide scheme administered by the National Mastitis Advisory Committee. Control in the organic herd was based on the same principles excluding (since 2005) the use of antibiotics. In particular, emphasis was placed on key measures: vigilance, separation of infected cows, a clean stress-free environment, high quality teat spraying, post-milking stripping of high somatic cell count (SCC) quarters, appropriate treatment, supportive therapy and appropriate culling. An iodine-based teat spray was used on both herds post milking. Financial penalties apply to bulk milk submitted with a SCC exceeding 400,000 cells per mL.
The predominant major mastitis pathogens in New Zealand are *Streptococcus uberis* and *Staphylococcus aureus*. The most commonly isolated minor pathogens are coagulase-negative staphylococci (CNS) (Petrovski et al, 2011). Prevalence of subclinical mastitis (SCM) is an important pre-requisite to estimating the cost of mastitis to the dairy industry (Petrovski *et al*, 2006). A previous paper reported on mastitis in the two herds from 2003 to 2007 (Thatcher et al, 2008). This paper presents the prevalence of SCM and describes the bulk milk somatic cell count (BMSCC) of both herds from the 2006/07 season to the end of the project in 2011.

Material and methods

In November 2003, a sampling regime began whereby milk from each quarter of each cow in both herds was submitted for bacterial culture. Sampling occurred 4 times per season; at calving, 14 days after calving, at mid lactation and at drying off. Culture and classification of organisms was carried out by New Zealand Veterinary Pathology Ltd. Additional data was gathered from monthly individual somatic cell counts (ISCC) carried out by the Livestock Improvement Corporation as part of routine herd testing and daily BMSCC

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provided by Fonterra. DCRU staff carried out regular California Mastitis Tests (CMT) on known or suspected infected cows.

In February 2008 a new manager was appointed. The two managers covering the period from 2006 to 2011 had different approaches within the framework of control strategies. These tended to reflect the strategies adopted by commercial organic farmers:

Manager 1 (May 2006 - December 2007): Emphasis on maximising saleable milk. Vigilance was vital for this to be effective as it involved adding milk from cows with higher ISCC to the bulk supply when BMSCC was low and withdrawing milk from those cows when it was high. The risk was that miscalculation may result in an elevated BMSCC penalty. Perhaps more importantly, the cows with higher ISCC were a risk to uninfected cows unless kept separated (logistically difficult at DCRU).
Manager 2 (February 2008 – May 2011): Emphasis on minimising the BMSCC from the middle of the 2008/09 season. This involved initially a higher culling rate and volume of milk discarded but minimised the risk of spread of contagious organisms. Segregation of known infected cows was undertaken as far as was practical and a small number of chronically infected quarters were dried off. The management changes are described in detail by Thatcher et al (2010).

Somatic cell count data were assessed by repeated Analysis of Variance using the MIXED function in SAS 9.3 (Cary Inc, USA). All other comparisons were made using the student t-test.

Results

The majority of quarters culture positive to *S. uberis* or CNS did not develop chronic SCM, as determined by concurrent ISCC or a positive CMT. There was a moderate association between a positive culture for *S. aureus* and a chronically elevated ISCC.Numbers of cows affected by SCM are presented in Table 1.

Table 1: Number of cows with an elevated individual cow somatic cell count (>150,000 cells/mL for cows or 120,000 cells/mL for heifers) two or more times per season

Season	2006/07	2007/08	2008/09	2009/10	2010/11
Organic	21	16	16	4	12
Conventional	14	16	13	6	9

Average seasonal BMSCC for both herds is presented in Table 2. From 2006 – 2008 the organic herd BMSCC exceeded the penalty level of 400,000 cells/ml 10 times and the conventional herd 6 times. From 2009 – 2011 the penalty level with the organic herd was exceeded once and the conventional herd never. For the 2009/10 season, the organic herd achieved the 44th lowest average BMSCC for Fonterra suppliers, covering some 90% of dairy farms in New Zealand. The conventional herd was the 56th lowest. BMSCC of both herds rose during the summer of 2010/11 associated with an increase in the prevalence of major pathogens but fell again towards the end of the season (Table 3). The season was also characterised by a substantial rise in both the prevalence of CNS and *Bacillus* species recovered from milk samples. CNS became very prevalent in the organic herd but only very few cases were associated with a rise in ISCC. There was no relationship with the presence of *Bacillus* and a raised SCC in the gland from which it was recovered but there was a strong association with the presence of CNS in the same sample.

Table 2: Average bulk milk somatic cell count (BMSCC) in thousands per mL and the number of BMSCC penalties (>400,000 cells/mL) for each herd by season.

Season	2006/07	2007/08	2008/09	2009/10	2010/11
Organic	233	226	148	67	145
Conventional	194	195	154	75	139
BMSCC penalties organic, conventional	3, 2	4, 2	3, 2	0, 0	1, 0

Although the project finished in May 2011, the organic herd was retained for a further 1½ seasons. Average BMSCC for the 2011/12 season was 156,000. Average BMSCC from the start of the 2012/13 season until the herd was disbanded in January 2013 was 126,000 and there was one penalty for this entire period.

Table 3: Number of bacteriologically positive cows (any sample) associated with an increased individual cow somatic cell count (>150,000 cells/mL for cows, 120,000 cells/mLfor heifers) in each herd, by season

Season	2009/10		2010/11	
	organic	conventional	organic	conventional
Staphylococcus aureus	0	1	4	2
Streptococcus uberis	0	2	6	2
Streeptococcus dysgalactia	0	0	1	3
Coagulase-negative staphylococci	4	4	6	3

While between 2003 and 2007 typically 2 – 4 organic and 1 – 3 conventional cows were culled for chronic mastitis per season, a total of 9 organic and 6 conventional cows were culled for this reason between January 2009 and May 2010 (encompassing 1½ seasons). One cow was culled for mastitis from each herd during the 2010/11 season, thus the average cull rate between 2008 and 2011 was not significantly different from the period 2003 to 2007.

Discussion

The previous paper identified control of *S. aureus* as the most important factor in managing mastitis in a pastoral-based organic herd, while environmental pathogens were easier to control with adequate management of the cow's surroundings. The difficulty in eliminating *S. aureus* once well established in the udder means BMSCC may remain relatively high despite minimal spread of infection between cows. Management of BMSCC focused on the relatively small proportion of chronic SCM cases, identified by ISCC and monitored on a daily basis using the California Mastitis Test. Initial changes in management procedures targeting the incidence of *S. aureus* in the organic herd were instigated at the start of the 2006/07 season. Although there was a decline in the incidence of *S. aureus* and CNS recovered from milk samples and in the incidence of clinical mastitis in the organic herd, BMSCC remained relatively high.

From late in the 2008/09 season the removal of chronically infected cows and drying off a limited number of selected quarters resulted in the incidence of *S. aureus* detected in milk samples falling to very low levels. It was also characterised by a marked decline in the prevalence of subclinical infections. The 2010/11 season was similarly characterised by a low prevalence of *S. aureus.* However, the summer of 2010/11 was unusually wet and the rise in BMSCC of both herds at this time may have been due to a decline in the effectiveness of teat spraying typical of wet weather. Detection of *Bacillus* species in milk samples tends to indicate teats contaminated with mud and an increase in the incidence of *S. uberis* and *S. dysgalactiae* may have resulted from that. However, presence of *Streptococci* in samples remained relatively low (< 5% of quarters from day 14, both herds) indicating that measures to control faecal contamination of teats at critical times of year remained largely effective. The prevalence of SCM was not increased in quarters with *Bacillus* isolates indicating that intramammary infection was unlikely to be caused by this organism. The strong association between the concurrent presence of *Bacillus* species and CNS further points to teat spraying issues, particularly mid-season. Additionally, as the project was coming to an end, vigilance of farm staff may have declined.

Conclusion

It has been demonstrated that removal and/or segregation of high ISCC cows along with limited drying off of chronically infected quarters while maintaining strict measures to prevent spread of infection has a longer term benefit in reducing the prevalence of SCM and the likelihood of BMSCC penalties. Thus, instituting these measures can enable good control of mastitis in organic herds

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Soil Nutrient Status and okra pod yield as Influenced by plant density and Cattle dung Manure Application

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Key words: Cattle dung, plant density, okra, pod yield.

Abstract

The productivity of okra was enhanced by application of cattle dung which influenced soil nutrient status positively. Highest pod yield (7.39 t ha^{-1}) was obtained with 83,333 plants per hectare (pph)) and 450 kg N ha^{-1} cattle dung application. However, the population of 83,333 pph and 300 kg N ha^{-1} cattle dung application which gave the highest return per naira invested (3.28) and benefit: cost ratio (2.93) was assessed to be the best combination for optimum yield (7.13 t ha^{-1}).

Introduction

Low native soil fertility and in-appropriate plant population constrained okra production in Nigeria. Organic manure ameliorated nutrient imbalance, soil acidity, low organic matter, scarcity and high cost (Akanni *et al.,* 2011) which may improve okra productivity. Cattle dung contains appreciable content of organic matter. Three levels of cattle dung (0, 300 and 450 kg N ha^{-1}) and three plant densities (47,619, 66,666 and 83,333 plants per hectares (pph)) were evaluated to determine the best option for okra pod yield. The effect of organic amendment (cattle dung) on soil nutrient status was also considered.

Material and methods

The study was conducted for two years at the University of Benin, Benin Research farm located within Latitude 6^{0}14′ S and 7^{0}34′ N and Longitude 5^{0}40′ and 6^{0}43′ E. There were nine treatment combinations from two factors laid out in randomized complete block design (RCBD). The first factor was cattle dung application ((0, 300 and 450 kg ha^{-1})) incorporated into the soil two weeks before sowing okra seeds. The second factor was plant population derived by intra and inter row spacing of plants at 30 x 70 cm, 30 x 50 cm and 30 x 40 cm, to give plant densities of 47,619, 66,666 and 83,333 pph, respectively. Pre-sowing soil surface (0 – 15 cm depth) were collected on treatment basis from each plots and processed for chemical analysis as described by Mylavarapus and Kennelley (2002). Data obtained were combined and subjected to analysis of variance using SAS. Economic analysis was determined for the most profitable combination of tested factors for okra production (Erhabor, 2005).

Results

The cattle dung contained the following: organic C (5.65 %), total N (2.25 %), available P (890.00 mg kg^{-1}), Ca (2.00 cmol kg^{-1}), Mg (0.56 cmol kg^{-1}) and K (0.37 cmol kg^{-1}).

Table 1: Soil chemical properties after cattle dung application

Cattle dung	pH	Organic C	Toatal N	Available P	Exchangeable cation (cmol kg-1)		
(kg N ha^{-1})		(%)	(%)	(mg kg^{-1})	Ca	Mg	K
0	4.82	0.95	0.07	19.90	2.69	1.17	0.37
300	5.50	1.27	0.10	27.60	4.55	1.96	1.00
450	5.56	1.36	0.10	22.10	4.69	2.00	1.07
LSD(0.05)	0.560	0.173	0.013	7.370	1.227	0.716	0.383

The soil chemical properties after cattle dung application is presented in Table 1. Cattle dung application had significant effects on soil chemical properties. Soil pH was highest in plots treated with 450 kg N cattle dung ha^{-1} (5.56) and this was statistically similar to 300 kg N cattle ha^{-1} treated plots (5.50). Similar trend was observed in organic C, total N and exchangeable cations. In terms of available P, cattle dung application was only significantly different between control plots and those plots treated with 300 kg N ha^{-1} cattle dung. However, untreated plots and plots treated with 450 kg N cattle ha^{-1} were statistically comparable.

Table 2: Effects of plant density and cattle dung on pod yield

Plant density (pph)	Pod yield (g stand^{-1}) Cattle dung (kg N ha^{-1})				Pod yield (t ha^{-1}) Cattle dung (kg N ha^{-1})			
	0	300	450	Mean	0	300	450	Mean
47,619	44.00	132.00	136.33	104.11	2.09	6.29	6.50	4.96
66,666	25.33	99.67	102.67	75.89	1.70	6.64	6.84	5.06
83,333	20.33	85.67	88.67	64.89	1.69	7.13	7.39	5.4
Mean	29.89	105.78	109.22	81.63	1.83	6.69	6.91	5.14
LSD(0.05) Cattle dung				3.908				0.226
LSD(0.05) Plant density				3.908				0.226
LSD(0.05) Cattle dung x plant density				5.037				0.374

Pod yield per stand responded significantly to cow dung application and plant density (Table 2). Pod yield obtained with 300 and 450 kg ha^{-1} N was statistically comparable. Pod yield per stand decreased as plant population per hectare increased. Plant density and cattle dung application interaction significantly enhanced yield. A plant population of 83,333 pph and cow dung application rate of 450 kg N ha^{-1} recorded the highest yield (7.39 t ha^{-1}) which was statistically at par with those produced from treatments combinations of 83,333 pph and 300 kg N ha^{-1} and 66,666 pph and 450 kg N ha^{-1} with 7.13 and 6.84 t ha^{-1}, respectively.

Discussion

Increase in soil pH, N, P, Ca, Mg, K and organic C after cattle dung application is attributed to the amending effects of cattle dung. Okra benefited from cattle dung application which increased soil nutrients to the crop. This was manifested by the significant pod yield increase in treated plots. This trial clearly showed that higher plant density maximized pod yield through better light use efficiency.

This study revealed that okra pod productivity can be boosted to ensure sustainability and optimum yield through cattle dung application and plant density manipulation. The economic analysis showed that despite high production cost associated with the application of cattle dung in okra production, the venture is profitable. The optimum yield was obtained from a population of 83333 pph and 300 kg N cattle dung ha-1 which had the highest return per naira invested (3.28) and benefit: cost ratio (2.93).

Table 1: Economic analysis of the effect of cattle dung application and plant density on the performance of okra

Plant density	Item (₦)	Cattle dung application (kg N ha^{-1})		
(pph)		0	300	450
47619	Output (t ha^{-1})	2.09	6.29	6.50
	Total fixed cost	19,437.63	19,437.63	19,437.63
	Total variable cost	139,911.03	158,711.03	168,401.03
	Cost of production	159,348.66	178,208.66	187,838.66
	Total revenue	160,000.00	475,000.00	467,000.00
	Gross margin	200,088.97	316,228.97	298,598.97
	Net return	651.34	296,791.34	279,161.34
	Return per ₦ invested	1.14	2.99	2.83
	Benefit : cost ratio	1.00	2.67	2.49
66,666	Output (t ha^{-1})	1.70	6.64	6.84
	Total fixed cost	19,437.63	19,437.63	19,437.63
	Total variable cost	142,523.35	161,783.35	171,313.35
	Cost of production	162,360.98	181,220.98	190,650.98
	Total revenue	150,000.00	512,500.00	550,000.00
	Gross margin	7,476.65	350,716.00	378,786.60
	Net return	(-11,960.98)	331,279.02	359,348.97
	Return per ₦ invested	1.05	3.17	3.21
	Benefit : cost ratio	0.92	2.83	2.88
83,333	Output (t ha^{-1})	1.69	7.13	7.39
	Total fixed cost	19,437.63	19,437.63	19,437.63
	Total variable cost	145,559.26	164,419.26	173,839.26
	Cost of production	164,994.89	183,854.89	193,264.89
	Total revenue	142,500.00	540,000.00	557,250.00
	Gross margin	(-3,059.59)	375,580.74	388,410.74
	Net return	(-22,496.89)	356,145.02	363,973.11
	Return per ₦ invested	0.98	3.28	3.21
	Benefit : cost ratio	0.86	2.93	2.88

Assumption for economic analysis: Exchange rate ₦ 162 = $1

Total cost of production increased as the rate of cattle dung application and plant density increased up to the highest level (Table 3). Revenue, gross margin and net profit increased as cattle dung increased up to 450 kg N ha^{-1} (Table 3). Return per naira and Benefit: cost ratio was highest at a population of 83,333 plants and 300 kg N ha^{-1} cattle dung.

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Potentials of organic sesame production in humid tropical africa

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Key words: accessions, grain yield, sesame, varieties

Abstract

The development and release of improved and high yielding sesame varieties can fast track the drive to meet the increasing global demand for certified organic sesame. Sixteen varieties of sesame (E-8 (Check), NCRIBEN-01M, NCRIBEN-02M, NCRIBEN-03L, PBTil, Domu, ABBS, 530-6-1, Cameroon white, CIANO-16, CIANO-27, Pachequeno, Kwandere, Eva, Adakuawari and CROSS-95) were evaluated for their yield performance under organic system in 2010 – 2012. The grain yield of all the test varieties were greater than the world average (490 kg ha^{-1}), except Cameroon white and Domu when growing conditions were favourable in 2010 and 2011. However, under less favourable growing conditions of 2012, only Kwandere, Adakuawari, CIANO-27, ABBS, 530-6-1, PBTil, NCRIBEN-02M and E-8 recorded grain yield above world average. It is therefore, recommended that Kwandere, Adakuawari, CIANO-27 and NCRIBEN-02M be advanced to the farmers for large scale production alongside the varieties already with them.

Introduction

Sesame (*Sesamum indicum* L.) is an old oilseed crop grown mainly for its seed which contains approximately 50% oil and 25% protein (Burden 2005). There is an increasing global demand for organic sesame because of the growing health consciousness and high nutritional qualities of sesame seeds as excellent source of food, edible oil and bio-medicine (WIKIPEDIA, 2012). The potential of organic sesame has been grossly underutilized hitherto in Africa even though the continent is naturally endowed with climate favorable for sesame cultivation (Olowe et al. 2009). Unfortunately, the current world average yield of sesame still remains low at 0.49 t ha $^{-1}$ as against 5.5 t ha $^{-1}$ recorded as average composite yield in the European Union (FAO 2012). Therefore, this study was carried out to evaluate the yield performance of recently released and some newly acquired accessions of sesame under organic system with a view to recommending those with high yield potential for cultivation.

Material and methods

The three year field studies were conducted on the research plots of the Organic Agriculture Projects in Tertiary Institutions in Nigeria (OAPTIN) situated at the Teaching and Research farm of the Federal University of Agriculture, Abeokuta (7^o 15´ N, 3^o 25´ E, 140 m.a.b.s.l) during the late cropping season (July – November) of 2010, 2011 and 2012. A total of fourteen and fifteen varieties were evaluated in 2010 and 2011, and 2012, respectively and their details were as follows: E-8 (Check), recently released (NRICBEN-01M, NCRIBEN-02M and NCRIBEN-03L), available with farmers (PBTil, Domu, ABBS, and 530-6-1), and recently acquired accessions (Cameroon white, CIANO-16, CIANO-27, Pachequeno, Kwandere, Eva, Adakuawari and CROSS-95). The test varieties were sown at a spacing of 60 x 5 cm in a randomized complete block design and replicated twice in 2010 and 2011. However, in 2012, a split plot design was used in which Fertilizer application (F0 – no fertilizer and F1 – organic fertilizer applied) was assigned to the main plot and the 15 test accessions to the sub plot. Organic fertilizer (Aleshinloye Fertilizer - 1.2%N, 76 ppm P, 13.75 cmol K, 10.28 cmol Na) was applied at the rate of 50 tonnes ha^{-1} equivalent to 60 kg N.ha^{-1} of the inorganic fertilizer recommended for conventional sesame (Olowe and Busari, 2000). Data were collected on number of branches and capsules per plant and weight of seeds and capsules per plant, 1000 seed weight and grain yield on plot basis. All data collected were subjected to analysis of variance and where significant, means were separated using the least significant difference method.

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Results

Growing conditions were more favourable during the late cropping season in 2010 and 2011 because rainfall distribution was relatively better (2010 - 791.2 mm and 2011 - 934.0 mm) than 2012 with 415.4 mm. As such, a combined analysis of variance was conducted on the data for 2010 and 2011. Mean values of grain yield and some yield attributes averaged over 2010 and 2011 are presented in Table 1 and the main effects means of these traits, and variety by fertilizer interaction effect on grain yield in Table 2. The test accessions were significantly (*p<0.05*) different for weight of capsules and seeds per plant in 2010 – 2012 (Tables 1 and 2) and 1000 seed weight in 2010 - 2011 (Table 1). Eight (including E-8, Check) out of the fourteen accessions recorded 1000 seed weight lower than 3.0 g in 2010 and 2011. Whereas, only 530-6-1, CROSS 95 and Kwandere recorded values greater than 3.0 g in 2012 under dry growing conditions. Varietal and variety by fertilizer interaction effects significantly (*p<0.05; F-test*) affected grain yield of the test varieties in 2012.

Discussion

According to Day (2000) and Burden (2005), sesame premium seed qualities include colour (white-pearly white), size (1000 seed weight ≥ 3.0 g) oil content (40 – 50%) and moisture content (< 6%). All the accessions in our study had pearly-white seed colour. Six out of 14 of the test accessions recorded 1000 seed weight ≥ 3.0 g in 2010 – 2011. Whereas, three varieties out of 15 recorded values ≥ 3.0 g under dry growing conditions in 2012. Under more favouarble conditions in 2010 and 2011, all the accessions recorded grain yield higher than the world average of 490 kg ha^{-1} (FAO 2012), except Cameroon white and Domu. However, when growth conditions were less favourable in 2012, the accessions produced lower grain yield under control (176.5 – 343.5 kg ha^{-1}) relative to applied organic fertilizer (432.5 - 732.6 kg ha^{-1}). This indicates that application of organic fertilizer enhanced the yield performance of these accessions and thus confirmed their potential in the region.

Suggestions to tackle the future challenges of organic sesame production

Future efforts should be geared towards developing new and improved sesame varieties with the potential of producing high seed yield using organic agriculture best practices. This is quest is being driven by the steady increase in demand for organic sesame in the world market.

Table 1: Grain yield and some yield attributes of fourteen sesame accessions (means of 2010 and 2011)

Varieties	No[a]. of branches	No[a]. of capsules	Wt[b]. of capsules **(g)**	Wt[b].of seeds **(g)**	1000 **SeedWt[b]** **(g)**	Grain **Yield (kg/ha)**
E-8 (Check)	4.2	30.8	12.1	2.66	2.8	589.9
NCRIBEN-02M	2.7	24.6	9.73	2.41	3.4	533.1
Cameroon white	3.3	18.8	7.5	1.61	2.5	347.9
PBTil	4.6	39.8	15.4	4.59	2.7	984.2
530-6-1	2.9	37.1	21.1	4.93	3.2	1066.0
ABBS	3.4	31.3	11.2	2.91	2.5	627.5
CIANO-16	3.1	25.9	11.9	3.94	1.7	825.2
Adakuawari	3.6	38.6	14.4	3.93	2.6	883.7
NCRIBEN-03L	4.2	46.8	14.4	4.29	3.0	914.9
CIANO-27	3.8	34.6	13.7	4.36	2.6	928.0
Pachequena	4.2	38.3	13.5	4.07	2.8	845.0
Domu	2.8	27.9	8.7	1.80	3.0	398.0
Kwandere	3.4	21.5	10.2	2.17	3.2	455.0
Eva	3.1	26.2	10.8	2.84	3.4	616.8
lsd (0.05)	ns	ns	6.16	2.32	0.44	ns

ns: not significant
[a] No: number
[b]Wt: weight

Table 2: Main effect means of grain yield and some yield attributes, and the fertilizer X variety interaction effect on grain yield of fifteen sesame accessions in 2012

Varieties	No[a]. of branches	No[a]. of capsules	Wt[b]. of capsules	Wt[b]. of Seeds (g)	1000 SeedWt[b] (g)	Grain Yield ($kg.ha^{-1}$) 2012	Grain yield ($kg.ha^{-1}$) F0[c]	F1[d]
E-8 (Check)	1.9	23.8	10.3	1.47	2.90	494.7	314.9	674.4
NCRIBEN-02M	1.8	14.7	7.6	1.22	2.96	488.9	245.3	732.6
Cameroon white	2.8	9.5	5.0	0.78	2.81	284.6	188.5	380.6
PBTil	2.8	10.5	4.8	0.92	2.50	394.9	216.8	572.9
530-6-1	2.8	11.5	7.4	1.13	3.01	440.9	250.6	631.1
ABBS	2.0	17.0	7.2	1.21	2.99	384.2	179.2	589.2
CIANO-16	2.3	8.3	5.2	0.78	2.95	281.1	237.8	324.5
Adakuawari	2.2	12.2	5.6	1.03	2.92	390.5	248.1	532.8
CIANO-27	2.7	9.7	4.8	0.98	2.91	403.2	216.6	589.8
Pachequena	2.2	10.2	4.4	0.70	2.80	252.7	179.9	325.4
NCRIBEN-03L	2.0	15.0	6.4	0.89	2.75	384.3	343.5	425.3
Eva	2.0	10.0	5.9	0.98	2.87	360.5	278.4	442.9
NCRIBEN-01M	2.3	10.0	4.7	0.71	2.94	302.3	214.3	390.3
Cross 95	2.2	8.0	3.5	0.57	3.08	301.9	176.5	427.4
Kwandere	2.2	12.5	9.4	1.27	3.14	451.9	339.5	564.5
lsd (0.05)	Ns	5.48	2.58	0.37	ns	109.64	155.06	

ns: not significant
[a] No: number
[b] Wt: weight
[c] F0: No organic fertilizer
[d] F1: Organic fertilizer

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Agronomic performance of soybeans (*Glycine max* (L.) Merrill) in an organic crop rotation system

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Key words: continuous, conventional, crop rotation, grain yield, soybean

Abstract

Soybean was sown after sunflower, sesame and maize between 2008 and 2012 to assess its agronomic performance under continuous, rotational and conventional cropping systems. The experiment was laid out in a randomized complete block design and replicated four times. Soybean grown under rotational cropping system produced significantly ($p<0.05$) higher number of branches, seeds and pods per plant than the soybean under continuous and conventional cropping systems in 2012. Similar trend was recorded in 2011 and 2012 for grain yield. On average, grain yield performance of soybean under rotational cropping system (2,445.0 – 2758.3 kg.ha^{-1}) was superior to the yield of soybean under continuous and conventional cropping systems (1343.8 – 2556.3 kg.ha^{-1}) as the rotation scheme became stable from 2010 to 2012. Inclusion of soybean in crop rotation scheme is hereby recommended for sustainable organic crop production systems in the humid tropics.

Introduction

Soybean (*Glycine max* (L.) Merrill) is a grain legume crop grown mainly for its high quality seeds (Weiss 2000). The inclusion of soybean in a crop rotation system is very crucial because it provides the soil with nitrogen through nitrogen fixation, reduces soil erosion, improves soil structure and increases soil organic mater content apart from the economic yield (seeds) it provides for the farmer (Peel 2010). Unfortunately, crop rotation is seldom practiced by most farmers in tropical Africa because it requires special management or additional planning skills to effectively plan and execute. Therefore, there is the need to generate scientific information that can assist in developing appropriate recommendation package for crops such as soybean, sunflower, sesame and maize that have economic importance in an organic crop rotation system. This study evaluated the agronomic performance of soybean under rotational, continuous and conventional cropping systems.

Material and methods

The field trials were carried out between 2008 and 2012 on the organic agriculture research plots of the Organic Agriculture Project in Tertiary Institutions in Nigeria (OAPTIN) located on the Teaching and Research Farm of the Federal University of Agriculture, Abeokuta (9^o 15´ N, 3^o 25´ E, altitude 140 m.a.s.l). The component crops in the experiment were soybean, sunflower, sesame and maize (Table 1). The crops were grown in the late cropping season (July – November) each year. The soil of the experimental field was oxic Paleudulf (Adetunji 1991). The test variety of soybean grown was TGx 1448-2E, an improved late maturing variety resistant to pod shattering (Asofo-Adejei and Adekunle 2001). The experimental design was randomized complete block design (RCBD) with four replicates and the treatments evaluated were continuous, rotational and conventional cropping systems. The conventional plots were located at about 15 m away from the organic plots in order to avoid any commingling. The row spacing adopted was 60 x 5 cm (266,000 plants ha^{-1}). The conventional soybean plots received pre-emergence herbicide (galex + gramoxone), inorganic fertilizer (30 kg N ha^{-1}, 56 kg P_2O_5 ha^{-1} and 100 kg K_2O ha^{-1}) application. The organic fertilizer (Aleshinloye Fertilizer - 1.2%N, 76 ppm P, 13.75 cmol K, 10.28 cmol Na) equivalent to 30 kg N ha^{-1} of the inorganic fertilizer was applied at the rate of 25 tonnes ha^{-1} to the continuous and rotational cropping systems plots in 2010 – 2012. No herbicides and inorganic fertilizers were applied to the continuous and rotational plots during the experiment. All the experimental plots were weeded twice at 4 and 8 weeks after sowing, WAS each year. Data were collected on some yield attributes: number of branches, pods and seeds per plant, weight of pods and seeds per plant, and grain yield on yearly basis. All data collected were

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subjected to analysis of variance and where cropping systems effects were significant, means were separated using the least significant difference method.

Results

Data on grain yield (2008 – 2012) and some yield attributes of soybean (2012) are presented in Table 2. Rainfall data taken on daily basis showed a distribution that varied markedly during the period of experimentation (328.0, 479.5, 791.2, 934.0 and 451.7 mm in 2008, 2009, 2010, 2011 and 2012, respectively). At the commencement of the study in 2008, cropping system had no significant effect on grain yield. However, cropping system significantly (*p<0.05, F-test*) affected grain yield in subsequent years, except in 2010 even though the rotational cropping system produced grain yield 7.3 and 51.2% higher than the conventional and continuous cropping systems. Cropping system significantly (*p<0.05; F-test*) affected number of branches, seeds and pods per plant in 2012. Soybean plants grown under rotational cropping system recorded significantly *(p<0.05)* higher number of branches, seeds and pods per plant than those under continuous and conventional cropping systems.

Table 1: Rotation scheme involving sesame, sunflower, soybean and maize

2008	2009	2010	2011	2012
Sunflower	Sesame	Maize	**Soybean**	**Sunflower**
Sesame	**Soybean**	Sunflower	Maize	**Sesame**
Maize	Sunflower	**Soybean**	Sesame	**Maize**
Soybean	**Maize**	**Sesame**	**Sunflower**	**Soybean**

Table 2: Grain yield (2008 – 2012) and some yield attributes of soybeans (2012) under three cropping systems

Cropping System	Number per plant			Weight per plant (g)		Grain yield (kg.ha^{-1})					
	bran-ches	seeds	pods	seeds	pods	mean	2008	2009	2010	2011	2012
Continuous	2.9	156.8	78.5	21.3	11.8	1822.4	623.0	1343.8	1269.3	1893.3	**1390.4**
Rotational	4.9	317.3	132.8	34.0	19.5	1822.4	1029.0	2758.3	2445.0	2711.7	**2153.3**
Conventional	3.2	163.9	75.7	25.0	13.8	2004.0	1771.5	2556.3	1733.0	1913.2	**1995.6**
Lsd 0.05	**0.59**	**74.03**	**22.16**	**ns**	**ns**	**ns**	**481.1**	**ns**	**415.6**	**556.12**	**511.79**

ns: not significant

Discussion

The grain yield of soybeans under the conventional and rotational cropping systems were at par and superior to the yield from continuous cropping system between 2008 and 2012. In 2012, the significantly higher grain yield recorded under rotational cropping system could be attributed to significantly higher number of branches, seeds and pods per plant relative to the soybeans under continuous and conventional cropping systems.This trend corroborated earlier findings that yields from organic plots are usually higher than yields from conventional plots especially in drought years because of better water holding capacity of soils under organic system than the conventional soils (Posner et al. 2008). This confirmed the potential of crop rotation in soil fertlity management under organic production systems in the tropics because the grain yield values (1029.0 – 2758.3 kg ha^{-1}) recorded compared favorably with the African (729 kg ha^{-1}) and world (2,250 kg ha^{-1}) averages (FAO, 2004).

Suggestions to tackle the future challenges of organic soybean production

Organic soybean production has been confirmed to be a profitable venture. Resource poor farmers in the tropics that produce over 70 percent of food consumed cannot afford to purchase synthetic fertilizers to boost production. Inclusion of soybean in crop rotation system coupled with the application of organic fertilizer will definitely enhance the fertility status of tropical soils and thereby increase crop productivity.

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Eggplant (*Solanum sp*) performance in organic and inorganic systems in South-Eastern Nigeria

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Key words: Poultry manure, Solanum sp, egg plant fruit yield, gross returns, fish effluent.

Abstract

The problem of rural-urban migration in Nigeria has resulted in very dense urban populations. The location of poultry and aquaculture enterprises in urban and peri-urban areas of the country has exacerbated the problem of pollution. However, these wastes can be a valuable resource for use in agriculture. The aim of this study was to examine the effects of fibre glass fish tank effluent, poultry manure, NPK and control on two eggplant varieties and weeds. The response of eggplant fruit yield to poultry manure was significant and greater than the response to fish effluent, which also gave higher yield than NPK fertilizer or control. Kaduna variety produced yield that was higher by 71% and had lower weed density compared to Ngwa local. The highest gross monetary returns were obtained from application of poultry manure, followed by fish effluent while Kaduna variety had higher returns than Ngwa local.

Introduction

The eggplant (*Solanum* sp) is an important vegetable crop in Nigeria. Species that are more popularly grown for their fruit and, in some cases also, the leaves and tender shoots exist. The crop has great potential for income generation as the fruits are consumed almost on daily basis by urban families.

Manuring and choice of variety are amongst the most practical ways of raising yields of vegetables. Increasing urban populations have resulted in a growing tendency for poultry and aquaculture enterprises to be located in urban and peri-urban areas in Nigeria. Apart from increasing poultry population, aquaculture in Nigeria has recently expanded with the potential of producing about 2.5 million metric tons of fish annually, which suggests that huge amount of fish effluent will be discharged into the environment (Osaigbovo *et al*, 2010). This study investigated the effects of poultry manure, fish effluent and NPK fertilizer on eggplant in south eastern Nigeria.

Material and methods

The field experiment was conducted between January and July, 2013 at the Michael Okpara University of Agriculture, Umudike, Nigeria Research Farm. Umudike is situated at latitude 05^0 29'N, longitude 07^0 33'E, 122m altitude. The soil is a sandy loam ultisol (sand 69%, silt 14%, clay 17%, N 0.14%, P 0.62% and K 0.45%).

Treatments comprised four manure sources and two eggplant genotypes laid out as factorial in randomized complete block with four replications. The eggplants were *Solanum gilo* cv Kaduna (round green with medium sized fruit) and Ngwa local (green striped with medium sized fruit) while the manure sources were poultry manure at 10t/ha, fibre glass fish tank effluent ($1m^3$ volume stocked with 250 *Heterobranchus longifilis* fingerlings), NPK (20:10:10) at 300kg/ha and control (no manure). The chemical characteristics of the poultry manure were pH (water) 7.06, %N3.38, % P1.27 and % K 0.67. The fish effluent had pH of 6.14, % N of 0.03, % P of 0.11 and % K of 0.24. Each plot measured 1.2m X 1.2m.

The seed was sown in nursery beds on 11 January, 2013 and transplanted in the field plots (sunken beds) on 12 February, 2013. Poultry manure was thoroughly worked into appropriate plots to incubate for 1 week before the seedlings were transplanted at a spacing of 40cm X 30cm. After transplanting, plots that did not receive fish effluent as treatment were irrigated with water from borehole. Hoe weeding was done at 6 weeks after transplanting (WAT). Insect pest control was done with Decis at 1L/ha. Data were collected on weed density and dry matter at 6 WAT. Records were taken on number and weight of fruits and gross returns (₦160 = $1). The data collected were subjected to analysis of variance.

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Results

Weed density and dry weight

Although the manurial treatments had no obvious effects on weed density, there was significant difference among the cultivars in their ability to reduce weed population (Fig. 1). Weed density was reduced significantly by 61% under Kaduna variety compared to Ngwa local.

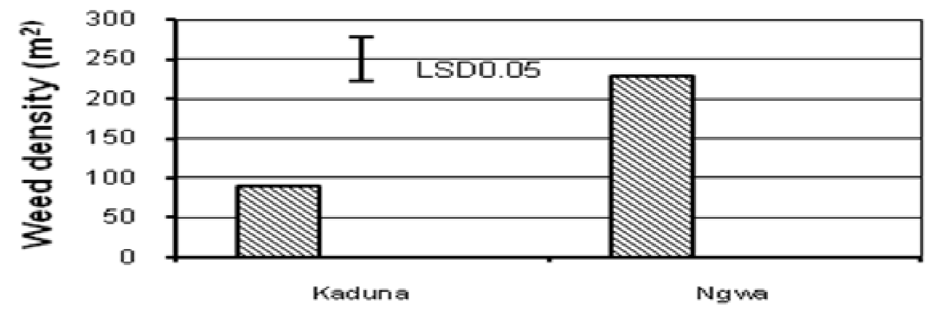

Fig. 1: Effect of egg plant variety on weed density at 6 weeks after transplanting

Weed dry weight was reduced significantly by 44% in fish effluent and 27% in NPK compared to poultry manure application (Fig.2). Variety and interaction effects were not significant.

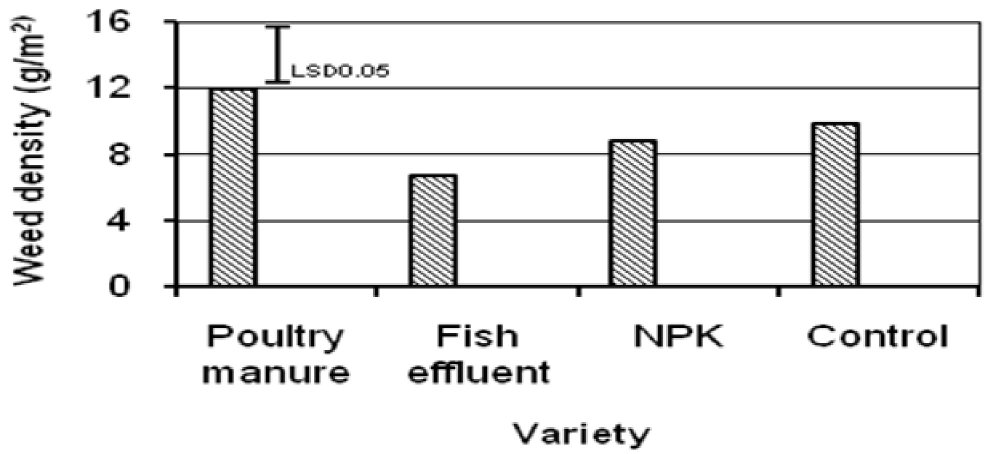

Fig. 2: Effect of manure source on weed biomass at 6 weeks after transplanting

Yield and gross returns

On average, poultry manure gave significantly the highest number of fruits per plant while NPK or the control gave the lowest number of fruits (Table 1). Variety and interaction effects were not significant.

Application of poultry manure gave significantly highest eggplant fruit yield, followed by fish effluent which gave higher yield, than did the application of NPK or control.On average, Kaduna variety gave 71% significantly higher fruit yield than Ngwa local. Interactions were not significant.

Similarly, application of poultry manure generated the highest gross monetary returns, followed by fish effluent. Kaduna variety also gave higher gross returns than Ngwa local. Interactions were not significant.

Discussion

The lower weed density in the Kaduna variety was attributable to the broader leaves which reduced light penetration down the crop canopy. On the other hand, the application of poultry manure encouraged greater weed growth due probably to more availability of water and nutrients as reported by Amanullah *et al* (2010). Okpara *et al* (2011) made a similar observation in which the application of manure increased weed biomass at 6 weeks after planting.

The higher fruit yields and gross returns obtained from manure applications (Poultry manure followed by fish effluent) were ascribed to the probable effects of organic manures in improving soil chemical and physical characteristics (Mbah and Mbagwu, 2003; Mbagwu, 1989). Among the cultivars, Kaduna variety gave higher yield and gross returns than Ngwa local, due mainly to an increase in average weight per fruit in the former. This finding is of interest from both the economical and ecological points of view.

Table 1. Effect of Manure Sources and Eggplant Varieties on Number of Fruits/Plant Fruit Yield and Gross returns.

Varieties	Manure Source				
	PM	FE	NPK	Control	Mean
Number of Fruits/Plant					
Kaduna	21.8	13.5	6.6	7.1	12.3
Ngwa	14.9	9.9	8.6	7.7	10.1
Mean	18.4	11.7	7.6	7.1	
Fruit Yield (t/ha)					
Kaduna	51.9	34.5	15.1	21.8	30.8
Ngwa	30.2	16.5	14.5	11.1	18.0
Mean	41.0	25.5	14.8	16.5	
Gross returns ($/ha)					
Kaduna	202892	134606	58817	85296	120403
Ngwa	117775	64475	56462	43288	70500
Mean	160333	99540	57639	64292	

		Number of Fruits	Fruit Yield	Gross Returns
LSD (0.05) for manure (M)	Means =	46.6	10.4	40443.6
LSD (0.05) for variety (V)	Means =	NS	7.3	28597.9
LSD (0.05) for M X V	Means =	NS	NS	NS

PM = Poultry manure, FE = fish effluent, NPK = inorganic fertilizer.

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Comparative effects of organic manure sources and rates on performance of groundnut varieties

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Key words: Organic manure, groundnut varieties, sources, rates.

Abstract

An experiment was conducted at the Teaching and Research farm of the Institute for Agricultural Research (IAR), Ahmadu Bello University (ABU) Zaria. The aim was to study effects of different organic manure sources on performance of groundnut varieties. Treatments consisted of three organic manure source, (Poultry manure, (PM) cow dung (CD) and household waste (HW) each at two levels (1 ton and 2 tons), two varieties of groundnut SAMNUT 21 (V_1) and SAMNUT 23 (V_2) and a control. The treatments were factorially combined and assigned in a randomized complete block design and replicated three times. The results indicated that pod yield of groundnut was highest with the application of 2 tons poultry manure. Canopy spread was significantly highest with application of all the manures compared to the control. Plant height and haulm yield were however not significantly affected by manure application.

Introduction

Groundnut removes fairly large quantities of nutrients from the soil. It depletes the soil nutrients rapidly unless the soil is adequately fertilized. If present levels of soil productivity are to be sustained, alternative sources of plant nutrients such as poultry manure, cow dung and household wastes must be promoted. Adequate fertilization in the form of application of organic manures does not only improve yield but also maintains soil health and sustains the soil productivity (Lourduraj, 1999).

Organic manures as valuable by-products of farming and agro-allied industries, contribute to plant growth through their favourable effects on the physical, chemical and biological properties of soil and nutrient availability. Stevenson (1994), Maheswarappa et al., (1999), Bhuma (2001), Mukhtar et al.,(2006, 2009) have documented many benefits attributable to the use of organic manures.This study was therefore initiated to find out the effect of different organic manure on groundnut crop**.**

Material and methods

A field experiment was conducted during the rainy season of 2013 at the Institute for Agricultural Research Farm Samaru, Ahmadu Bello University Zaria, to examine the comparative effects of types and rates of organic manure on performance of groundnut varieties.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The treatments were composed of two varieties of groundnut SAMNUT 21 and SAMNUT 23, three manure rates as follows: poultry manure, cow dung and household waste and a control plot where no manure was applied and ; two different rates each of all the manures 1 ton and 2 tons/ha.

There were totally fourteen treatments as follows; T1: I ton/ha cow dung + SAMNUT 21, T2: 1 ton/ha cow dung + SAMNUT 23, T3: 2 tons/ha cow dung + SAMNUT 21, T4: 2 tons/ha cow dung + SAMNUT 23, T5: 1 ton/ha household waste + SAMNUT 21,T6: 1 ton/ha household waste + SAMNUT 23, T7: 2 tons/ha household waste + SAMNUT 21, T8: 2 tons/ha household waste + SAMNUT 23, T9: 1 ton/ha poultry manure + SAMNUT 21, T10: 1 ton/ha poultry manure + SAMNUT 23, T_{11}: 2 tons/ha poultry manure + SAMNUT 21, T12 : 2 tons/ha poultry manure + SAMNUT 23,T13 :SAMNUT 21only, T14: SAMNUT 23 only.

The poultry manure and cow dung were obtained from College of Agriculture Samaru and National Animal Production Research Institute Farms respectively while the household waste was collected from backyard waste that was routinely piled and burnt. At two weeks prior to sowing, all the manures were drilled in plots as per treatment. Groundnut varieties SAMNUT 21 and SAMNUT 23 were sown on 17th of July 2013. All other agronomic practices necessary for groundnut cultivation, with the exception of fertilizer application were adopted. Data was collected on the following growth parameters:- plant height at 4 weeks after sowing (WAS), 6WAS, 8WAS and 12WAS;Canopy spread at 6WAS, 8WAS and12WAS; and days to 50% flowering.

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Data collected was analyzed using SPSS version 17. Where significant, means were separated using Duncan Multiple Range Test (DMRT 1955).

Results

The result of chemical analysis for the various manures used in the experiment is presented in Table 1. Percent nitrogen was higher in poultry manure (4.48%) than in cow dung (2.90) and household waste (2.4) in that order. Phosphorus and potassium contents were highest in household waste than in poultry manure (0.79; 0.74) or cow dung (0.14; 0.20).

Table 1. Chemical properties of cow dung, household waste and poultry manure

Sample	% N	P (meq/kg)	K (meq/100g)	Na (meq/100g)
Cow dung	2.90	0.74	0.20	0.04
Household waste	2.40	2.50	1.00	0.87
Poultry manure	4.48	0.79	0.14	0.08

The result of effect of sources and types of organic manure on performance of groundnut varieties is presented in Table 2. Plant height of the groundnut was not significantly affected by sources and rates of manure used although increase in height of the plant was observed in response to increasing rates of cow dung and poultry manure from one to two tons.

Table 2. Effect of sources and rates of organic manures on plant height, canopy spread, pod yield and haulm yield of groundnut varieties in 2013 rainy season at Samaru.

Treatment				
Organic manure	Plant height (cm)	Canopy spread (cm)	Pod yield (g)	Haulm yield (Kg)
CD1	37.38	45.3b	109.9b	0.4000
CD2	36.97	54.4a	225.78ab	0.23
HW1	40.92	57.07a	124.95ab	0.38
HW2	37.47	54.25a	185.58ab	0.23
PM1	37.23	56.55a	170.57ab	0.42
PM2	40.40	51.62a	173.80am	0.43
Control	41.97	55.10a	240.52a	0.35
Variety				
SAMNUT 21	39.92	38.42	155.20	0.34
SAMNUT 23	37.89	38.27	196.55	0.36

The significantly widest canopies were observed in plots that received organic manures compared with the control. Poultry manure at 2 tons/ha led to the significantly highest pod yield of groundnut compared to the control which was statistically at par with all other treatments. However no significant differences were observed among the manure sources and rates types on haulm yield of the groundnut.
The varieties used were not significantly different in their response to organic manure rates and types with respect to plant height, canopy spread, pod yield and haulm yield.

Discussion

Organic manures have a profound effect on improving soil physical, chemical and biological properties and enhancing productivity of field crops. The positive response of groundnut to increase in application poultry manure from one to two tons indicates that the crop has benefited from the manure application.This result is similar to that obtained by Subrahmaniyan et al., (2000) who reported that application of FYM at 10 to 15tha^{-1} increased the pod and haulm yields and improved the yield parameters like shelling percentage, 100 seed weight and sound mature kernel compared to the recommended dose of fertilizers.

Conclusion

In most small holder farms in developing countries, poor soil fertility and nutrient management combined with use of unimproved crop varieties are major causes of low yield of groundnut. The use of organic manures alongside improved varieties coupled with appropriate agronomic practices suitable for a particular crop variety and ecology will go a long way towards improving the yield of groundnut.

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Organic/inorganic leaf amaranth production: the case of poultry manure, fish effluent and npk fertiliser

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Key words: Amaranthus sp., organic, inorganic fertilizer, poultry manure, fish effluent, yield

Abstract

The work evaluated the responses of two Amaranthus cultivars to poultry manure, fish effluent, NPK fertiliser and control in randomised complete block design. A. hybridus was taller, had thicker stem and more leaves per plant than A. viridis. For each Amaranthus variety, poultry manure produced highest number of leaves and tallest plants with thickest stem followed by fish effluent and NPK fertiliser. A. hybridus had higher leaf and marketable yields/ha than A. viridis. Leaf and marketable yields/ha were highest with poultry manure followed by fish effluent and NPK fertilizer. Leaf yield/ha increased by 105, 34 and 34% for poultry manure, fish effluent and NPK fertilizer, respectively compared with the control in A. hybridus and by 284, 132 and 146% in A. viridis. Similarly, marketable yield/ha increased by 116, 45 and 45% for poultry manure, fish effluent and NPK, respectively in A. hybridus and by 176, 16 and 43% in A. viridis over the control.

Introduction

The need for vegetables in urban nutrition in Nigeria is increasing due to high urban population. Equally urban dwellers are beginning to show greater interest in fish farming and poultry production to improve household nutrition. But these enterprises generate wastes, which pollute the environment. The fish water wastes from fish culture is usually termed fish 'effluent' Poultry manure is readily available in Nigeria and could be put to agricultural use.

There is need to employ these animal wastes as fertilisers for vegetable crop production, especially in peri-urban areas. Research information is scanty on the comparative effects of fish water effluent, poultry manure or inorganic fertiliser on vegetable production. The aim of the study was to evaluate the effect of fish water effluent, poultry manure or NPK fertiliser on the growth and yield of vegetables with leaf amaranth as a test crop.

Material and methods

A field experiment was conducted at Michael Okpara University of Agriculture, Umudike, Nigeria (latitude 05° 29´ N, longitude 07° 33´ E, 122 m above sea level) research farm in 2013 to determine the effect of organic and inorganic fertilisers on two leaf amaranth species. Umudike is within the tropical rainforest agro-ecological zone of Nigeria with average rainfall of 2200 mm per annum, mean maximum and minimum temperatures of 31.7° C and 21° C, respectively. The soil of the experiment site is a sandy loam ultisol with 69% sand, 14% silt and 17% clay. It had 0.14%, 0.62% and 0.45% nitrogen (N), available phosphorus (P) and exchangeable potassium (K), respectively.

A 2 x 4 factorial experiment in randomised complete block design with three replications was carried out. The treatment comprised two leaf amaranth species (*Amaranthus hybridus* and *A. viridis*) treated with three fertiliser sources (Poultry manure, fish water effluent, NPK 20:10:10) and no fertiliser as control. The poultry manure was collected from the University deep litter poultry pens and composted whereas the fish water effluent was from fibre glass tanks of 1 m^3 volume stocked with 250 *Heterobranchus longifilis* fingerlings.

Chemical analyses showed that the poultry manure had 7.06 pH, 3.38% (N), 1.27% (P) and 0.67% K; the values for fish water effluent were 6.14 pH, 0.021% N, 0.11% P and 0.24% K. Poultry manure (10 t/ha) was applied and worked in at seed bed (1.2 m x 1.2 m) preparation and 300 kg/ha NPK 20:10:10 fertiliser was applied 2 weeks after transplanting (WAT) where as fish water effluent was used as irrigation water

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depending on the treatment schedule. The no fertiliser, NPK and poultry manure plots were irrigated with water from borehole. Three weeks old seedlings of *A. hybridus* and *A. viridis* were transplanted into the various treated sunken beds at a spacing of 0.3 m x 0.3 m.

At 6 WAT, four plants were randomly used to collect data on plant height, number of leaves per plant and stem girth. Fresh leaves and marketable leaves were harvested weekly from four plants from middle rows and the harvests were later cumulated to obtain total leaf (edible) and marketable (leaf + shoot) yields per hectare.

The data collected were subjected to analysis of variance for factorial experiment in randomised complete block design and Fisher's protected least significant difference (F-LSD) test at 0.05 probability level was used to compare the treatment means.

Results

Growth: *Amaranthus hybridus* plants were taller, produced more leaves and had thicker stem than *A. viridis* (Table 1). The differences in the growth of the crop might be due to genetic make up of the cultivars. Poultry manure had the highest growth parameters but there was no significant ($P > 0.05$) difference between NPK and fish water effluent for the number of leaves per plant and stem girth (Table 1). Interaction of the fertilizer type x amaranth cultivar indicated that for each fertilizer type, *A. hybridus* performed better than *A. viridis* for plant height but for the number of leaves per plant in the control plots, *A. hybridus* produced more leaves than *A. viridis*. There was no significant ($P > 0.05$) for stem girth. Khan et al. (2010) had reported taller plants, thicker stems and larger leaf areas for sorghum and maize with fish water effluents compared with ordinary fresh water.

Table 1: Effect of fertilizer type on the growth of two leaf amaranth cultivars 6 weeks after planting

	Fertiliser type				
	Control	NPK	Fish water effluent	Poultry manure	Mean
Cultivar	Plant height (cm)				
A. hybridus	78.11	78.89	88.77	99.90	86.41
A. viridis	31.10	36.43	35.84	74.00	44.34
Means	54.60	57.66	62.30	86.95	
	Number of leaves/plant				
A. hybridus	13.44	13.22	13.95	16.78	14.35
A. viridis	9.11	10.89	11.77	19.11	12.72
Means	11.28	12.05	12.84	17.94	
	Stem girth (cm)				
A. hybridus	2.04	2.06	2.02	2.65	2.19
A. viridis	1.08	1.42	1.32	1.62	1.36
Means	1.56	1.74	1.67	2.14	
	Plant height	No. of leaves/plant	Stem girth		
$LSD_{0.05}$ for 2 cultivar means (C)	4.29	1.59	0.21		
$LSD_{0.05}$ for 2 fertiliser means (F)	6.03	2.24	0.30		
$LSD_{0.05}$ for 2 C x F means	8.53	3.17	NS		

Yield: For each fertilizer type, fresh leaf yield/ha and marketable yield/ha were always higher for *A. hybridus* than *A. viridis* and for each amaranth cultivar, poultry manure had the highest leaf and marketable yields/ha (Table 2). There was no significant difference
($P > 0.05$) between the fish water effluent and the inorganic fertilizer for leaf and marketable yields/ha but fish water effluent treatment produced higher leaf and marketable yields/ha than the control. Leaf yield/ha increased by 105, 34 and 34% for poultry manure, fish effluent and NPK fertilizer, respectively compared with the control in *A. hybridus* and by 284, 132 and 146% in *A. viridis*. Similarly, marketable yield/ha

increased by 116, 45 and 45% for poultry manure, fish effluent and NPK, respectively in *A. hybridus* and by 176, 16 and 43% in *A. viridis* over the control.

Table 2: Fresh leaf and marketable yields of two leaf amaranth cultivar influenced by fertilizer type

	Fertiliser type					
	Control	NPK	Fish water effluent	Poultry manure		Mean
Cultivar	**Leaf yield (t/ha)**					
A. hybridus	9.58	12.60	12.86	19.63		13.67
A. viridis	1.38	3.21	3.40	5.30		3.32
Means	5.48	7.91	8.13	12.47		
	Marketable yield (t/ha)					
A. hybridus	10.66	15.50	15.47	23.05		16.17
A. viridis	3.60	4.19	5.16	9.94		5.72
Means	7.13	9.84	10.31	16.50		
		Leaf yield	Marketable yield			
$LSD_{0.05}$ for 2 cultivar means (C)		1.40	2.24			
$LSD_{0.05}$ for 2 fertiliser means (F)		1.97	3.17			
$LSD_{0.05}$ for 2 C x F means		2.79	NS			

Discussion

The higher yields from organic fertilizers (fish water effluent and poultry manure) compared to inorganic fertiliser (NPK) could be due to higher nutrients and improvement of the soil physico-chemical properties such as increased infiltration rate, water retention, soil aggregate and nutrient stabilizers (Carsky *et* al., 2001 and Osaigbovo *et al*., 2010).

In conclusion,fish water effluent and poultry manure increased the growth, leaf and marketable yields of *Amaranthus* species. They as biowastes could be put to agricultural use and reduce environmental pollution.

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Bridging the Gap between Old and New Technology: Consideration of Indigenous Knowledge in Maize Pests Management Practices in Nigeria

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Key words: Ecology, Indigenous, Knowledge, Organic, Food, Sustainability

Abstract

Effects of chemical based products on the environment and human health have been established. This study determined the perception of the effectiveness of indigenous and organic maize pest management practices among maize farmers in order to bridge the gap between the old and new technology. Farmers' level of awareness on indigenous and organic maize pests management practices was high (58%) and the respondents level of utilization was also high at (61.3%), with a favourable perception about the effectiveness of indigenous and organic maize pests management practices and some of these practices are; cultural practices of traps, practice of bush fallow, early planting, crop rotation, mixed cropping system and biological pest control. Improvement of information on indigenous best practices to merge with Ecological Organic Agriculture system for maize pest management through adequate extension services is eminent to enhance sustainable health of food and farmers.

Introduction

Maize is considered in this research because it is a very important crop in Nigerian. It is utilized mainly for human consumption and used as constituents of livestock feed. It is a staple food and is an important source of carbohydrate and if eaten in the matured state, it provides useful quantities of vitamins C. The yellow grain varieties have vitamin A. It is a source of income and maize leaves and stalks contain about 30% of the total nutrients in corn plants; hence it is utilized for pasture. Maize also occupies a central position in having a meaningful, workable and effective food security system in any society. Indigenous knowledge (IK) is the knowledge used by local people to make a living in a particular environment (Warren, 1991). This is often conceptualizing in the field of sustainable development to include indigenous technical knowledge, traditional environmental knowledge, rural knowledge, local knowledge and farmer's or pastoralist's knowledge. "A body of knowledge built up by a group of people through generations of living in close contact with nature" (Johnson, 1992). It is acquired through observation and the study handed down from generation to generation for sustainable development (Achim, 2008, Akinbile, 2006). Such practices help to protect the natural ecology. The issue of pest management has to be linked with ecological organic agriculture which is the practice of eco-friendly and organic agriculture that is strictly on production system that sustain the health of soil, ecosystem and people. It combines tradition, innovations and science to the benefits shared in environment and promotes fair relationships and a good quality of life for all involved and this is also what the indigenous knowledge highlights.

Therefore, traditional ecological organic agriculture is important for the identification of indigenous practices and for the formulation of sustainable pest management strategies relevant to ecological production management system that would promote and enhance biodiversity. In view of the above, an assessment of indigenous and organic maize pests' management practices in the study area will help to show how effective these practices are and guide us to provide a clear picture of what is needed to promote organic agriculture in order to ensure effective management of our natural resources.

Methods

The study was carried out in Oyo State. Oyo State is one of the food baskets of Nigeria. Beside Ibadan, there are four (4) big towns with large population; they are Ogbomoso, Oyo, Iseyin, and Saki. Other fairly big towns in the state are Igboho, Kishi, Okeho, Igboora, lalupon, Ilero, Eruwa and Igbeti. Agriculture is the major source of income for the greater number of people in the state. Apart from providing food and shelter, employment, industrial raw materials, it remains an important source of internally generated revenue in the state. The climate favours the growth of food crops like yam, cassava, millet, maize, fruits, vegetables and plantains. Cash crops such as cocoa, Tobacco and Timber are also abound in the state. The state has two vegetation zones which are derived savannah and forest zones. The target population of the study includes all maize farmers in Oyo state. Purposive sampling method was used to select two Local Government Areas (LGAs) out of thirty three local government areas in the state where maize farming is the major activity of the dwellers because of the focus of the study which is to determine the effectiveness of indigenous and organic maize pest's management practices in Oyo sate. The selected Local Government areas were Itesiwaju and Atisbo Local Government Area. Thereafter a systematic sampling technique was used to select 25 percent of the registered maize farmers from each of the Local Government area making a total of 150 (One hundred and fifty) respondents. The data for the study was collected using structured questionnaire combined with personal interview schedule to elicit information from maize farmers that cannot complete the questionnaire on their own.

Results

The general objective of the study was to determine the effectiveness of indigenous and organic maize pest management practices in Oyo state. The specific objectives however include to ascertain sources of information on indigenous and organic maize pests management practices, to identify knowledge of prevalent maize pests and the damage caused in the study area, to ascertain farmers level of awareness on indigenous and organic maize pests management practices, to determine farmers level of utilization of indigenous and organic maize pests management practices and to determine farmers perception about the effectiveness of indigenous and organic maize pests management practices. Result of analysis on selected socio- economic characteristics showed that the respondents have the mean age of 49.97 years. Majority (62%) had formal education while few (38%) had no formal education. Majority (64.7) of the respondents had between 1–30 years farming experience while (35.3%) had 31 and above years farming experience. The farmers had an average farm size of nine (9), with average monthly income of $150, majority (57.3%) of the respondents used both family labour and hired labour while (38%) of the respondents used hired labour and very few (4.7%) used family labour, the sources of land acquisition are mainly on inheritance with majority (78.7%) of the respondents farming on inherited family land.

On sources of information on indigenous and organic knowledge of maize pests' management, majority had access to information on a regular basis through the following sources, fellow farmers (72%), relatives (66%) and radio (65.3%) respondents. It was also noted that most of the information sources provided farmers with useful information on ecological knowledge of pests' management practices but not on a regularly. The farmers knowledge of prevalent maize pests and the damage caused by the pests was very high with majority (87.3%) of the total respondents had high knowledge of the prevalent pests and the damage caused to the maize both on the field and in storage house, while (12.7%) of the respondents had low knowledge of maize pests and their damage caused to the maize plant. Moreover, the result of the study also revealed that majority (58%) of the respondents had high awareness of indigenous and organic maize pests' management practices, while 42% of the respondents had low awareness level of indigenous and organic maize pest management practices. The high awareness implies that respondents are fully aware of what indigenous and organic maize pest management practices entails. Besides, farmers' utilization level of indigenous and organic maize pest management practices was also high at 61.3% level. Their high level of utilization was as a result of the high awareness level of indigenous and organic maize pest management practices in the study area. The result of the analysis also showed that more than half (58%) of the respondents had favourable perception towards the effectiveness of indigenous and organic maize pests management practices, while less than half (42%) of the respondents had unfavourable perception.

The study also revealed that, there was no significant relationship between socio – economic characteristics such as age ($r = 0.091$, $p = 0.270$), year of formal education ($r = 0.010$, $p = 0.903$), farming experience ($r = 0.128$, $p = 0.120$), family size ($r = 0.072$, $p = 0.380$), average income per month ($r = 0.056$, $p = 0.499$) and respondents perception of the effectiveness of indigenous and organic maize pest management practices. The implication of these results is that age, years of formal education, farming experience; family size and average income per month do not necessarily vary with the respondents' perception of the effectiveness of indigenous and organic knowledge of maize pest management practices. This implies that farmer's perception of the effectiveness of indigenous and organic maize pest management practices is not influenced by the respondent's those variables. However, It was revealed form the findings that there is no significant relationship between sources of information ($r = .036$, $p = 0.663$), awareness ($r = -.039$, $p = 0.637$), knowledge ($r = -.083$, $p = 0.311$) and respondents' perception of the effectiveness of indigenous and organic maize pest management practices in the study area. This implies that farmer's perception is not influenced by the sources of information, awareness and knowledge.

Discussion

Based on the result of this study, the respondents' level of awareness towards the effectiveness of indigenous and organic knowledge of maize pest management practices was high, the utilization of these management practices was also high and their perception was also favourable. Many respondents still were not awareness, had low utilization and unfavourable perception to some indigenous and organic maize pest management practices. The farmers perceive indigenous knowledge and organic system to mean the same and better option for against conventional farming system.

Suggestions to tackle with the future challenges

Based on the result of this study, the respondents' level of awareness towards the effectiveness of indigenous and organic knowledge of maize pest management practices was high, the utilization of these management practices was also high and their perception was also favourable. Many respondents still were not awareness, had low utilization and unfavourable perception to some indigenous and organic maize pest management practices. The farmers perceive indigenous knowledge and organic system to mean the same and better option for against conventional farming system.

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Evaluation of different rates of Jathropha (Jathropha curcas) seed cake on the growth of Amaranthus caudatus

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Key words: Amaranthus caudatus, Jathropha, Cake, Yield

Abstract

A field experiment was conducted at Kwara State University Teaching and Research Farm, Malete, Kwara State, Nigeria to evaluate the performance of different rates of Jathropha seed cake on the growth and yield of Amaranthus caudatus. The five treatments tested were; 3 Jathropha seed cake application rates (2.0, 2.5 and 3.0 t/ha), NPK at 100kg N/ha and control. The treatments were laid out in a randomized complete block design with three replications. Growth and yield parameters such as plant height, number of leaves, stem girth and fresh weight were taken. The results (p<0.05) indicated that application of Jathropha seed cake at 2.5 t/ha produced taller plants more profuse leaves and higher shoot fresh weight compared to NPK or the control treatment. In conclusion, Jathropha seed cake at 2.5 t/ha could be good alternatives to NPK fertilizer in raising leafy vegetable.

Introduction

Amaranthus caudatus is grown for its leaves and is among the highly prized leaf vegetables in Nigeria due to their high nutritional and commercial significance. There is an increasing awareness of value of leafy vegetable in contributing to balanced diet, particularly in area where animal protein is deficient. Nitrogen was found to be the primary limiting factors of amaranths production (Pospisil *et al*., 2006). Most Nigerian soils have low nitrogen and the low nitrogen status is usually supplemented with N fertilizer and the importance of this source has increased over the year. Several sources of organic materials and residues abound in Nigeria which can be processed, packaged and made available as branded organic fertilizer at a cheap rate for home gardening, horticulture and farming as a whole (Olowoake and Adeoye, 2010). Seed cake of Jatropha is a major by-product of the Bio-diesel extraction process. The cake is rich in nitrogen (3.2%) and phosphorus (1.4%) and potassium and can be used as manures (Openshaw, 2000, Keremane, *et al.*, 2003). Hence, the prospect of Jathropha cake as one of the organic materials needs to be further evaluated in greater details. This study explores the possibility for using jatropha seed cake waste as an organic fertilizer on the growth and yield of Amaranthus caudatus.

Material and methods

Experiment were conducted during 2011 and 2012 cropping seasons at Kwara State University Teaching and Research Farm, Malete (8^0 71'N and 4^0 44'E) Kwara State, Nigeria. Prior to land preparation, soil samples from the top 0 - 15 cm were collected from the experimental site for laboratory analysis (Okalebo *et al*., 2002). The seeds of Amaranthus caudatus were sown on prepared nursery beds and water regularly using a watering can and checked for seedling emergence. Transplanting of amaranths seedlings into their respective plots in the field took place two weeks after sowing. The site was manually cleared and 15 raised beds were made to conserve the soil and its nutrient availability. The experimental plot was divided into three blocks each containing five beds. Each bed size was 2m x 1m with 1m alley between plots and blocks. Seedlings were transplanted at 2 weeks after transplanting on beds at spacing 50cm x 20cm. The treatments consisted of Jathropha seed cake at the rate of 2.0, 2.5 and 3.0t/ha, NPK at 100kg N/ha and control. Each vegetable bed contained thirty plants out of which five were randomly tagged for data collection. Collection of data commenced from 2 weeks after transplanting and was done weekly till 6th weeks. The data taken include, plant height, stem girth, number of leaves per plant, fresh root weight and yield. The data collected were subjected to analysis of variance (ANOVA) and treatment means were separated by Duncan Multiple Range Test (DMRT).

Results

Table 2 shows the effect of different rates of Jathropha cake and NPK on plant height, number of leaves and stem girth of Amaranth at 6 WAT (Weeks After Transplanting). Plants treated with NPK had mean height of 54.5cm which was significantly higher than the control but not significantly different (p<0.05) from values obtained in Jathropha cake at 2.5 t/ha. However, other Jathropha cake at 2.5 and 3.0 t/ha out performed the control, which had the lowest plant height of 44.2cm at 6 WAT. Jathropha cake 2.5 t/ha produced highest number of leaves, which is significantly difference from other treatment. Among the fertilizer treatments, the use of Jathropha cake at 2.5t/ha gave the best stem girth (3.7 cm) which was significantly different ($p<0.05$) from NPK, Jathropha cake at 2.0 t/ha, 3.0 t/ha including control.

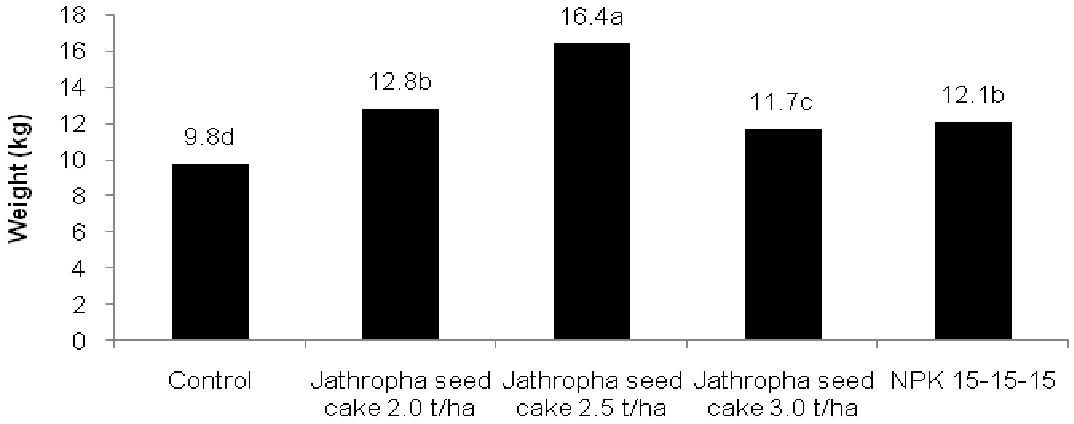

Fig. 1 Effects of fertilizer treatments on the yield of Amaranthus caudatus

Means having the same letter along the columns indicate no significant difference using Duncan's Multiple Range Test at 5% probability level.

Figure 1 shows the results obtained from application of fertilizer treatments on the yield of Amaranthus. Jathropha seed cake at 2.5t/ha had the highest yield (16.4 t/ha) which was significantly higher ($p<0.05$) than the yield obtained from other fertilizer treatments including control

Discussion

The highest plant height obtained from NPK and Jathropha cake at 2.5 t/ha may probably due to faster release of NPK and immobilization of N from of Jathropha cake (Ogunlade *et al*., 2011; Van Lauwe *et al.,* 2002). Jathropha cake at 2.5 t/ha significantly enhanced the production of leaves than NPK and other treatments including control. The same trend applies to stem girth at 6 WAT. This could be to quick decomposition and consequent release of nutrients in Jathropha cake (Balasubramaniyan *et. al*., 2003). The higher number of leaves from Jathropha cake at 2.5t/ha over the NPK could be due to sustaining release of nutrients from the former over the latter. Yields of *Amaranthus caudatus* obtained from Jathropha cake at 2.5 t/ha had the highest value of 16.4 t/ha were significantly different than the yield obtained from other treatments. This is similar to work of Busiso (2007) who reported higher maize yield from application of Jathropha seed cake.

Table 1: Amaranthus as affected by NPK and Jathropha seed cake at 6 WAT

Treatment	Plant Height (cm)	No of Leaves	Stem girth (cm)
Control	44.2c	58.7.0d	2.0c
Jathropha seed cake 2.0 t/ha	48.4b	68.7c	3.2b
Jathropha seed cake 2.5 t/ha	51.3a	96.2a	3.7a
Jathropha seed cake 3.0 t/ha	49.1b	66.4c	3.4b
NPK 15-15-15	54.5a	89.0b	3.4b

Conclusion

The use of organic wastes as soil amendments remains a sustainable way to improve soil productivity and enhanced food security. Results obtained from this study showed that Jathropha cake at 2.5 t/ha can be applied as organic amendments to improve growth and yield of *Amaranthus caudatus* instead of mineral fertilizers.

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Improving the yield of *Celosia argentea in* organic farming system with system of crop intensification

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Key words: *Celosia argentea,* System of Crop Intensification

Abstract

A field study was conducted at the University of Ibadan, Nigeria to investigate the effect of System of Crop Intensification (SCI) on the growth and yield performance of Celosia argentea. Two seeding rates were used; lower seed rate at 13 kg/ha and farmers' traditional seed rate at 26 kg/ha as high seed rate. The results showed that growth and yield of celosia were significantly (P<0.05) influenced by SCI. The result of seeding rates' effects on number of leaves, stem width and yield showed that low seed rate performed better than high seed rate. Low seed rate resulted in higher marketable fresh leaf yield of 12.24 t/ha compared to high seed rate of 8.82 t/ha. The accrued revenue ranges between ₦882,000 to ₦1,224,000 [₦150 = $1 (US Dollar)] for high seed rate and low seed rate respectively, subsequently increasing farmers' income. Overall, this investigation revealed that both growth and yield of Celosia argentea can be improved with low seeding rate, a feature of SCI.

Introduction

Celosia argentea is a leafy vegetable of the genus *Celosia* and Amaranthaceae family. The crop is produced in Nigeria by small holders' farmers; solely or intercropped with arable starchy staples to produce enough food to satisfy their dietary and cash requirements. The average yield of this crop (7.60 t/ha) has been limited by obsolete cultural practices employed in its production, such as seeding rates and non-use of fertilizer input among others (FAO, 2004). Optimum production on limited area of agricucltural land is another concern by many small holders organic vegetable farmers in most parts of the world. This has resulted into SCI. SCI is a methodology for increasing crop productivity by reducing crop population per unit land area, improving the management of crop and soil while reducing external inputs. A reasonable increase in yield of rice and millet has been obtained with SCI. Therefore, there is a need to consider if the yield of Celosia could also be improved with SCI.

Material and methods

This participatory research was conducted with a group of 8 farmers. It was conducted on the farmers' plots at the Ajibode end of the Teaching and Research farm of University of Ibadan, Nigeria from January to April, 2011(Latitude $7^0 27^1$ N, Longitude $3^0 54^1$ E). It was carried out on raised seedbeds of 4.0 m width, 5.0 m long and 0.2 m height. Poultry manure extract at the rate of 100 kg N ha^{-1} (Aduayi *et al.*, 2002) was applied as basal application at 2 weeks after sowing. The experiment laid in a randomized complete block design with four replicates. The experimental treatments were low seed rate and high seed rate which was the farmers' traditional seed rate. The quantity of seeds sowed was 26 kg ha^{-1} for high seed rate and low seed rate of 13 kg ha^{-1}. Harvesting was done at 5 Weeks after Sowing (WAS). All data obtained were subjected to Analysis of Variance and means separated using least significant difference ($p<0.05$). Economic analysis was used to determine the cost and economic return for *Celosia argentea* production.

Results and discussions

Reduction in seeding rate of celosia which is one of the feature of System of Crop Intensification resulted in significant ($p > 0.05$) increase in the numbers of leaf during the growth stage. Changes in the number of leaves are bound to affect the general plant growth and vigour, as they are the major organs of photosynthesis of the plant. Number of leaves increased progressively throughout data collection period. High seed rate resulted in a greater the number of leaf per unit area (m^2). Number of leaves in low seed rate showed significant ($P<0.05$) difference as compared to high seed rate at 4 and 5 WAS (Table 1). Changes in stem girth were significant ($p < 0.05$) at 4 and 5 WAS (Table 1). This observation is supported by work of Law-Ogbomo and Ekunwe (2011) who reported that planting density significantly affect stem girth. Low seed rate led to an increase in the stem girth. This was due to differences in improved light interception, nutrients

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absorption and utilization capacity of plants (Law-Ogbomo and Ekunwe, 2011). The height of plant is an important growth character directly linked with the productive potential of a plant. An optimum plant height was reported to be positively correlated with productivity of the plant (Saeed *et al.*, 2001). In this investigation, plant height generally increased progressively throughout data collection periods. This may be attributed to the basal application of poultry manure extract. Low seed rate had taller plants (Table 1) however, there was no significant ($p > 0.05$) difference between treatments. The effect of seeding rate on yield (Table 2) gives a better fresh weight of leaf, root and total weight of plant. The yield observed for leaf, root and total fresh weight (g/plant) for low seed rate were 6.8, 2.45 and 16.22 respectively. This was significantly ($p > 0.05$) different from high seed rate (g/plant) with 2.45, 1.42 and 9.22 for leaf, root and total fresh weight respectively. The result was in line with finds of Madakadze *et al.* (2007), who reported that spacing significantly affect leaf area, fresh and dry weight of celosia. An average yield of 7.60 ton ha^{-1} of celosia has being reported by FAO (2004). In this investigation, reduction in seeding rate of celosia which is a feature of System of Crop Intensification improved yield. This ultimately resulted in an increase in the marketable yield of celosia (Figure 1) at 12.24 ton ha^{-1} for low seed rate as compared to 8.82 ton ha^{-1} for high seed rate. This in itself is an interesting outcome, since the research was farmers‘ participatory. High seeding rate lead to increased competetion for sunlight and soil nutrients among the crops. This may have resulted in the reduced yield observed in the high seeding rate.

Table 1: Effect of crop intensification on growth parameter of *Celosia argentea*

Parameter	Treatments (Seed rate)	3 WAS	4 WAS	5 WAS
Plant height (cm)	Low seed rate	7.51	20.43	33.48
	High seed rate	7.21	19.47	31.50
	LSD	ns	Ns	ns
No. of Leaves	Low seed rate	6.66	12.44	18.87
	High seed rate	6.78	9.96	16.17
	LSD	ns	1.66	1.12
Stem girth (cm)	Low seed rate	0.88	1.98	2.43
	High seed rate	0.84	1.75	2.00
	LSD	ns	0.06	0.06

Table 2: Effect of crop intensification on fresh weight (ton ha^{-1}) of *Celosia argentea*

Parameters	Low seed rate	High seed rate	LSD	
Leaf	6.80	2.45	1.17	***
Stem	6.97	5.35	ns	
Root	2.45	1.42	0.63	**
Total (g/plant)	16.22	9.22	4.01	*
Total (ton / ha^{-1})	29.20	33.19		

*,**,*** Significant at P<0.05, P<0.01 and P<0.001, ns: Not Significant

Table 3: Economic analysis of crop intensification on the performance of *Celosia argentea*

Treatments	Low seed rate	High seed rate
Gross revenue (₦100 kg^{-1})	1,224,000	882,000
Variable cost (Seed cost) (₦)	35,415	59,625
Net variable and fixed cost (₦)	457,740	457,740
Total cost (₦)	493,155	517,365
Net Profit (₦)	730,845	364,635

Assumption for economic analysis: Exchange rate, ₦150 = $1 (US Dollar)

Figure 1: Marketable yield of *Celosia argentea* in ton ha^{-1}

Economic Analysis

The gross margin and net return was highly influenced by seed rate reduction. Total cost of production increased as seed rate increased (Table 3). However, higher revenue was obtained at lower seed rates. The accrued revenue / ha ranged between ₦882,000 to ₦1,224,000 for high seed rate and low seed rate respectively, which inferred 38.8% difference. A net profit of ₦730,845 and ₦364,635 was obtained for low seed rate and high seed rate respectively. These findings imply that profitable crop production depends on adequate seeding rates but not excessive plant stands.

Conclusions

In the present investigation, it can be concluded that reduction in planting density of *Celosia argentea* (which is a feature of system of crop intensification), resulted into an increase in the marketable yield of *Celosia argentea* and subsequently increased farmers' income. Thus, seed rate of celosia at 13 kg ha^{-1} is recommended for improve yield of the crop and higher income for farmers.

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Coverage of organic agricultural news in nigerian Newspapers

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Key words: Coverage, Organic, Agriculture, News, Ecological

Abstract

The study was on coverage and content analysis of organic agricultural news in 3 selected Nigerian Newspapers. The Nigerian Tribune, Guardian and Punch newspapers. The study covered the period of January 2010 – July 2012.

Result showed that Tribune (61.9%) has the highest number of reportage with punch being the least.The newspapers reported more general issues (66.7%) than the other content categories which are food safety news (19%), economic concentration news (9.5%), and environmental news (4.8%).Tribune allotted more space to organic agricultural news with 76.8% than Guardian 15.2% and Punch 8.1%. There is no significant difference in the types of newscoverage on Organic agricultural articles in the selected Newspapers (F =0.227, p =0.799). The study concluded that coverage of organic agriculture is low, this affects the level of awareness of the people in the practice. The study recommends that Nigeria press should be sensitive to issues on organic agriculture.

Introduction

There is a growing concern about the environmental impact and health risks of food grown with the aid of chemical fertilizers, synthetic pesticides; to disseminate this information needs to be treated with urgent action on the part of the government and the whole populace.Communicating ideas to farmers through the news print media solicit a more effective response. Effective News, information and communication becomes pertinent before development can take place (Oladeji and Olowu, 2001). Newspapers provide information, create awareness, increase knowledge and stimulate positive attitudes of people towards issues.Yahaya and Olowu (1993) asserts that despite the increasing number of dailies being published in Nigeria, it is very important to note that coverage of agriculture based news is extremely low. Therefore, there is need to get the farmers and the consumers informed about the benefits of organic agriculture. This study aimed to examine the extent to which the Nigerian Newspaper covers information on organic agriculture.

Material and methods

Three Nigerian daily newspapers that have been in continuous production were selected. The sampled newspapers were the Nigerian Tribune, the Punch, and the Guardian daily newspapers. They are among the most widely read thereby having a wider coverage in Nigeria as noted by Nigeria Press Council (2010).Though organic agriculture has been in practice for decades, but it was not until recently (less than 10years) that researchers started talking about the benefits due to its impact on the environment, food safety and health. Based on this, a period of twoyears, starting from January 2010 – July, 2012 was chosen as the time frame for this study.

Results

Table 1 shows the frequency distribution of organic agriculture articles in the selected newspapers within the chosen time frame (January 1st, 2010 – July 31st, 2012).

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Table 1: Frequency distribution of organic agriculture articles in the three selected Newspapers.

Year	Tribune	Guardian	Punch	Total
2010	05	02	-	07
2011	06	01	01	08
2012	02	02	02	06
Total	13	05	03	21

Table2: Types of Organic Agriculture news in the selected newspapers from Jan, 2010-July, 2012.

Content Categories	Tribune	Guardian	Punch	Total
Food Safety	2(9.5)*	1(4.8)	1(4.8)	4(19)
Environment	1(4.8)	-	-	1(4.8)
Economic concentration	-	2(9.5)	-	2(9.5)
General issues	10(47.6)	2(9.5)	2(9.5)	14(66.7)
Total	13	5	3	21

Table 3: ANOVA result of the significant difference in types of Organic Agriculturalnews in the three selected newspapers.

Variable	Df	Mean square	f-value	p-value	Decision
Content category	2	0.366	0.227	0.799	Not significant

P > 0.05

Discussion

In 2010, the total news that was reported on organic agriculture was seven (7). In 2011, total reportage on organic agriculture was eight (8).From January 1st – July 31st, 2012, total reportage in the tree selected newspapers was six (6). This implies that organic agricultural news was not frequent in the newspapers.

Table 2 reveals that the three selected newspapers reported more general issues (66.7%) than the other content categories.This result shows that less attention is being given to issues relating to impact of organic agriculture on food safety and environment.This is in line with Abolade, 2011, which says that inadequate information on organic agricultural contribute to the low level of peopie involvement in organic agricultural practices.

The result on table 3 shows that there is no significant difference in the type of coverage of Organic agricultural articles in agricultural news in the three selected Nigerian daily newspapers (F-value =0.227, p-value is=0.799),This implies that the three selected Nigerian daily newspapers cover general issues.

Suggestions to tackle with the future challenges of organic animal husbandry

This study reveals the low level of coverage of organic agriculture by the selected newspapers and this affects the awareness and participation of people in the practice. This study has sensitized the print media to pay a careful attention to the reporting pattern, content, direction and space allotted to Organic Agriculture and other agriculture related news by newspapers editors, reporters, researcher, farmers and all stakeholders.

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Effect of organic turmeric (*Curcuma longa*) feeding on testicular histology of rabbits exposed to ultraviolet radiation

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Key words: organic, turmeric, ultraviolet radiation, testes, rabbits

Abstract

Thirty six male rabbits of 450-600g body weights fed with organic turmeric (OT) containing diet (D_2) or without OT supplementation (D_1) were randomly assigned to six treatment groups: Control (T0); D2 plus Ultraviolet radiation (UV,T1); D2 until UV (T2); D2 after UV (T3); D1 non-turmeric–fed with UV (T4) and D2 without UV (T5). UV irradiated animals showed conspicuous damage in their testicular tissues. The OT corrected UV-induced damages and offered a prophylactic protection to the testicular tissues. It was concluded that OT feeding could restore the testicular tissue damage by ultraviolet radiation.

Introduction

Rabbits can be raised on high fiber feeds and industrial by-products, not utilized by man (N.R.C, 1981). The small body size, short generation interval, rapid growth rate, genetic diversity and high reproductive potentials are characteristics, which make them suitable as meat producing livestock in developing countries (Arijeniwa et al. 2000).

Trends in applying nutritional antioxidants in diseases related to oxidative stress have gained immense interest in recent years. Turmeric plant (*Curcuma longa*) is a rhizome, which has been known to be a spice as well as medicinal agent (Eigner and Scholz, 1999). Curcumin is the main active ingredient in Turmeric (Osawa et al. 1995). Curcumin has been found to have nematocidal, antifungal and anti-inflammatory effect as well as the ability to scavenge free radicals. It modulates anti-oxidant properties against oxidative tissue damage through the inhibition of Reactive Oxygen Species (ROS) generation, with no side effect (Osawa et al. 1995; Khanna 1999). According to Asami et al (2003) and Brandt et al (2010), several studies have shown that crops grown with organic principles have significantly higher levels of certain minerals, vitamins, antioxidants and phytonutrients, and thus could give substantial protection against deleterous risks.

Ultraviolet (UV) radiation is an invisible light ray, to which living organisms are generally exposed on daily basis. It induces the production of Vitamin D in the skin, which helps bone growth and maintenance of bone density, immunity, cell proliferation, insulin secretion and maintenance of normal blood pressure (Vieth 1999). However, it has been indicated that when organisms are exposed to ultraviolet radiation, a constant fraction of the living cells are inactivated during each progressive increment in time by absorption of light, which causes a photochemical reaction that alters the molecular components essential to cell function (Davies et al. 2002). Prolonged exposure to solar ultraviolet radiation may result in acute and chronic health effects on the skin, eye and immune system through mutagenic or carcinogenic process (USERPA 1966). Such exposure is associated with various pathological conditions that include reproductive dysfunctions, consequent upon oxidative stress. This is one of the plausible mechanisms for UV induced cellular deteriorations. Currently, there is a dearth of information on the use of organic turmeric to mitigate the harmful effect of UV radiation on reproductive organs of rabbits. This study was therefore conducted to investigate the efficacy of organic turmeric on the structural architecture of the testes of rabbits exposed to UV radiation.

Material and methods

The experiment was conducted at the Rabbit Unit of Ladoke Akintola University of Technology (LAUTECH) Agricultural Services (LAS) Ltd Certified Organic Farm, Ogbomoso, Nigeria. Thirty six male weaner rabbits of mixed breed, weighing between 450 - 600g were weight-balanced and randomly assigned to 6 dietary treatment groups of 6 rabbits each. Each rabbit was housed individually and received experimental diet,

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prepared mostly from feed ingredients, harvested on the organic farm, with Moringa olifera at 0.2% inclusion, to replace synthetic lysine and methionine. A premix, which included garlic, ginger and *Asparagus racemous*, served as ethno veterinary provision in the feed. Fresh grass and legumes were cut daily and allowed to wilt before they were generously offered later in the day. The experimental diet was offered to the rabbits with fresh water ad libitum, fortified with organic Horney as anti-stress, during the first two weeks, to acclimatize before data collection. The rabbits received diets either without 2% organic turmeric (D_1) or with 2% organic turmeric (D_2) for the nine-week experimental period. The treatments were T0 (Control – No organic Turmeric, no UV radiation exposure); T1 (Turmeric feeding before and after UV radiation exposure); T2 (Turmeric feeding before and not after UV radiation exposure); T3 (Turmeric feeding after UV radiation); T4 (UV radiation exposure without turmeric feeding) and T5 (Turmeric feeding without UV radiation exposure). Rabbits were exposed to UV radiation in a radiation box of 1 x $2m^2$ equipped with UV fluorescent tubes, measuring 0.61m. The rabbits were exposed for 10 minutes per animal per day for five days. Animals were slaughtered 30 days after exposure to ultraviolet radiation and the male reproductive organs were carefully removed for histological examinations after the standard procedure for slide preparation.

Results

The histological results are shown in Figures 1 to 6. Figure 1 shows the testicular structure of rabbits fed the control diet (T0). The testicular structure was normal with seminiferous tubules full of spermatogenic cells with normal Sertoli cells. The basement membrane was normal and showed no abnormality. Figure 2 shows the testicular structure of rabbits in T1.The seminiferous tubules were necrotic, with some disintegration of the lumen and degenerative effect on the epithelial lining of the cells. Figure 3 represents the T2. There was no major damage to the testicular cells but the seminiferous tubules were smaller. Figure 4 represents T3. There were no major damages to the germinal, Leydig and Sertoli cells. The seminiferous tubules were normal with spermatozoa at various stages of development in the lumen. Figure 5 shows the testicular structure of rabbits in T4. Degeneration of basement membrane, germ and Sertoli cells were observed. The seminiferous tubules were distorted; the Leydig cells were diffused into the lumen and spermatozoa were disorganized. Figure 6 represents the T5. There was no major damage to the basement membrane, germ and Sertoli cells. The seminiferous tubules were normal with conspicuous spermatozoa at various stages of development. The Leydig cells were also intact.

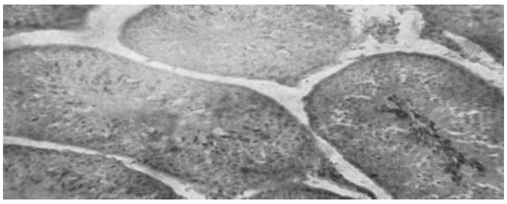

Figure 1. Testis of Control rabbits, turmeric No UV radiation) x100

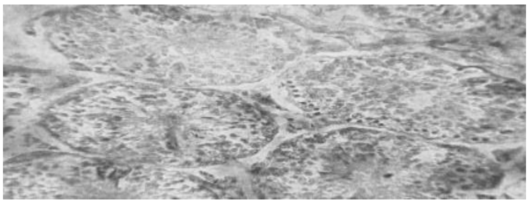

Figure 2. Testis of rabbits fed turmeric(No before and after UV radiation x100

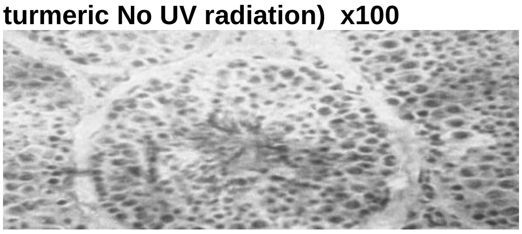

Figure 3. Testis of rabbitsed turmeric before to UV radiation x100

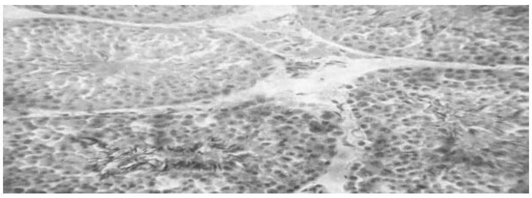

Figure 4. Testis of rabbits fed turmericexposure after UV radiation x100

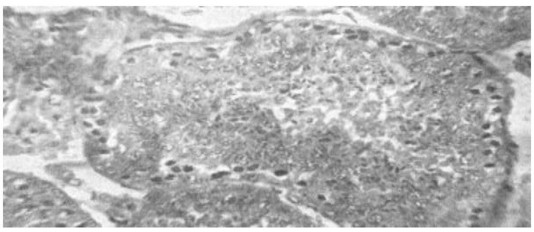

Figure 5. Testis of rabbits exposed to UV Radiation without turmeric feeding x100

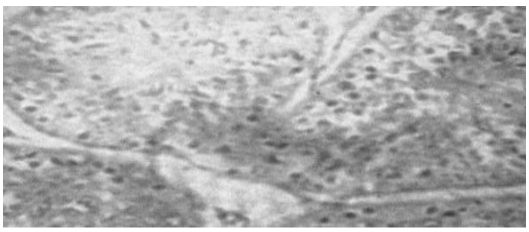

Figure 6. Testis of rabbits fed turmeric withoutexposure to UV radiation x100

Discussion

The histological results showed that rabbits that were not exposed to UV radiation had no damage to their cells while varying degrees of necrosis were observed in the rabbits exposed to UV radiation. Pamphilon et al (1991) reported that necrosis is the morphological change caused by the progressive degenerative action of enzymes on the lethally injured cells. Powell et al (1993) reported that UV radiation is known to affect the cell membranes of living organisms. It changes the cell surface antigens thereby blocking the cell to cell interactions and antigen introduction. The ameliorative property of the organic turmeric demonstrated over the negative effect of UV radiation on the testis in this study, can be explained by the fact that the organic soils on which such crops grow, typically have higher soil quality with more available natural micronutrients. These crops will therefore, naturally struggle to build up antioxidant and nutrient stores on their own, in order to protect and strengthen themselves, rather than waiting to receive rations of instantly available synthetic nutrients, which are supplied only to their conventional farm counterparts. Thus, these typically stronger plants, with more nutrient-dense food from the organic soil, offer more nutrients to the consumers of such crops as reported by Asami et al. (2003). Nutrigenomic studies have elucidated how extra nutritional constituents that usually occur in small quantities in foods, interact with the genome by modifying gene expression and consequently altering protein and metabolite composition within the cells, and even participating in the DNA repair and replication process (Zheng and Chen 2005; Subbiah 2008).

Conclusion

Inclusion of organic Turmeric, simply boiled, dried and powdered without any sophisticated processing to extract curcumin, in the diet ameliorated the effect of UV radiation on the testes of rabbits in the study. Organic turmeric could serve as prophylactic and curative treatment for reproductive damages that may result from exposure to UV radiation.

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Need Assessment of women vegetable farmers on ecological organic agriculture (EOA) in Nigeria

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Key words: Ecological Organic Agriculture, Women, Vegetable, Agric-support

Abstract

The respondents had high level of knowledge (72.5%), information (54.2%), but with majority (51.7%) having unfavourable perception towards Organic Agricultural (OA) practices. There was significant relationship between the respondents' sources of information and training need (p=0.001) including agric-support service need (p=0.000). Also there was a significant relationship between farmers' knowledge and training needs (p=0.030) and agric-support support service needs (p=0.006). Significant correlation was determined between the farmers' perception and Agric-support service need (r=0.000).The most important need of the respondents is Agric-support service need. The constraints faced by the respondents in order of severity include lack of capital, pest infestation, and insufficient crop yield. Vegetable production method used was via seed cultivation. The result necessitates more of *agric-support services and training in order to make organic vegetable production a sustainable farming practice hence improving food security globally.*

Introduction

Excessive use of agrochemicals and mechanization causes soil de-conditioning, where nutrients are leached and ultimately leads to reduced water retention, making it unsuitable for agriculture. There is also significant groundwater pollution and environmental damage, which extends farther than just the farm areas. The use and widespread of toxic, synthetic pesticides often do not kill only the desired target of the application, but other species as well (Bernama, 2009). Half of all farmers in the developing world are women, and women farmers could grow 30% more food if they have access to the same resources as men. The deep concern of some women for the health of the environment is closely connected to their perception as sustainers and nurturers of life, including their desire to raise healthy children. In Nigeria, women play a dominant role in agricultural production (Meludu 2004). The role of women farmers in production of food staples like vegetables and cereal is important since the motivation for participation in agriculture is to contribute to household food security (Meludu,2005) . Women farmers play a significant role in vegetable production and marketing which therefore contributes to household food self sufficiency (Oguntade, 2009). It is therefore very essential to determine the women farmers' knowledge and perception on OA and also take into consideration their information, social and economic needs as well as constraints to right of entry to the development of OA that would inform further research and training.

Material and methods

The study area for this research is Nigeria with a case of Akinyele Local government area of Oyo state, Ibadan. It is one of the eleven local governments within Ibadan metropolis. The headquarters is at Moniya, Ibadan. Purposive sampling technique was used to select 40% of the wards in the Local Government area which gave a total of 5 wards and 20% of villages in the wards were selected because of the high concentration of women vegetable farmers in those areas. Random sampling technique was used to select 40% making a total of 120 respondents. Collection of data was done through the use of primary and secondary sources. Structured questionnaire containing items based on the objectives of this study was used to collect information from the women vegetable farmers. Interview schedule was also conducted where necessary using local dialect in order to bridge the illiteracy barrier among some respondents of the study.

Results

The Overall Need Assessment data of women vegetable farmers in the study area are presented in Table 1. It was revealed that the respondents expressed low need for Information, moderate need for training and

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high need for Agric support service on organic agriculture in the study which confirms that the most expressed need by the farmers in order of priority include Agric-support services, Training and Information need respectively.

Table 1: Distribution of respondents according to overall Needs Assessment

Needs Category	Extent of Need High Freq %	Low Freq %
Information	51 (42.5)	69 (57.5)
Training	59 (49.2)	61 (50.8)
Agric-support services	71 (59.2)	49 (40.8)

Source: Field survey data 2013. * percentages in parentheses

The overall information, knowledge and perception category of respondents are presented in table 2 and it revealed that the respondents have high level of information and knowledge about organic agriculture but majority of them had unfavourable perception towards organic agricultural practices.

Table 2: Overall Information, knowledge & Perception category

Level of information	Freq	%
High	65	54.2
Low	55	45.8
Level of Knowledge*		
High	87	72.5
Low	33	27.5
Level of Perception*		
Favourable	58	48.3
Unfavourable	62	51.7

*** indicates multiple responses**

Discussion

The most commonly cultivated vegetables by the respondents includes amaranth, celosia, corchorus and bitter leaf and the most adopted source of information by the respondents on organic agriculture is family and friends (54.2%) followed by radio and extension agents (25.8%) respectively, the result indicated that the respondents' sources of information was significant to their training need (p=0.001) and agric-support service need (p=0.000). Majority of the respondents have a high level of information on organic agriculture (54.2%) with a high knowledge of 72.5% showing therefore that the farmers' knowledge level is significant to their training (p=0.030) and agric-support support service needs (p=0.006), a higher percentage having an unfavourable perception to organic agriculture (51.7%). The constraints faced by the farmers in order of severity include lack of capital, pest and disease infestation, difficult marketing of organic products. The most important need of the respondents is the Agric-support service need.

Suggestions to tackle with the future challenges

Organic agricultural inputs can be made available for farmers through the farmer's they belong for easy accessibility so as to increase their vegetable production. Accessibility to marketing units for collection and sales of organic products, transportation facilities to be able to transfer vegetable products from farm without losing its nutritional as well as economical value is also a necessity. Adequate irrigation, storage and processing facilities will also help farmers to be able to preserve their vegetable products from deteriorating before getting to the end users.

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The pesticidal Potential of *Alternanthera brasiliana* (L.) o. Kuntze ins Solving pest problem in organic agriculture

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Key words: *Amaranthus cruentus*, *Alternanthera brasiliana*, *Hymenia recurvalis*, phytochemicals, pesticidal activity, toxicity

Abstract

This study was carried out at the Teaching and Research Farm of University of Ibadan, Nigeria between March and May 2013, to evaluate the pesticidal potential of A. brasiliana on H. recurvalis pest of A. cruentus. There were six treatments of different serial concentration levels of 100, 75, 50 and 25% of A. brasiliana extract, Cypermethrin (1ml/100mls) and control (no insecticide), replicated four times and laid out in a randomized complete block design (RCBD) and applied on A. cruentus at 3 and 5 Weeks After Sowing (WAS). Data collected were on plant height , number of leaves, stem girth, leaf area and fresh weight/yield of A. cruentus and analyzed using descriptive statistics and ANOVA at P = 0.05. Results revealed the presence of saponins, flavonoids, reducing sugar, glycosides and resins as the phytochemical compounds present in A. brasiliana leaf powder. Significant differences (p<0.05) were observed among the treatments in growth and yield parameters of A. cruentus. The pesticidal efficacy of A. brasiliana extract at 100% on H.recurvalis insect pest compared favourably with synthetic cypermethrin and other treated plots in recording highest while control recorded the lowest values in all parameters in the study. This study revealed that A. brasiliana extract could suppress H. recurvalis insect pest and could be used as botanical pesticide in Amaranthus cruentus production in organic farming.

Introduction

Synthetic pesticide misuse around the world has been known to cause costly environmental pollution (Adesiyan, 2005) and disruption of the balance of nature. The indiscriminate use of chemicals in the control of pests has led to problems such as pest resistance; toxic residues in agricultural produce, health hazards to the users and unintentional deaths annually (Fuglie, 1998). Indiscriminate applications of synthetic insecticides to vegetables have been reported to cause variable changes in brain on consumption (Ecobichon *et al*., 1994).

Besides, generalized toxic effects of the insecticides include, decreased number of implantation sites, decreased number of viable foetuses and weight gain of foetuses in rabbits have been reported (Elbetieha *et al.,* 2001). Some botanical pesticides with no toxic effects as that of synthetic have been reported by several researchers as insecticides, acaricides, bactericides, antifungal and nematicides, include Essential oils from sunflower, Neem (*Azadiracta indica*), (Bakali *et al*., 2008; Akhtar *et al*., 2008;). However, the need to screen for more naturally occurring compounds in plants as bio-rational pesticides with low cash input, readily available to farmers and eco-friendly in pest management and crop protection (Isman, 2006, Fayinminnu, 2010) led to the choice of *A. brasiliana*; an important perennial herb, native to tropical and subtropical regions of Australia and South America, traditionally used as a galactagogue (induces milk secretion), abortifacient (causes abortion) and febrifuge (alleviates fever), whose leaves are used like spinach in soups and also used for indigestion being prospected for its insecticidal properties. The plant is known to be medicinal: antibiotic and antiviral, antioxidant, antimicrobial and insecticidal properties (Mariani *et al*., 2008) but not much has been done to exploit its insecticidal potentials.

Therefore, the objective of this work was to evaluate the pesticidal potential of *A. brasiliana* leaf extract on *H. recurvalis* insect pest of *A. cruentus* (green leafy vegetable) in organic agriculture.

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Material and methods

The experiment was carried out between March and May 2013, at the Teaching and Research Farm and Toxicology Laboratory of The Department of Crop Protection and Environmental Biology (CPEB), University of Ibadan, Ibadan, Nigeria. Seeds of *A*. *cruentus* used were collected from germplasm of the Faculty of Agriculture and Forestry while the leaves of *A. brasiliana* were harvested from the Teaching and Research Farm, University of Ibadan.

- **Phytochemical Screening:**

This was performed on the leaf powder of *A. brasiliana* in the Organic Laboratory of the Chemistry Department, University of Ibadan. The phytochemical compounds were determined by the method of Harbone and Sofola (2007).

- **Preparation of *Alternanthera brasiliana* Leaf Powder Extract:**

Extraction procedure was carried out in Toxicology Laboratory (CPEB) according to the method of Ahn and Chung (2000) with a modification; One hundred and forty-four grams (144gms) of the leaves were used. The leaves were air-dried for seven (7) days, cut into chips and milled into powder. The powder was soaked for 24 hours and the solution was filtered through muslin cloth to remove the debris. Filtrate obtained was passed through Whatman No.1 filter paper. The final filtrate of plant part was considered as the full strength (100%) of the aqueous extract. Serial dilutions were made to obtain 75%, 50% and 25% (v/v) strength. The extracts were stored in refrigerator at 20oC for 24hours prior to use to prevent putrefaction and degradation of phytochemicals present in them. The extracts were used for the bioassay.

- **Field Work:**

This was carried out at the Teaching and Research Farm University of Ibadan, Ibadan, Nigeria. Each experimental plot size was 2m x 1m, replicated four times and laid out in a randomized complete block design (RCBD). *A*. *cruentus* seeds were sown by drilling and later thinned to one seedling per stand at 2WAS. The six treatments of 100, 75, 50 and 25% of *A. brasiliana* extract, Cypermethrin (1ml/100mls) and control (no insecticide) were applied as insecticide on *A*. *cruentus* at 3 and 5WAS.

- **Data Collection and Statistical analysis**

At weekly intervals, *A.cruentus* plants were assessed for growth parameters by measuring the plant height (using meter rule), stem girth diameter at 1cm above soil level (using a pair of Vernier calliper), number of leaves produced, leaf area and fresh weight/yield at harvest. All data obtained were subjected to analysis of variance (ANOVA), the means were compared by Duncan`s Multiple Range Test (DMRT) at
P = 0.05 for significance.

Results

Table 1: Phytochemicals Present in Leaf Powder of *Alternanthera brasiliana*

Compounds	Powdered Leaf Extract
Saponins	**+**
Flavonoids	**+**
Phlobatanins	**-**
Cardiac glycosides	**-**
Alkaloids	**-**
Reducing sugar	**+**
Phenol	**-**
Anthraquinones	**-**
Glycosides	**+**
Resins	**+**
Steroids	**-**
Tannins	**-**

+ indicates presence
- indicates absence

Table 2: Mean values of *A. brasiliana* Extract and Cypermethrin on Growth and Yield Parameters of *A. cruentus.*

	Plant Parameters at 3WAS				Plant Parameters at 5WAS				
	PH (cm)	SG (cm)	NOL	LA (cm^2)	PH (cm)	SG (cm)	NOL	LA (cm^2)	Fr. Wt
Cypermethrin (1ml/100mls)	20.00^{a}	0.11^{c}	10.30_{a}	20.00^{a}	20.00^{a}	20.41^{a}	0.11c	12.35a	36.41a
100% Extract	21.53^{a}	0.14^{a}	11.15_{a}	25.00^{a}	21.53^{a}	0.14^{a}	13.15_{a}	46.04^{a}	57.49^{a}
75% Extract	12.50^{a}_{b}	0.13^{ab}	10.45_{a}	15.00^{a}	16.23^{b}	0.13^{ab}	14.45_{a}	37.29^{a}	38.95^{a}
50% Extract	14.90^{a}_{b}	0.13^{ab}	10.00_{a}	10.00^{a}	14.92^{b}	0.13^{ab}	12.75_{a}	36.41^{a}	42.26^{a}
25% Extract	15.73^{a}_{b}	0.12^{bc}	11.50_{a}	12.50^{a}	16.74^{a}_{b}	0.12^{bc}	11.55_{a}	32.08^{a}	32.93^{a}
Control (No Insecticide)	10.00^{c}	0.11^{c}	7.50^{a}	12.50^{a}	17.31^{a}_{b}	0.11^{c}	11.35_{a}	26.08^{a}	20.93^{ab}
LSD(<0.05)	4.28	0.01	4.12 (NS)	20.70 (NS)	0.01	4.12 (NS)	22.71 (NS)	35.95	

Means followed by the same alphabet(s) in each column are not significantly different from each other.
PH=Plant Height; SG=Stem Girth; NOL=Number of Leaves; LA=Leaf Area; WAS=Weeks After Sowing, NS=Not Significant; Fr. wt. =Fresh weight.

Discussion

The results revealed the presence of saponins, flavonoids, reducing sugar, glycosides and resins (Table 1) as the phytochemical compounds present in *Alternanthera brasiliana* leaf powder extract. The growth parameters of *A.cruentus* (Table 2) showed that, there were no significant differences ($p<0.05$) in NOL and LA amongst all the treatments at 3 and 5 WAS. Although 100% extract of *A. brasiliana* recorded the highest parameters while the control recorded the lowest. However, results shown significant differences ($p<0.05$) amongst treatments in PH and SG at 3 and 5WAS (Table 2). The 100% extract followed the same trend in recording highest parameters. The fresh weight/yield at harvest (Table 2) revealed significant difference ($p<0.05$) between 100% and the control while with no significant difference ($p<0.05$) amongst other treated plots. All plots treated with extracts of *A. brasiliana* at 50, 75 and 100% recorded higher yield over synthetic cypermethrin at1ml/ 100ml (recommended dose). The control however, recorded a significant reduction in yield (Table 2) compared with other treatments. This study showed the efficacy of 100% extract of *Alternanthera brasiliana* and lends credence to Mariani *et al* (2008) who advocated that the plant is known to contain insecticidal properties. The performance may be due to the presence of high concentrations of plant secondary metabolites; saponins (anti-feedant), flavonoids (phenolic compounds) and glycosides (reduces O_2 utilization) that might have affected and suppressed the insect pest as reported by Isman (2006) that secondary compounds like alkaloids, terpenoids, phenolic, flavonoids, chromenes and other minor chemicals are toxic to insects.

Suggestions

The use of synthetic chemicals will be tightly regulated in the future due to the well-documented environmental risks and this may lead to a growing demand for biological plant protection agents because sustainable food security cannot continue to rely on them. The production and utilization of bio-pesticides should become a common practice. It seems evident that extracts of *A. brasiliana as* plant-derived insecticides against *H. recurvalis* fits well with food and agriculture policies directed to the future. It therefore comes highly recommended to farmers.

However, further studies needs to be carried out on pesticidal activity of *A. brasiliana* as a bio-pesticide, to remove limitations in bio-pesticides raw material availability, potency variations, standardization of extraction methods, quality control and shelf life. This will promote organic farming, Integrated Pest Management and increase global food security.

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Amaranths (Amaranthus viridis) dry matter and soil Qualities: Organic vs Inorganic Fertilizers

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Key words: *Anarathus viridis*, Poultry manue, Manure extract, Compost

Abstract

In this paper, comparative effects sone organic fertilizers were investigated on Amaranthus viridis and soil quality. The study was carried out on the field in two successive plantings (first planting and residual) at the Department of Agronomy, University of Ibadan, Ibadan, Nigeria. Treatments used were poultry manure, poultry manure extract, NPK (15-15-15), and control at 100 kg N / ha, laid in a completely randomized block design with four replicates. Parameters observed were percentage dry matter and some chemical properties of the soils. The result of this research revealed that percentage dry matter accumulation of crop treated with poultry manure and poultry manure extract was better than that of mineral fertilizer NPK. Also, Poultry manure extract also improved post harvest soil nitrogen and pH than the NPK fertilizer. Thus, poultry manure and poultry manure extract which are organic fertilizers are recommended for raising quality green amaranth under similar soil condition.

Introduction

Fertilizer use impacts on both crop quality and the environment. Thus, it is necessary to evaluate the effects of both inorganic and organic fertilizers on *Amaranthus viridis* and soil qualities. While mineral fertilizers are getting more scarce and expensive for many peasant farmers in many developing countries (Obi and Ofoduru, 1997), their negative effects with intensive usd have tendency of reducing qualities of crops and soils productivity. Poultry manure and its extract as well as compost are common organic fertilizers used by some vegetable producers in Nigeria. *Amaranthus viriidis* is one of the species of amaranths used in common diets of Africans and Asians (Olaniyi *et. al*, 2008). Thus, the objective of this paper is to compare percentage dry matter accummulation of amaranths and some soil important parameters as influenced by poultry manure, poultry manure extract and mineral fertilizer NPK 15-15-15.

Material and methods

The experiment was conducted on a field at the experimental site of the Department of Agronomy, University of Ibadan, Nigeria (Latitude $7^0 27^1$ N, Longitude $3^0 54^1$ E), from December 2011 to February 2012. Fertilizer treatments were NPK (15:15:15), Poultry manure; Poultry manure extract and Control of no soil addition, laid in a randomized complete block design with four replicates. The dimension of each plot for the amaranth was 1.0 m x 1.5m. The fertilizers were applied at the rate of 100 kg N ha^{-1} Fertilizer treatments were applied at the rate of 100 kg N per hectare. Planting was done in two successions and harvesting was done at 4 and 5 Weeks after Sowing (WAS) respectively for main and residual planting (without any further fertilizer application). Crop percentage dry matter was subjected to Analysis of variance and means separated using least significant difference ($p<0.05$). Soil analyses were according to standard procedures as presented by Okalebo *et al.* (1993). The initial experimental soil's total nitrogen (0.11 g/kg) which was below the critical level for N (<1.5g/kg). organic matter content (47 g/kg) was high (>30 g/kg), while available phosphorus of 12 mg/kg was within critical range (8-20 mg/kg). The potassium, calcium, iron, copper, zinc and manganese concentrations of the soil were on the sufficient levels..The textural class of the experimental site was however found to be sandy loam.

Results

The results of the percentage dry matter content are shown on Table 1. At the main planting, effects of fertilizer treatments on the percentage dry matter accumulation in whole plants weight revealed that soil treated with poultry manure resulted into a significantly ($p<0.05$) higher percentage dry matter content (19.45 %) compared to that of NPK mineral fertilizer (4.47 %) and other fertilizer treatments. There was no significant difference between the poultry manure extract and the poultry manure treatments. Observations

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on other plants parts at the main planting followed same trend; showing that poultry manure extract resulted into significantly better effects than the NPK mineral fertilizer and control (no fertilizer) treatments. However, during the residual planting, poultry extract and the control soils resulted into better significantly ($p<0.05$) higher percentage dry matter accumulation, compared to other fertilizer treatments used. The Poultry manure extract was the best in plant whole weight percentage dry matter accumation (15.40 %), while the control treatment resulted best of the rest parameters observed: stem girth (12.83 %), root weight (17.10 %) and edible part (25.20 %).

The results of the soil analysis after first and residual plantings are shown in Table 2. At the end of the residual planting, the pH of the soils reamined slightly alkaline in all the treatments, except that of the NPK soil that became more slightly acidic (6.7) at the end of the resisual planting. The organic matter contents were better in other treatments compared to that of NPK and control treatments at the end of the residual plantings. Total nitrogen of the soils treated with poultry manure and control increased from 0.1 to 0.3 and 0.2 g/kg respectively. Anailable phosphorous contents poultry extract and poultry manure extract treatments increased to 20 and 19 mg/kg respectively from 14 mg/kg. However, the available phosphorus of the NPK and control soils reduced from 22 and 12 to 10 and 9 mg/kg respectively. However, the NPK treated soil resulted in highest exchangeable potasium of 0.3 cmol/kg at the end of the residual planting.

Table 1: Effects of fertilizer treatments on percentage dry matter of amaranth

Treatments	Main Planting (% dry matter)				Residual Planting (% dry matter)			
	Whole weight	Stem weight	Root weight	Edible part	Whole weight	Stem weight	Root weight	Edible part
Poultry manure extract	19.45	21.00	15.09	25.80	15.40	15.99	13.60	18.10
Poultry manure	16.67	19.10	11.22	23.10	9.90	10.35	8.90	10.50
NPK	4.47	3.90	7.97	5.50	6.30	5.97	8.40	5.60
Control	9.97	10.60	8.62	10.80	14.10	12.83	17.10	25.20
L.S.D ($p<0.05$)	6.18	8.11	6.11	12.60	6.95	6.35	9.97	10.92

Table 2: Post- planting chemical properties of soil subjected to treatments

Parameters	Measured values							
	Poultry manure extract		Poultry manure		NPK		Control	
	Main	Residual	Main	Residual	Main	Residual	Main	Residual
pH($H_2$0)	7.6	7.8	7.1	7.6	6.8	6.7	7.7	7.8
OC (g/kg)	21.6	19.2	28.2	24.6	10.8	6.6	24.0	9
Total N (g/kg)	0.2	0.2	0.1	0.3	0.2	0.1	0.1	0.2
Available p (mg/kg)	14	20	14	19	22	10	12	9
Exchangeable cation (cmol/kg)								
Ca	2.5	3.0	2.4	2.9	2.2	1.8	2.4	2.4
Mg	2.6	2.5	2.9	2.0	2.1	2.1	2.9	2.4
K	0.4	0.2	0.7	0.2	0.4	0.3	0.4	0.2
Na	0.8	1.2	0.9	4.0	0.8	0.1	0.8	0.9

Discussion

Generally, the results revealed that both the Poultry manure and the Poultry manure extract resulted in higher proportion of dry matter than mineral fertilizer NPK after residual plantings. This is indication that fertilizer treatments contributed to dry matter accumulation of *Amaranthus viridis*, like any other organic fertilizers (AdeOluwa, 2010). The implys that vegetables consumers could have better value for money in purchasing such treated vegetables per unit weight. Soil fertility status was better with other fertilizer treatments, especially the Poultry manure. The NPK treated soil had worst fertility status at the end of the residual planting. This result is in consonance with reports of Batiano and Mokwinye, (1991) and AdeOluwa (2010) that mineral fertilizers tend to degrade the soil with time. Thus, the use of poultry manure and its extract as organic fertilizers for raising *Amaranthus viridis* is encouraged for quality produce and sustainable soil.

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Softpest Multitrap - management of strawberry blossom weevil and European tarnished plant bug in organic strawberry and raspberry using semiochemical traps

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Key words: strawberry, raspberry, pest insects, plant volatiles, pheromones, semiochemical traps

Abstract

Many European organic strawberry and raspberry growers have large losses in yield (sometimes >80%) and reduced quality of their products because of insect damage. To meet these challenges a research project with partners from 6 countries has been established aiming to develop knowledge to manage populations of the major pest insects in the crops; Anthonomus rubi, Lygus rugulipennis *and* Byturus tomentosus*. The main hypothesis is that plant volatiles present in the original host plants in combination with the insect's respective pheromones are the most efficacious for attraction. For* A. rubi *this was confirmed during the first field season. However, variations in catches were found between habitats, generations and countries. For* L. rugulipennis *the temporal catches depended on latitude with an earlier onset in the North. To improve the efficiency of the insect pest traps, the project has also investigated trap design. The initial findings are promising and it is expected that the following two field seasons will allow us to add to the knowledge of insect pest management.*

Introduction

Among the major threats in organic strawberry and raspberry are the strawberry blossom weevil (*Anthonomus rubi* Herbst), the European tarnished plant bug (*Lygus rugulipennis* Popp.) and the raspberry beetle (*Byturus tomentosus* De Geer). In organic soft fruit production there are no effective control measures for many of these pest insects.

For many insect species pheromones and host plant volatiles are of major importance in mate finding and location of host plants for mating, feeding and oviposition. Thus, there is potential for using these insect-insect and/or insect-host plant interactions to develop new strategies and effective control measures for pest insects.

For *A. rubi* three male-specific compounds as components of an aggregation pheromone were identified (Innocenzi et al. 2001) and traps baited with this pheromone can be applied successfully to monitor the pest (Fountain et al. 2014). However, to control the weevil population stronger measures are needed (Cross et al. 2006a,b). Recent studies have shown that the attractiveness of the pheromone can be synergized with specific host plant volatiles (Wibe et al. *sub*.), i.e. the blend attracts more weevils than the pheromone or host plant volatile separately.

Investigations of the pheromone system of *L. rugulipennis* have shown that females produce three different compounds (Innocenzi et al. 2004, 2005). A precise blend of these released from specially-developed dispensers attracts males to traps in the field (Fountain et al., 2014). Frati et al. (2008) found that both male and female *L. rugulipennis* were strongly attracted to host plants when they had conspecific bugs on them in laboratory bioassays, suggesting that host-plant volatiles increased the attractiveness of the pheromone. Some of these host-plant volatiles were identified (Frati et al. 2009), however, preliminary studies failed to show enhancement of the attractiveness of the pheromone by these compounds.

For both *A. rubi* and *L. rugulipennis* it seems there are good possibilities for improving the attractiveness of the pheromone with host-plant volatiles, although further work is required to develop a lure for use in the field.

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For *B. tomentosus*, a very effective trap based on the key visual and olfactory characteristics of the raspberry flower has been developed to attract the beetle in raspberry plantations (Birch et al. 2008, Baroffio et al. 2012) and it is now commercially available for monitoring.

In this project we want to extend our knowledge of these systems to develop effective control measures to control these pests in organic crops.

The main hypothesis for the study of host plant volatiles of *A. rubi* and *L. rugulipennis* is that the flower volatiles present in the original host plants in combination with the insect's respective pheromones are the most effective for attraction of the Coleoptera and mirids. Conversely, volatiles from unhealthy host plants infested with fungi might deter the pests from feeding and hence provide a source of candidate repellent compounds. We further hypothesised, based on our previous research, that the natural semiochemical mechanisms of these pests and their host plants can be exploited in highly effective semiochemical traps for control by mass trapping. In addition, it is speculated that the attractive mechanisms for these two species are independent and can be combined into a single 'multi-species' trap.

The aim: To develop knowledge about how to manage populations of strawberry blossom weevil (*A. rubi*), European tarnished plant bug (*L. rugulipennis*) and the raspberry beetle (*B. tomentosus*) in organic strawberry and raspberry so that these two soft fruit crops can be grown without significant economic losses by these pests.

Material and methods

Our general strategy was to investigate host plant volatiles from raspberry, strawberry and other pest host plants for identification of important volatile cues for both *A. rubi* and *L. rugulipennis* (WP1); to evaluate host plant volatile synergists for sex pheromone lures to attract pest insects to traps in strawberry (WP2) and raspberry fields (WP3); and to optimise trap design, lures and methods of deployment for pest insect trapping in both crops (WP4). The project period is 2012-2014 and there will be three field seasons.

WP1. Host plant volatiles were collected and quantified by using several headspace sampling methods to enrich certain fractions of the volatiles. The volatile samples are analyzed using gas chromatography linked to mass spectrometry (GC-MS). The tasks were to:

- Investigate and compare flower and host leaf volatiles from raspberry and strawberry as potential synergists of *A. rubi* aggregation pheromone and *L. rugulipennis* female sex pheromone.
- Identify host volatiles from unhealthy/dying (e.g. fungi infested) strawberry plants that might act as repellents in order to add repellents in control strategy.
- Develop and produce lures based on plant volatiles for field testing.

WP2 *and* ***WP3*****.** Successful management of pest populations by mass trapping requires good knowledge of the target pest biology. The biology of *L. rugulipennis* is fairly well known, but there is lack of knowledge about overwintering strategies and how it is affected by mulching and weed cover. *A. rubi* has a univoltine life cycle, but variation in overwintering habitat in different countries has been observed (Trandem & Haslestad 2011). For both species we are using traps with species-specific lures to elucidate phenology and migration between different habitats and the effect of cropping methods. The tasks were to:

- Investigate overwintering sites and seasonal distribution of *A. rubi* and *L. rugulipennis* in strawberry- and raspberry crops. In raspberry crops studies of *B. tomentosus* are also included.
- Field evaluation of host plant volatile synergist(s) for the *A. rubi* and *L. rugulipennis* pheromones.
- Determine whether the characteristic host volatiles from unhealthy/dying plants identified are active in repelling *A. rubi.*
- Conduct large-scale field experiments to explore the density and pattern of trap deployment.

WP4**.** The current monitoring traps are a green funnel (bucket) trap with white or green cross vanes and the lure fixed at the top. This is satisfactory for monitoring but would be costly for mass trapping. An optimised design for mass trapping, where quite large numbers of traps are required, is needed. The tasks were to:

- Optimise trap designs and methods of deployment for *A. rubi* and *L. rugulipennis* mass trapping in strawberry and raspberry.

- Conduct field experiments to determine whether the same trap design could be used with acceptable control of *A. rubi*, *L. rugulipennis* and *B. tomentosus*, and whether the lures can be used in the same trap without interference.

Results

Here we present results from the first field season (2012):

Chemical analysis of plant volatiles (WP1)

- Wild strawberry plants and cultivars of strawberry have revealed differences in volatiles between the leaf and the bud.
- New volatiles in the host plants have been identified and candidates will be tested as attractants in the field.
- Analyses of fungi infected wild strawberry plants have identified possible candidates to repel pest insects in the fields.

In strawberry crops (WP2)

- In Norway *A. rubi* catches of the new generation (August) were conspicuously larger than those of the overwintered generation. The same was recorded in Denmark although the density of weevils was lower.
- *A. rubi* catches increased with crop age, while the catches of *L. rugulipennis* don't show the same tendency
- The temporal pattern of *L. rugulipennis* catches depended on latitude, probably reflecting differences in voltinism: in Norway, catches ceased after mid-June, while in UK and Denmark they peaked during July-August.

In raspberry crops (WP3)

- Large variation in trap catches of *A. rubi* between Switzerland and Norway were recorded. In Switzerland there was no effect of the trap position in the habitat (crop, boundary, forest), whereas in Norway the trap position had a significant effect by catching more in the crop.
- In spring, *A. rubi* becomes active when the temperature reaches 18°C. Mating occurs in May which corresponds to the development of leaves in the crop (April/May). A 2nd population peak appears during fruit development in Switzerland. This 2nd generation appears about one month later, depending on the temperature.
- In both Norway and Switzerland *B. tomentosus* was present before raspberry flowering, and in Norway there was a large trap catch peak at that time. In Switzerland a weak population peak is observed at the flowers development stage (BBCH 60-69, Schmid et al. 2001**)**.

Trap design (WP4)

- In strawberry crops the most effective traps for capturing *A. rubi* and *L. rugulipennis* were green cross vane bucket traps with no bee excluder grid over the funnel. These traps caught both species without attracting bees.
- In raspberry crops the most effective traps for catching *A. rubi* and *B. tomentosus* were white cross vane bucket traps with a grid to prevent bees being captured. This design caught both species and the efficacy was not affected by the incorporation of the grid.
- The height of the trap in the raspberry crops had an effect on the *A. rubi* catch. Significantly more *A. rubi* were found in traps on the ground than those placed at 0.75 or 1.5 m.

Discussion

To date, we have accumulated further information for developing strategies for managing insect pests in organic strawberry and raspberry. The chemical analysis has revealed specific volatile characteristics of different parts of the host plants, important information to understand the insect host plant attraction and selection. In addition potential attractive and repellent volatiles have been identified; new candidates for manipulating the insect populations in organic crops. These compounds will be further tested in the plantations in the next field seasons.

A. rubi second generation populations are larger than the new emerging generation*, in both* organic strawberry and raspberry crops. It is important to uncover what effects this overwintering second generation has the crops in the following year. Surprisingly, differences in trap catches depending on habitat were found in the different countries involved in this project.

Consequently, local conditions will need to be considered when devising strategies for insect pest management. Strawberry crops need different strategies to raspberry crops even though in some countries the insect pests may be the same. Latitude the crops are grown in is also important. However, there are no indications that the efficiency of the traps differs significantly from one location to another. Therefore, we hope to be able to develop one effective combined 'SOFTPEST' trap for two or three species in either strawberry or raspberry plantations.

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Bridging field experience and academia: an international agroecology doctoral programme

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Abstract

Distance between academic study and farmer practice is especially challenging in countries where limited resource farmers dominate agriculture. Doctoral research in holistic and systems strategies to solve practical challenges should be available for graduates of current agroecology MSc programs and for other professionals in development. Many mid-career specialists have superb field experience but lack opportunities for efficient and relevant doctoral studies that will prepare them to deal with complexity and uncertainty in today's agriculture. An international agroecology doctoral program is designed to meet this need, providing integrated education in production, economic, environmental, and social dimensions of food systems. Distance courses, regional workshops, and electronic networking will bring an international group of highly qualified agroecologists as instructors and research supervisors to help university, government, and non-profit employees gain a doctoral degree.

Introduction

Students interested in advanced agriculture and food systems education using holistic, integrated approaches seek opportunities for interdisciplinary doctoral research. Advisors are geographically dispersed and few universities have capacity to offer courses and supervision. Agroecology study programs in Ethiopia, Uganda, Nicaragua, and Sweden, funded by Swedish International Development Agency [Sida] in SLU Global are planning to meet this need. An international network of researchers, advisors, and instructors from Europe, Africa, and the Americas will provide courses and dissertation opportunities. Using distance courses, regional workshops, and electronic networking, an international faculty will offer education and research supervision for talented candidates in national research programmes, universities, aid and non-profit agencies, and private industry to achieve a doctoral degree.

Planning methods

To mobilize human intellectual resources and plan for collaborative advanced education activities, a project Agroecology in Practice [Agroecoprac, www.agroecoprac.org] that links universities in Sweden, Uganda, and Ethiopia has established new MSc study programs in three countries. An advanced program is available in Nicaragua. Study programs are built on the foundation of agroecology (Altieri 1983) often defined as the *ecology of food* systems (Francis et al. 2003), and variously considered a science, a practice, or a social movement (Wezel et al. 2009. Practical learning in the analysis of agroecosystems (Rickerl & Francis 2004) is emphasized, along with building capacity for catalyzing responsible change (Lieblein & Francis 2007; Lieblein et al. 2008).

Building on the momentum in these degree programs, an initiative to extend the concept to study at the doctoral level was explored with interested professionals in a planning workshop in March 2013 in Malmö, Sweden. Fifty educators and administrators from twenty-five universities and fifteen countries in Africa, Asia, Americas and Europe met to define priorities and set in motion an action plan for a doctoral study program in agroecology and capacity building. Through facilitated large and small group workshops, the participants explored the priorities for the study program, and sought to identify the most important action steps that are needed in nine categories [adapted from Salomonsson et al., 2013], of which six are described. The results and directions established in each of these priority areas are discussed, together with progress toward future implementation of the project (see Salomonsson et al. 2013 for complete report).

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Results

Educators met in alternating activities of individual discovery, interaction in small groups of three to five people, and general plenary discussion sessions to explore the most important areas to consider and steps to take in implementing the study and degree program. The following ideas were developed:

1. Selecting students

One of the first critical steps is careful selection of those student applicants who have the greatest potential to make meaningful contributions to future farming and food systems. Success of PhD graduates will depend on motivation and creativity that should be assessed carefully, in addition to using current admission requirements including certificates of prior degrees, transcripts of academic grades and/or placement, and letters of reference. Potential students who rank high on several important criteria should be those admitted. Among these criteria are:

- Capacity for becoming sophisticated communicators with multiple audiences
- Understanding history of technology and sciences, plus technical competence
- Interest in ethics and values as integral to study of systems and working with people
- Curiosity about multiple world views
- Empathy and respect for farmers and other stakeholders
- Proficiency in more than one language, including English
- Resilience in thought, decision making, and actions
- Potential to develop general and specialist skills, become creative and proactive
- Strong practical problem orientation and problem solving skills
- Resilient and flexible, open to change and new information

2. Building supervisory capacity in academic advisors

We consider it essential to carefully consider the capacities to be developed in an ideal supervisor, some of which may be additional to those needed for advising students in conventional and well-defined disciplines in the academy. Among ideas collected from the workshop participants, we consider it important for supervisors in agroecology to have:

- Agroecology background and/or PhD degree in a relevant area
- Capacity to move outside personal area of expertise and work in teams
- Creativity and willingness to take risks
- Ability to create innovative social situations and learning landscapes
- Willingness to lead a group of supervisors on a student's committee
- Potential and interest in reflection and innovation in the learning process
- Respect for intergenerational communication and equity issues
- Network of clients in farming and/or food systems and good working relationships
- Fluency in English and other language(s) in which the PhD thesis will be written
- Potential to reflect on personal paradigms and practices
- Flexibility, resilience, innovation, and capacity for stimulating students
- Interest in broad learning landscape at different levels of scale
- Knowledge of systems and integrative sciences, biological/ social science methods
- Sensitivity to gender, economic, racial, cultural, and background differences

3. Identifying the core principles and needs of students

The Agricultural Sustainability Institute [ASI] at University of California – Davis recently elaborated a set of operational principles that can be used as a foundation for establishing agroecology principles for the new doctoral program. Among those identified are:

- Practicing sustainability**:** using sustainable practices in all operations and actively striving to embody core values in all program planning, including building community and promoting respect for the dignity of all people.

- o Building legitimacy by spanning boundaries across disciplines and countries, pursuing science in the public interest, operating with historical awareness of the roots of agroecology, and seeking consensus while respecting differences.
- o Creating useful education by communicating for responsible impact, integrating knowledge and bridging academia with stakeholder experience and interests, maintaining commitment to experiential learning, and fostering a learning organization.
- o Striving for credibility by setting a forward-looking educational agenda, maintaining a multidisciplinary balance, seeking scientific integration and synthesis, and fostering open inquiry by instructors and students in their post-graduate studies. [modified from principles of ASI: htttp://asi.ucdavis.edu/about/ASI.operational.principles.pdf/view]

These principles provide a starting point for establishing the principles for the agroecology doctoral study program, and they can guide our quest to meet the needs of students.

4. <u>Designing joint courses that build capacity of students for responsible action</u>

Distance and blended courses will be developed and made accessible to students in the agroecology doctoral program, and completing course requirements through individual and team learning activities will require well-organized networking by instructors and the overall program planning group. To the extent possible, we will build on existing classes and infrastructure of participating universities, as well as develop new courses where needed. These will be open to other students in collaborating universities, in part as a means to recruit agroecology doctoral students to the program.

5. <u>Developing a resource network and institutional collaboration</u>

Most participants in the planning workshop are well known to each other through prior collaborative research or education activities. With the growing interest in agroecology there are courses and BSc study programs in many universities, and it is essential to survey what is available and assemble a list of key potential participants in a global agroecology network that can support the new doctoral students. We expect that this roster of experts will provide ideas for students to choose supervisors and members of their doctoral committees, which can now come from the network in addition to their home universities. It was recommended that we develop a keyword search system for accessing gray literature resources in agroecology, since much of this is not easily found through conventional search strategies. A similar directory of advisor expertise that is searchable will help students locate people most appropriate to support their dissertation research.

6. <u>Establishing key sources of funding for students and faculty mobility and research</u>

Initially we will explore continuing support from SIDA and SLU as these organizations were instrumental in catalyzing the initial organizational meetings. A five-year proposal is under development. Yet success in the program will depend on financial support for a part-time coordinator at each of the collaborating universities, funding for coordination meetings to supplement what can be done on line, and especially funding for doctoral students who will need to meet their advisors, participate in regional workshops and team learning activities, and support their field research in the university of choice. Broader sources of funding from E.U., U.S. Department of Education, other national funding sources in the North, and private foundations will be essential to success of the programme.

Conclusions

An agroecology doctoral program that also includes capacity building as an invaluable dimension for future leaders in agriculture and food systems is moving off the drawing board and into action. There have been numerous discussions, extensive correspondence and visioning about how the program could be organized, and a major workshop with key potential players from universities. Success will now depend on identifying additional start-up financial support and investment of time and energy by the planners who are convinced about the importance of this practical advanced education. An agroecology doctoral study and research program will serve to bridge the gap between what is currently offered in academic universities and what can be learned from farmers and other professionals in the food system. This will provide opportunities for continued studies by graduates of the agroecology MSc programs, and for mid-career professionals in government, university, and non-profit organizations.

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Animal manure – reduced quality by anaerobic digestion?

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Key words: arable crops, biogas, perennial ley, soil organic matter, yield levels

Abstract

Anaerobic digestion may reduce emissions of greenhouse gases, but we know little about its impact on soil fertility. Reduced concentrations of easily degradable C in the manure may imply less food for the soil fauna and microflora. A field experiment to study its effect on crop yields and soil characteristics, established in 2011, showed comparable yield levels in perennial ley over 3 years when digested slurry was compared with undigested slurry. Digestion had no influence on either soil nutrient concentrations or soil organic matter levels over the first 2 years. Application of high amounts of manure caused the death of both surface-dwelling and soil-living earthworms shortly after application, but the long-term effect of manure application seemed more positive, especially at low application levels. So far, we have observed only small differences in the effects of digested and undigested manure.

Introduction

By anaerobic digestion (AD) of manure, farmers may produce biogas to replace fossil fuels and reduce methane emission during storage. AD may also ease manure handling and reduce the content of animal pathogens and viable weed seeds. A reduced proportion of easily degradable carbon (C) in the digested manure may affect soil organic matter, fauna and microflora. Organic nitrogen (N) is mineralized during digestion, so that the proportion of mineral N is commonly higher in digestates than in untreated manure. Higher availability of N applied in manure may increase crop yields and possibly compensate for the organic C removed via AD. The effect of AD of animal manure is under study in the project "SoilEffects". We present results from the first three growing seasons, 2011-2013, to discuss whether AD of manure affects soil characteristics and plant yields.

Material and methods

A biogas plant was established in 2010 at Tingvoll research farm, NW Norway, for AD of the slurry from 25 organically managed dairy cows. Yields and soil characteristics were studied in a field experiment with different manure application in two cropping systems: 1) arable crops (no legumes) with annual ploughing and 2) perennial grass-clover ley established in 2010. The crops in the arable system were oats (2011), ryegrass (2012) and spring wheat (2013). Low and high application levels of digested manure (D) and untreated manure (U) were compared, with total levels of 85 (low, L) and 170 (high, H) kg total N ha^{-1} yr^{-1} applied to arable crops, and 110 (L) and 220 (H) kg to perennial ley. No manure was applied in the control treatment. Each cropping system had four replicate blocks. Within each block, the treatments were randomly distributed on experimental plots (3 m x 8 m). The manure was diluted with water to < 5 % dry matter (DM). In arable crops, the manure was incorporated using a rake in 2011 and 2012. In 2013, the manure was incorporated with a horizontal rotavator. From each plot, a composite sample of 10 soil cores was taken in spring 2011 (before starting the experiment) and in spring 2013 (before manure application). The soil is a loamy sand, with low extractable phosphorus (P) status (< 40 mg P-AL kg^{-1} dry soil) and very high acid-soluble potassium (K) status (>1200 mg K-HNO_3 kg^{-1} dry soil) (Table 3). P-AL values in six of the 20 soil samples in the arable cropping system were below the detection limit (< 20 mg) in 2011, but set to 15 mg to facilitate statistical analysis. Immediately after manure application in spring 2013, the numbers of dead earthworms on the soil surface were recorded, and in autumn 2013, earthworms were sorted from soil cubes (8 l).

Statistical analyses were performed using Minitab 16 and SAS Statistical Software. A general linear model was used to test the effect of treatments on yield levels, and Tukey t-test at the 5 % level to compare the

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mean values of treatments. For comparisons of soil analyses in 2011 and 2013, paired t-tests were performed.

Results

Yields

In the grass system, the yield levels were strongly increased by manure application (Table 1). Digested manure gave the same yields as untreated manure. The yields declined over time in the control treatment, and hence the relative differences between the fertilized treatments and the control increased. In the fertilized treatments, the yield levels increased from 2011 to 2012. In treatments with low levels of manure, this seemed to continue also in 2013, whereas in the treatments with high levels, the total yields were slightly lower in 2013 than in 2012 (Table 1).

Table 1: Total and relative yields of ley (sum of two cuttings) in 2011-13, tonnes of dry matter ha^{-1} by different application of manures. N= no manure (control), U= untreated manure, D= anaerobically digested manure, L = low level of manure, H = high level. Statistically significant differences within year (P<0.05) are suffixed as a, b and c.

Treatment	2011	2011rel.	2012	2012 rel.	2013	2013 rel.
N	6.61 a	100	5.42 a	100	4.62 a	100
UL	8.05 ab	122	9.03 b	167	9.11 b	197
UH	8.78 b	133	10.45 bc	193	10.23 b	221
DL	8.19 b	124	8.95 b	165	9.28 b	201
DH	8.44 b	128	11.56 c	213	10.58 b	228

In the arable system, the apparent yield increase due to manure application was not statistically significant in any year, but a tendency (P = 0.095) was found in 2013 (Table 2). However, differences in growth characteristics such as straw length and plant colour were clearly visible between treatment plots during the growing season in 2011, and straw length was significantly increased by the DH treatment (Table 2).

Table 2. Total and relative yields of arable crops in each year 2011-13, tonnes of dry matter ha^{-1}, sum of straw + grain in 2011 and 2013, sum of two cuts of ryegrass 2012. Manure treatments and suffixed letters as in Table 1. The column "2011 cm" shows the mean length of oats straw in 2011.

Treatm.	2011	2011rel.	2011cm	2012	2012 rel.	2013	2013 rel.
N	5.35 a	100	65 a	2.23 a	100	2.98 a	100
UL	5.80 a	108	69 a	2.56 a	115	3.22 a	108
UH	5.98 a	112	72 ab	2.75 a	123	3.83 a	128
DL	5.60 a	105	71 ab	2.57 a	115	3.80 a	128
DH	6.11 a	114	78 b	2.64 a	118	4.00 a	134

Yield levels in 2012 were generally very low due to poor establishment of fodder rape, which had to be replaced by a late-sown ryegrass crop. Emissions of N_2O were measured in this system in 2012, showing higher values than former measurements in ley at Tingvoll. This may indicate that the manure was not sufficiently well incorporated, and may partly account for the lack of fertilization effect in both 2011 and 2012. In 2013, when a horizontal rotary harrow was used for combined soil tillage and incorporation of manure, the yield effects were larger (Table 2). Furthermore, a clearly better yield effect was obtained for the digested manure in 2013. Comparing the means of both digested manure treatments with the mean of the untreated manure treatments and the control, close to significant differences were obtained (P= 0.056) and the mean yields were D = 3.9(a), U = 3.5(ab) and N = 3.0(b) tonnes DM ha^{-1}.

Soil characteristics

In spite of the relatively short experimental period, statistically significant changes in some soil properties were found (Table 3). The soil content of organic matter (SOM), shown as ignition loss, decreased in the arable system. This result was expected, since soil tillage tends to decrease SOM. In the grass system, with much higher initial values of SOM, the values seemed to increase in both treatments with high manure application, and to decrease in the other treatments, but the differences between 2011 and 2013 were not statistically significant in this cropping system. For pH, a slight increase was found in most treatments (Table 3). This may have been attributable to wetter soil conditions at soil sampling in 2013, causing pH increase. For extractable P, no decrease was found in the control treatments, where this could be expected since there was no replacement of the plant nutrients removed. However, as the soil has a high content of SOM, there were probably sufficient P reserves. In the fertilized treatments in the grass system, the levels of applied manure increased the soil P concentrations, especially at the high application levels. In the arable system, less P was removed from the soil due to generally low yield levels. Hence, larger increases in extractable P could have been expected. However, the P status of the arable system soil system was generally lower (Table 3), and more P seemed then to be required to increase the P-AL level. For acid-soluble K, significant decreases were found in many treatments, in spite of manure application. Yield levels were high in the grass system, and grass-clover leys extract a lot of K from the soil. Also in the arable system, with much lower yields, significant decreases in soil K were found.

Soil aggregate size distribution and aggregate stability were measured after sampling in spring 2013. None of the size fractions were affected significantly by manure application. The aggregate stability was high, especially on the grass plots (mean 93%), due to their high content of soil organic matter and the known positive effect of grass on soil stability. On these plots, there was no significant effect of the manure applications during the previous two years. On the arable plots, where the stability was ca. 85% on control plots, significant (P=0.02) increases of stability by 2-3 %-units were found with all four manure treatments.

Table 3. Selected soil characteristics (0-20 cm depth) at the start of the experiment in spring 2011, mean values of four replicate plots per treatment and crop, compared to values in spring 2013 after two years of manure application. Phosphorus (P) and potassium (K) concentrations in mg kg^{-1} dry soil. Statistically valid changes and tendencies (by paired t-test) = (*) for P < 0.1, * for P < 0.05, ** for P < 0.01.

	Tr.	Ignition loss %		pH		Extractable P		Acid-soluble K	
		2011	2013	-11	2013	2011	2013	2011	2013
GRASS	N	10.83	10.18	5.80	5.98(*)	28.3	30.0	112	101
	UL	10.65	10.28	5.75	6.03*	26.8	35.0*	128	113(*)
	UH	11.90	12.33	5.85	6.18*	30.5	43.3**	126	108
	DL	11.25	10.50	5.85	6.08**	26.5	32.5(*)	131	106**
	DH	12.05	12.33	5.83	6.10*	31.3	40.0*	115	103*
ARABLE	N	6.73	6.38	5.83	5.95*	27.5	25.8	180	155 (*)
	UL	6.28	5.53*	5.90	5.95	21.8	24.3	178	155*
	UH	6.48	5.78*	5.83	5.98*	21.3	26.3(*)	173	165
	DL	7.05	6.33(*)	5.93	6.08	21.3	25.3*	170	150*
	DH	6.35	6.05	5.88	6.08*	23.8	29.3(*)	175	160

Earthworms

In the ley, many earthworms came to the surface and died shortly after manure application. In 2013, 19 dead worms m^{-2} were found in UH, 11 in DH, 4 in DL, 2 in UL and 0 in N. Dead worms belonged to both surface dwelling species (*Lumbricus rubellus, L. terrestris*) and more soil dwelling species (*Aporrectodea caliginosa, A.rosea)*. In the autumn of 2013, the average earthworm density without manure application was 150 m^{-2}. The highest density (244 individuals m^{-2}) was found with application of high amounts of digested slurry. With application of low amounts of both types of manure it was also well above the control treatment (200 m^{-2} for UL and 181 for DL). The lowest value was found with high amounts of undigested slurry (119 m^{-2}). However, as the variation was high, none of the latter figures differed significantly.

Conclusions

In perennial ley, both untreated and digested manure increased the yield levels significantly and to a similar extent. In arable crops, when the manure was thoroughly incorporated into the soil there was a tendency for better yields to be obtained with digested manure. Arable cropping decreased the soil organic matter content (SOM). High manure application caused death of many earthworms. More work is required to conclude whether anaerobic digestion gives manure of poorer quality for organic farming systems, but its short-term effects seem so far to have been minor.

Combining farmer experience and academic knowledge: summer agroecosystems analysis course

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Key words: Experiential learning, team projects, on-farm education, phenomenology

Abstract

To understand multiple facets of today's complex farming systems requires us to move beyond the narrow disciplinary focus found in most university agriculture courses. Learning from farmers who are intimately involved with daily decision making on the farm is highly instructive. Experienced at designing systems and choosing appropriate practices season after season, farmers can provide valuable knowledge to complement lessons taught in the academic classroom. Traditional agricultural departments are human constructs developed for our convenience, and thus scarcely represent valid lenses through which to view the complex ecological structure of farms. To adequately delve into mechanisms of crop/weed, crop/animal, product/market, and myriad other interactions involved in agriculture, it is essential that we draw on methods from the biophysical and social sciences to help us understand the human activity system of farming. We call this approach agroecology analysis.

Introduction

For more than a decade, we have led a summer course using experiential learning to help students understand the complexity of farming systems. Students visit and interview farmers in Iowa, Minnesota, South Dakota, and Nebraska, with students taking responsibility for designing the inquiry, processing information collected, and evaluating what they learn in the context of each farm. In addition, students design potential options for farmers to consider for improving the sustainability of their operations. Team projects provide a measure of learning about farming systems, while individual reflection documents provide a place for self-evaluation and personal reflection. We describe this course as a bridge between farmer-based and academic knowledge, an integration of disciplines and methods, and a discovery process that builds student capacity to understand complex, dynamic farm processes. The phenomenological approach features an open-ended case method to study the farms (Francis et al. 2009).

Material and methods

The heart of this course is a series of interviews with farmers about their operations. In the midwestern United States, this includes field crops, vegetables, beef and dairy cattle, swine, sheep and goats, and various combinations of these enterprises. Starting education on the farm has been called phenomenology (Østergaard et al., 2010). When students conduct interviews and tour farms together, they build a common context in which to compare and contrast farming operations as well as their own methods of evaluation. Students bring prior schooling and personal experiences in agriculture to this analysis. Each project team benefits from the collective experience and diverse academic history as the course unfolds over the week.

Foundationally, we believe that a multidisciplinary perspective is useful to understand the many biological interactions, economic dimensions, environmental impacts, and social elements of each farm, and also how the farm family relates to the local community. Education and research using this perspective should be termed *agroecology: the ecology of food systems* (Francis et al. 2003). Therefore, the course includes multiple methods for studying and evaluating farms. Some key tools are introduced early in the course so students can clarify their pre-course assigned readings and develop questions for their farmer interviews (Francis et al., 2009). The process includes biological, economic, and environmental review in a process described in *Agroecosystems Analysis* (Rickerl and Francis, 2004). Experiential learning has a rich history in U.S. academia (Moncure and Francis, 2011), and we have been especially happy with the open-ended case learning strategy that students use to put farmers' questions into a whole farm perspective (Francis et al., 2011). In addition, when students, instructors, and farmers work together to discuss the challenges on a farm, this can provide a rich, real-world opportunity for learning. We find that four threads weave through the

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course and help students build bridges across gaps between former classes—what could be called the boundary areas or *ecotones of learning*.

Results

Four themes that appear particularly important in the success of this summer course in the analysis of farm agroecosystems include: 1) valuing farmer experience, limitations, and wisdom; 2) focusing on multidisciplinary study and learning to sort out complexity in related farming systems; 3) using methods of analysis from the biophysical and social sciences, and 4) studying each farm as an open-ended case study in which the challenges must be discovered by the students and potential future changes explored with the farmers.

1. Phenomenology: bridging farmer experience and academic knowledge

While many courses start with the history of the discipline and study of theory from a particular perspective, phenomenology begins with the farm and the experience itself (Østergaard et al. 2010). Armed with minimal tools and often useful prior experience in such fields as agronomy, horticulture, economics, and plant protection, teams of students spend an evening discussing what questions they should ask farmers to uncover details of crop and animal production, market options and economic outcomes of different enterprises, environmental challenges created by current production systems, and the critical labor, family, and community issues that impact a farm's success. For each farm visit (typically 6 to 9 farms in four separate states), a brief tour of fields and facilities and in-depth interview with the farmer/farm family provides an overview of enterprises, integration of activities, and the key economic factors that contribute to sustainable operations. Through personal observations and listening to the farmer, students begin to understand major enterprises and activities and piece together key interactions that relate the farm to its natural resource base. After multiple team discussions, the student groups prepare a document that compares and contrasts the farms, using metrics and indicators derived by each team. It is intriguing to see the different methods used and results achieved by creative students each year, and their abilities to discuss differences of opinion and arrive at some consensus in their reports.

2. Multidisciplinary learning: moving out of our silos of knowledge

Another important bridge encountered by students during this on-farm learning adventure is spanning the disciplines they have experienced in prior university courses. They learn to appreciate the different lenses through which farms can be viewed, depending on one's focus or prior education, and to learn the terms and perspectives used by others on their teams. The instructors collectively represent more than 125 years of research and teaching experience in prairie ecology, genetics, plant physiology, agronomy, horticulture, soils and forage crops, animal science, international agriculture, and food systems, plus practical farming experience and decades of working with farmers. We could describe the week as a process of helping students move away from their prescribed silos (represented by major departments of study) in the university, and welcoming them to the complex world of the farmer and the real-world context in which he or she makes decisions. At times this real-world context can be an arduous and confusing journey, but one that students appear to appreciate in the end.

3. Biophysical and social science variables: bridges in methodology

Agronomists and animal scientists are accustomed to recording hectares of each crop, livestock numbers, production inputs and practices, and yields/weight gains, while economists look at costs and returns and alternative marketing opportunities. Environmental scientists measure water quality, soil erosion, and biodiversity on the farm and in the landscape. Rural sociologists observe family and community dynamics, including how the strength of local institutions and infrastructure relates to size of farm and quality of life. These are but four examples of focus that students can bring to the study of farms in this course. What they all discover is the need for many types of measurements and different methods of viewing and evaluating the farm and its enterprises. For example, they must add the skills of interviewing and social system evaluation to what they already knew about recording crop varieties and fertilizer rates. More important than specific measurements and methods are the perspectives students gain from other major fields of study, and how to focus broadly on the total context of the farm, an entity not easily defined by any single set of criteria.

4. Open-ended cases: experiential learning and discovery

The use of the case study as a learning technique has grown from its initial application in business schools. In fact, the University of Minnesota has developed a number of agriculture decision cases that are well respected and widely used (American Society of Agronomy, 2005). In most case studies, the answers to a particular inquiry are already known to the client and the instructor, and the students must be clever enough to figure out the correct answer. In contrast, the open-ended case approach explores situations in which the answers are not known, and even the questions may be poorly defined (Francis et al., 2009). In our course, students are responsible, through their interviews with farmers, for discovering the issues and defining the key questions. They must explore the situation in enough detail to evaluate present enterprises and system designs and evaluate the relative sustainability of different strategies, and explore possible changes. This can be challenging for students who come from an academic environment where they are charged with figuring out the one right answer on an exam. Here they are put into an imaginary role as advisors who learn as much as possible about the farm in a short time, perform an evaluation, and consider potential modifications of current systems. This is a real-world situation that most will face in a future job, where often the goals are loosely defined and there is never full information for making decisions.

Conclusions

Evaluation of student learning in this summer travel course has been integral and ongoing. This involves continuous assessment through one-page questionnaires completed each evening, and frequent interactions with students at meals, during travel, and at farm visits. A faculty mentor is assigned to each group, and instructors meet each evening to share observations and modify next-day activities. Insight on learning was summarized (Wiedenhoeft et al., 2003), and a graduate student evaluated daily evaluation sheets over seven years (Harms et al., 2009). This hands-on, minds-on immersion in farm operations was highly successful in providing students new ideas about how farms work and how farmers make decisions. One recent student said, " I learned more in one week on farms than in a full semester of courses back on campus." While this may not always be the case, we are encouraged by student feedback that this is an effective way to study complex systems.

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Bridging farmer experience and science: learning for agroecological design of sustainable farming systems

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Key words: experiential learning, agroecology, farming, food systems, phenomenology

Abstract

Bridging the gap between academia and farmers requires unique learning methods, teaching based on multiple information sources, and instructor willingness to embrace the importance of farmer experience as a legitimate resource. Agroecology is emerging as one holistic field that includes farming and food systems, and integrates production, economics, environmental issues, and social dimensions in education. We explore how biophysical and socioeconomic characteristics and research methods are important to understanding human activity systems related to food, and we use examples from organic farming, permaculture, multiple cropping, crop/animal, and local systems to expand student understanding of food security and food sovereignty. Instructors are mentors and co-learners using phenomenology and practical experience with stakeholders in a carefully designed educational journey through the food system learning landscape. The Agroecology MSc Program is used as a case study.

Introduction

Bridging the gap between academia and farmer experience is crucial in developing learning programs using phenomenology. Agroecology is an integrative and holistic approach to study agricultural and food systems. Understanding farmer systems and ecological principles as foundation, focusing on uniqueness of place in farming design, shifting from disciplines to holistic perspectives, and integrating human dimensions are all essential. Farmer experience in organic farming, multiple cropping systems, permaculture, and crop/animal systems provides teaching examples to bridge theory and practice. On-farm discussions with farmers build communication skills and confidence in working with stakeholders. Learning agroecology as the *ecology of food systems* includes production, economic, environmental and social factors in future systems design (Francis et al., 2003). Experiences here are based on more than a decade of teaching in at the Norwegian University of Life Sciences (NMBU).

Learning methods

Methods of guiding students through an agroecology learning landscape and developing greater capacity to communicate with stakeholders are imbedded in the curriculum of a MSc course in classroom and field. The course begins with transect walks across farms and natural landscapes to develop multiple senses to understand the farming context (Francis et al. 2012). Students work on farms and interview farmers in an initial exercise, learning key interview techniques and designing relevant questions to make best use of the farmer's time (Ostergaard et al. 2013). Interviews are designed to learn about current farmer systems and their rural context. Focus on ecological principles in classroom, discussions, and farm conversations provides understanding of farm, field and enterprise niches, uniqueness of place, and that one system does not fit all circumstances (Altieri 1983). Importance of holistic thinking and moving from discipline-based to transdisciplinary approaches is fostered in lectures, discussions, and interviews with farmers (Lieblein et al. 2008), and in reflections by students who summarize field experiences and draw mind maps to organize information from farms they have visited (Breland et al. 2012). Integrating understanding of people at the heart of the human activity systems we call farming is accomplished by maintaining continual focus on decisions and designs that farmers develop in choice of practices and farming systems each year. A visioning process is introduced in class and in the field with clients (Lieblein et al. 2011). By practicing these methods with farmers, and engaging a wider stakeholder group in study of community food systems,

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students gain confidence in dealing with those who design and implement changes in the system, and thus become better prepared for responsible action in the future (Lieblein and Francis 2007). The educational process has been successful in a one-semester full-immersion module in autumn term at NMBU (30 ECTS) and in an on-line introductory agroecology course in spring term taught by instructors from four Nordic universities (5 ECTS). In these courses, we recognize the multiple interpretations of the term *agroecology* as a science, as a set of practices, and as a movement (Wezel et al. 2009), and encourage students to explore all three as an integrated and holistic approach to learning.

Results

When students work on farms, even for one day, they begin to learn first-hand about the rigours of farm labor and rural life. They also learn to value the criteria of farmers and why they have designed their current systems, plus how these relate to the science that they have learned at the university. An important next step is to understand the foundations of ecology and how these apply to present systems and how they could be used for future systems design. To appreciate the multiple and complex connections in farming and food systems, we find it essential for students to think outside the traditional disciplines in our agricultural education and research system, and to develop skills for whole systems thinking. These whole systems include the farm owner or manager who designs the farming system and selects the practices, and those professionals who are part of the food system as teachers, advisors, and government officials. Results in each of these areas and how we have observed student learning is discussed in more detail.

1. Learning from indigenous systems and building bridges to science

It comes as surprise to some students that our courses give major attention to farmer experience at the same time as we are exploring principles of science and especially ecology. The full day of work on biodynamic farms in the second week of the course have focused student energies on tasks selected by the farmers, and tasks have ranged from harvesting onions and potatoes, to stacking firewood, to cleaning livestock barns, and even to searching the forest for lost goats that had likely been killed by wolves. In each situation, students felt that they were contributing labor to activities considered important to the farmer, and in a way exchanging their time for what the farmer provided to them during the interview and farm tour. On numerous occasions farmers have invited students for lunch where they have joined the family and farm interns in a valuable discussion of farming and some details about the specific operations.

Experiences such as combing the forest for goat carcasses provided high adventure, and exposed students to the risks inherent in livestock raising in remote areas of summer pasture. They learned about the personal strength needed to work alone, at a distance from the farm and the safety and companionship of others. The team that stacked wood all day could be seen as pursuing a totally menial task, yet their reports of discussions on alternative sources of fuel, renewable energy options, and life cycle analysis of timber as it compares to other means of heat and power revealed the rich learning experience that was generated from within the group. We were not sure at the outset if this would be seen as useful by farmers and a worthwhile investment of limited learning time by students, but both groups have confirmed the value of the exercise.

Yet more important than the social experience of getting to know farmers and families as people, and more than the high adventure of perhaps sighting a predatory wolf in the forest, were the gains in understanding the farming system and the reasons why certain enterprises and practices were chosen to fit into the context of a certain environment and set of natural and human resources. The students learned that green manures and composting provided viable alternatives to chemical fertilizers on these farms, that farmers could live with a low level of weed infestation in fields, and that biodiversity in the field margins and natural areas on small farms were part of the total ecosystem. The experiences provided a bridge to the principles they had learned previously in classes, and students were learning about holistic farming design using ecological models as the starting point. This is a clear bridge between farmer experience and science.

2. Building farm and food systems designed using ecological principles

Central to agroecology is the application of ecological principles to design farming systems that are more dependent on internal, renewable resources and less on imported fossil fuels and their derived production inputs. Nutrient and water cycles, natural methods of pest protection, and conservation of energy through practices that mimic the functions of natural ecosystems are emphasized in texts and journal articles in agroecology (eg. Gliessman 2007). Research in science to better understand how structure and function in alternative systems contribute to productivity and stability has increased in recent years, although there is still a domination of the chemical and industrial paradigm in most education in agriculture. One of the best sources of empirical data, perspectives, and applications of ecoprinciples is still the collective experiences of farmers.

Although experienced farmers on the ground may not use the same terms as scientists in universities, farmers possess a wealth of information and practices that need to be observed, evaluated, and incorporated into a comprehensive agroecological education for students. Obviously not everything is correct, nor can all practices be widely applied. This is where student and instructor energy, careful consideration of the literature, and common sense come into evaluation. We have found that student observations of farmer practices and the ideas gleaned from interviews can be highly instructive in helping us all bridge the gap between farmers and university. Although we are hesitant to challenge the conventional wisdom of practices that appear to work on a particular farm, we can inquire together with students about how and why a specific activity is successful, whether that is consistent with research information, and how important context can be in the evaluation of practices and results. This is a learning process that involves students, farmer clients, and instructors working together to 'bridge the gap'.

3. Shifting from disciplines to whole systems thinking

Implicit in the agroecosystems analysis of farms and food systems is the importance of shifting beyond comfortable disciplinary boundaries and into the mode of whole systems thinking. The classical disciplines, as well as ecological principles, are all human constructs that we use for convenience to understand and communicate about components and systems. Farmers are by nature holistic thinkers, although they may appear to focus down on specific components such as which hybrid to plant or what weed management strategy to apply. While conducting interviews with farmers, our students at times express frustration with not being able to get answers to all their pre-designed questions. Their clients may pursue what appear to be tangents to the questions, while in fact they are hoping to communicate the complexity of problems and how so many issues are connected. This is a good lesson coming from interviews, and students profit by the broad perspective uncovered by interviews even while talking about specific practices and rotations. Multiple crops and crop/animal integrated systems are particularly interesting because of the complexity of their structure and the multiple objectives farmers have in their design and expected diversities outputs.

4. Integrating the human dimension into evaluation of food systems

Perhaps the most complex challenge for students is incorporating the human component into their thinking and analysis of systems. This is likely due to their prior focus on the biophysical and economic issues, one by one, without explicitly thinking that the bridges that link all the components are more than nutrient/crop interactions or responses to irrigation, but are obviously related directly to the human management of the system. Students uncover incredible complexity on the farm, and even more in community food systems. They grapple with how to understand complexity by using a series of 'agroecosystems analysis' tools, including social science methods, and strive to use science to put a foundation under what are observed as practical and functioning systems on the farm and in the community (Rickerl and Francis 2004). These provide essential perspective for designing potential future scenarios, our preferred output from student teams, rather than specific solutions or rigid recommendations.

Conclusions

We conclude that the agroecology MSc course in autumn at NMBU provides both safe space and a stimulating team environment that fosters systems learning as well as gains in confidence for communicating with a range of stakeholders in the field. Communication is key to bridging of knowledge from farmers and other clients and academic science from the university. Through multiple interviews and data collection in the field, access to official statistics, use of tools from both natural science and social science disciplines, and reflection on results students are empowered to learn about complex farming and food systems and to use the results to design potential scenarios to present back to their clients in the field. This learning approach is then applied to a thesis project that culminates the agroecology MSc degree, and phenomenology as a foundation for learning has proven successful for more than a decade in agroecology at NMBU.

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Contaminants in manure – a problem for organic farming?

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Key words: animal manure, contaminants, plant uptake, regulation, pesticide, medicine

Abstract

Animal manure used in organic agriculture might be contaminated by undesirable elements such as heavy metals, veterinary medicines or pesticides. Contamination might occur by using conventional fodder or manure, from on farm usage of veterinary medicines, from drinking water or animal fixtures. In turn these contaminants can be transferred to the food chain, thus posing a risk to the health of soil organisms, animals, plants and humans. Research has shown that undesirable elements, e.g residues of veterinary medicines, can be taken up by plants. There is, however a lack of knowledge concerning the fate of many undesirable compounds. More research is needed related to these compounds' dissipation rate and particularly their potential for transfer to plants. This is necessary in order to secure safe management of manure on organic farms and also to enable decision makers in framing satisfactory standards for use of manure in conventional and organic farming.

Introduction

Within certain restrictions, conventional animal manure can be used in organic farming when the farm's own resources do not cover the demand for plant nutrients.
Research has shown that the pathways of organic compounds such as veterinary medicines and pesticides may be unpredictable and that undesirable elements can be transferred to the food chain. The purpose of this investigation was to gain more knowledge concerning potential contaminants in manure and how they might influence the quality of organic produce. The work was carried out through a literature review and through contact with researchers, governmental authorities, organic certifying organizations and organic farmer organisations, mainly in the Nordic countries but also in other European countries.
A Nordic workshop for researchers, control bodies, advisers and government administration was arranged to exchange knowledge and to discuss the need for future research.

Findings

A survey (Holten 2012) among Norwegian certified organic farmers showed that different types of conventional manure are used for both fodder and food production. Many farmers wish to continue using manure from conventional farming.
The literature review (Serikstad et al. 2012), which came forward as a request from The Norwegian Food Safety Authority (NFSA) and The Advisory Committee for Organic Farming Regulations, describes both sources of possible contaminants, status on research and need for further investigations.

The sources of heavy metals in manure are mainly the fodder but also drinking water, bedding and the fixtures where the farm animals are kept. Manure from pigs and poultry can contain amounts of copper (Cu) and zinc (Zn) at levels that reduce the quality and affect its usage according to Norwegian regulations for organic fertilisers. This might apply to manure from other animals and other heavy metals as well.

Residues of veterinary medicine can be found in animal manure (Jacobsen and Halling-Sørensen 2006, Martínez-Carballo et al. 2007). These residues can be taken up by plants and localised in different parts depending on the plant species and the type of medicine (Boxall et al. 2006, Eggen et al. 2011). Special attention should be given to veterinary medicine used as prophylactic treatments for the whole herd.

Residues of certain herbicides in manure and compost have been found to give crop failure or deformation. Particular consideration should be given to persistent pesticides. Pesticide residues can reduce the quality of commercial manure and compost and cause problems for the companies who sell these products. The decomposition time of organic compounds in the environment, including potential residues of medicines or pesticides, will be prolonged in the cold, Nordic climate compared to a warmer climate.

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Conventional manure is used in organic farming in Norway. The manure can come from parallel production on the farm, conventional farms or as commercial fertilisers. Usage is restricted based on the amount of nitrogen. As yet there are no special restrictions regarding levels of contaminants in animal manure from one's own or imported conventional manure. Commercial fertilisers based on conventional animal manure are regulated through the general governmental regulation for fertilisers. This only specifies levels for heavy metals. For other potential contaminants such as veterinary medicines or pesticides, the regulation only requests precaution so products won't contain such substances at levels that might pose a threat to health or the environment.

Discussion

The basic principles of organic farming, in this case especially related to the principles of health, ecology and care, imply that special attention should be given to precaution and responsibility. These are key concerns in the management of organic farming. Taking these principles seriously would mean a more restrictive practice on the use of animal manure from conventional farming. A more restrictive use of manure could, however, lead to nutrient deficiency in organic management. On the other hand, it is important for both the environment and the reputation of organic food products that this source of nutrients doesn't contain any toxic contaminants. Through identifying which compounds might be present, their environmental properties and their residue levels in manure and environment, the authorities will be able to establish restricted practice based on knowledge.

Conclusion

Both the literature review and contact with relevant research and advisory institutions in Europe shows that there is a need to investigate the topic further. There is a lack of documentation on residue levels of veterinary medicine and pesticides in animal manure. Furthermore, when the risk compounds are detected, there is a need for knowledge related to these compounds' dissipation rate, and particularly their potential for transfer to plants. Since there are no analytical methods established for many of the relevant compounds in environmental matrixes, establishing this and performing a screening of potential risk compounds in different manures after medicinal treatment should be the very first step. Those who make standards for use of manure in conventional and organic farming need more knowledge to make better decisions.

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Evaluation of student reflective documents in agroecology education: a qualitative analysis of experiential learning

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Key words: experiential learning, educational evaluation, agroecology

Abstract

Agroecology student learner documents facilitate self-evaluation by students in a course on farming and food systems. Students reflect on their roles in learning in classroom, discussions, field teamwork, and stakeholder meetings. A database of documents from 13 years of courses and more than 200 students provides opportunity for qualitative analysis and interpretation of core consistencies and meanings from their writings. We use this systematic evaluation of learner documents to better understand the educational process as viewed by our students, and to design and improve learning activities in the classroom and in the field. It is especially important to focus on their interactions with stakeholders, find out what they learn from these encounters, and see how the field projects can be modified to create an enhanced learning environment. One goal is to help students acquire and practice communication skills that will be useful in their thesis projects as well as in future life work.

Introduction

This paper describes an evaluation of experiential learning in agroecology, based on analysis of learning outcomes as described by students in their individual Learner (Reflection) Documents. Galt et al. (2013) highlighted the importance of reflective essays in reinforcing experiential learning. Each fall semester since 2000, students in an agroecology course in farming and food systems at the Norwegian University of Life Sciences (UMB) have submitted a self-evaluation of their learning as well as the teaching process. Their Learner Document is based on a log the students write about their experiences in the field, including interactions with stakeholders on farms and in communities, and lectures and discussion sessions with students and facilitators in and out of the classroom. Together with practical aspects described in the log is an in-depth reflection by each student on the learning process. While the students work in teams of four to six people to produce a Client (Stakeholder) Document, in cooperation with their stakeholders in the farming and food system, the Learner Document is written individually and reflects their personal learning experience.

Material and methods in an Agroecology Course

The Norwegian University of Life Sciences offers a two-year Master of Science in Agroecology (http://www.umb.no/study-options/article/master-of-science-in-agroecology) that attracts students from around the world, all concerned about long-term sustainability of agriculture and food systems. Agroecology: Action Learning in Farming and Food Systems is a full-time, sixteen-week, 30 ECTS course during the first semester of the master's degree. The goal of this course is to develop knowledge, skills and attitudes enabling students to deal with complex situations in agricultural and food systems development (Lieblein et al., 2012). This means that they should not only acquire theoretical knowledge about agroecosystems, but also gain experience with methodology and tools for describing, analysing, and improving them.

The pedagogical basis of the programme is experiential learning with situations "out there" placed in the centre—not as examples of theory but as starting points for the learning process, where theory and experiences will be linked. We thereby aim at bridging the frequently experienced gap between knowing and doing by initiating the learning process using phenomenology, where we begin on the farm and in the food system and the key issues emerge from the experience (Francis et al., 2012).

The ability to relate discipline-specific knowledge (theory) to the cases "out there" is a key requirement, both for understanding the present situation and for proposing improvements. However, agroecosystems are complex, and the challenges they contain do not conform to disciplinary boundaries. The learning process

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thus requires a systemic approach to capture the totality of a complex situation and in which integration of several disciplines is essential to understand the whole system.

The dynamic and complex nature of agroecosystems and their environments requires that those involved in development of sustainable farming and food systems become capable of and motivated for continual renewal and life-long learning. Therefore, learning to learn and learning toward the future are central goals in the agroecology course. In a culture of curiosity, the students' goal is not to uncover answers already known by the teachers but to engage in a joint exploration process together with the facilitators and people in the cases being investigated.

The intended competency profile of graduates in agroecology therefore includes the capacity to achieve the following:

- Knowledge of farming and food systems
- Ability to link real-life situations and theory
- Skill and comfort in using appropriate methods
- Confidence in handling complexity and change
- Competent communication and facilitation skills
- Potential for autonomous and life-long learning

Students work in groups, with each group assigned to an ongoing project in Norway that deals with sustainability of farming and food. The case study encompasses the entire food system, including a farm interested in major changes in the farm operation. The task of the project work is an extensive analysis of the current and desired future of farming and food systems. This implies working with a farmer to develop a farm conversion plan and with other community stakeholders to develop the food system in the region/municipality.

The students prepare two group reports or Client Documents, one for the farmer and one for the food system stakeholders. Focus is on what the stakeholders could consider as scenarios to achieve their future vision developed during the systems inquiry. In addition each student prepares an individual report, the Learner Document. As the project work is the core of the course, the students include in the Learner Document a condensed version of the Client Document. An important goal of the project work is to improve their ability to link the concrete and practical situations experienced during the project work with theoretical knowledge, and the reflection document is their opportunity to demonstrate such ability. The students' empirical material from the fieldwork, as well as from the entire course, is analysed and discussed in relation to current knowledge in the area. It is important for this analysis that they have carefully logged the experiences and facts that will be the basis for their discussion and reflection.

What we look for in the Learner Documents is the degree to which they use agroecological perspectives and terms to describe the farming and food systems' structure and functioning (what), the process of farm and food systems analysis and transition planning (how), and the goals and values involved (why). Further we assess whether they are able to critically examine both concepts and methods and how these were used in their particular case study. Finally, do they reflect on their personal experience from the systems inquiry, including communication with the stakeholders and fellow group members, and its role in their learning?

This analysis is based on the Learner Documents submitted over a period of 13 years. From the beginning of the program in 2000, the course consisted of two parts: a course on Farming System, followed by a course on Food System. During the years from 2000 to 2008, the students wrote a Client Document and a Learner Document pertaining to each course. From these years there are 270 Learner Documents (139 from the Farming System, and 131 from the Food System Course). In 2009 it was decided to merge the two courses into one, embracing both Farming and Food System. From 2009 to 2012, the students wrote a Client Document for the Farming System, and a Client Document for the Food System, but one Learner Document for the whole semester. From these last four years there are 86 Learner Documents.

Table 1: Table of Learner Documents for Analysis

Learner Documents	Farming system	Food System	Farming and Food System	Total # Learner Documents
2000-2008	139	131		270
2009-2012			86	86
2000-2012	139	131	86	356

The Learner Documents are mostly between 15 and 45 pages long, while a few reach beyond 80 pages. With a low estimate of what is relevant text, this body of information includes at least 10.000 pages. This relatively large volume of text is being explored through a systematic classification process, in order to analyse the content. We code the material by identifying themes in the text, and our main themes are the ones related to the course goals, namely reflection, observation, visioning, dialogue and participation. These themes are further divided into sub-codes, as a way of structuring our data and to be able to capture the full richness of the material.

Coding themes with examples of their sub-codes are as follows:

1. Reflection

Students indicate understanding of the structure and function of farming and food systems, display systems thinking by discussing complexity, holism, and how the parts are related to the whole. They link theory to real life situations, and link experience to their personal development. Students are analytical with an etic or 'outsider' approach.

2. Observation

Students show that they have the competence to create a rich picture of a situation or a problem, and to carefully examine situations before drawing conclusions.

3. Visioning

Students reveal the capacity to go beyond existing thought patterns, a willingness to take risks, and are not inhibited by a fear of failing.

4. Dialogue

Students demonstrate the ability to listen, to express interest in other perspectives, a willingness to change or to reconsider personal point of view and learn from others, and exhibit writing skills.

5. Participation

Students recognize values and goal conflicts, dare to act, and are empathically engaged.

Results and discussion

Although we are still early in the analytical process, we observe that student descriptions indicate a rich and extensive volume of text on the learning experience from their points of view. Some trends that can be mentioned are:

Many students express that they are excited with the fieldwork based on cases, and describe how they will remember what they learned in this setting, working alongside their peers and interacting with stakeholders in the farming and food systems. For many this was their first learning experience starting out in the field, and then later to explore theory as needed in their specific case. This eased the understanding of abstract theories, and helped give lived examples to pin them on. At the same time, this linking of real life experiences to theory is weak among some students. Such as shift in the starting point for learning can be described, with reference to Aristotle in the Nicomachean Ethics (Bostock, 2000), as a shift from theoretical knowledge (theology, natural sciences and mathematics) to practical knowledge (called Praxis by Aristotle). The practical knowledge is activated and developed when dealing with unique cases, and it is different from theoretical knowledge (Lieblein et al., 2012).

The extent to which students are able to reflect on their own learning experience also varies, from eloquent descriptions of the cognitive process of thinking about thinking, to those that are almost purely descriptive of the activities undertaken during the course. Some admitted being overwhelmed when realizing the complexity of a food system, and how this makes changes seem challenging. At the same time this realization indicates an understanding of systems, relationships between the whole and the parts, and resistance to change.

There are numerous interesting reflections of learning from interactions within the group. Some learn from initial frustrations and are able to create productive cooperation, while others seem to use those difficulties as an explanation for how they performed in the course. Several indicate the feeling of being ready to take on the world. After this experience of working in an environment of multiple perspectives dealing with complex problems, they feel confidence in communicating with stakeholders and well prepared to take on other challenging tasks.

On the whole, experiential learning based on the students' own solving of real-life cases proves to be a meaningful and valuable experience. The knowledge acquired through bridging the academic study of farming and food systems with their own lived experience is not easily replaced—hopefully only through careful and critical evaluation.

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Participatory Breeding on Organic Vegetables

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Key words: organic, participatory breeding, vegetables, variety development, seed production, on-farm

Abstract

To impede diversity loss and encourage organic farmer seed independence, the development of varieties suitable for organic farming was done in Regions 4A, 4B, 8 and 12, in the Philippines using participatory breeding protocols. Segregating lines and populations were given to cooperators for continuous evaluation and selection, breeding for desirable traits, and seed production. Aloague Farm has been planting their selections of cherry tomato and lettuce for several seasons; selections from both crops are grown in commercial scale. In OISCA Farm, selections on pepper and tomato were commercially produced and sold in weekend organic market. Cooperators in Region 8 are producing their selections in bitter gourd, sitao, squash and eggplant for market while potential varieties were developed in pepper, eggplant, tomato, and sitao from on-station trials. In Region 12, several organic farmers are already selling their produce from selected lines. Seeds of these lines were shared with other farmers around the area.

Introduction

In the Philippines, there had been increasing interest to go into organic farming since the approval of the Organic Agriculture Act but several constraints such as lack of training, information, and organic farm inputs have been experienced by stakeholders. The problem on seed availability forced organic farmers to use conventional varieties; however, researches show that good performance in conventional systems does not indicate the same performance in organic conditions (Murphy et al. 2007). Thus, organic growers need crop varieties well-adapted to the low-input conditions of organic systems (Zystro 2012). One way of solving the problem is through participatory breeding where farmers develop and adapt crop varieties to the specific conditions and farm practices in their areas (Halewood et al. 2007). This study was undertaken to train selected organic growers on organic variety development and seed production, to develop organic varieties of selected vegetables through participatory breeding, and to produce seeds of the organic varieties developed.

Materials and Methods

<u>Germplasm Collection, Orientation, Training and Seed Distribution</u>

The germplasm includes materials from the study group which were mainly entries from other organic breeding projects and potential organic varieties developed by the group, as well as farmers' varieties and landraces. The cooperators were allowed to contribute germplasm that they want to improve. Commercial varieties were used as check varieties for the trials.

In each region, orientation and initial training was first conducted to familiarize the farmers with the objectives, mechanics, expected output and terms of reference of the study and to identify priority crops per region. Topics discussed during the trainings include breeding, pest and cultural management, production of organic farm inputs, and seed production. After the orientation, initial seeds of crops preferred by the farmers were distributed. For Regions 8 and 12, seeds given to the cooperators include pole sitao (7 entries), squash (3), tomato (4), and eggplant (6). The entries were mainly lines that can further be improved with selection and one check variety per crop. In Region 4A, two sets of seeds were given to each farm cooperator; one set includes potential organic varieties while the other set was mainly segregating lines of the cooperators' preferred crops.

There were also seeds allotted for on-station trials in each region (PAMANA, UPLB in Region 4A, Abuyog Experimental Station in Region 8, and DA-CEMIARC Tupi, South Cotabato in Region 12). Crops planted on-station include pole sitao, squash, cucumber, watermelon, melon, tomato, pepper and eggplant – each crop having five F_5-F_6 lines. In the on-station trials, selection of potential organic varieties and initial organic seed production was accomplished; afterwards, the harvested seeds were distributed to the cooperators in the respective regions. In addition, on-station trials served as laboratories of the cooperators during training days and as back-up for on-farm trials.

On-station and On-farm Evaluation of Germplasm

The lines given to the cooperators were evaluated under low input condition in their respective farms. Cultural management depends on the farmers' option, as long as they comply with the Philippine National Standard for Organic Agriculture. Line and individual plants were selected depending on the market and farmers' preferences. Other factors considered were plant vigor, reaction to pests and diseases, fruit characteristics, yield, and over-all acceptability. When selected plants started to flower, selfing, sibbing and hybridization were done by the cooperators. Seeds from selfed or sibbed fruits were obtained for purification and use for succeeding trials.

For on-station trials, entries were planted on raised beds covered with plastic mulch. Standard plot sizes were used, namely 5 meters long and 1 meter wide with 0.5 meter spacing between plots. There were two planting rows per plot with holes spaced at 50 cm along the row and 75 cm apart. Minimal fertilizer application, weeding, and pest control measures were observed. Vermicompost was the main organic fertilizer used which was applied at the rate of 1 kg/m^2. Fermented plant and fruit juices were also applied during the vegetative and reproductive stages of the plants. Pest management interventions include planting of insect-repellent aromatic plants and spraying of hot pepper solution (25 g/L) whenever necessary. Barrier plants and attractants were also planted within and around the area. Weeds were allowed to grow between plots.

Monitoring of Trials and Data Gathering

Visitation of on-farm trials in the target regions was done once or twice every month. For every visit, hands-on training on selection, pollination, hybridization and seed production was carried out (whichever is applicable during a particular visit). Observations on co-operators' selected lines, crosses formed, and seed-produced entries were noted, along with their basis on selection. For on-station trials, data obtained include days to flowering and harvesting, plant vigor, reaction to pests and diseases, and horticultural characters. Plants having the desired characteristics based on these factors were selected, seed produced, and subjected to further evaluation and purification.

Results

Aloague Farm has its own selections in table tomato, cherry tomato, lettuce, pepper, cucumber, squash, and eggplant. Selections in cherry tomato and lettuce, the farm's two priority crops, have already been planted for several seasons. Selections on these crops differ based on the preferences of the consumer eg. small cherry, large cherry, fine curls, etc (see Table 1). They were also able to make their own crosses in pepper. In Kai Farms, also in Cavite, the selections in tomato and eggplant were seed produced for the next round of production.

In OISCA in Quezon, the co-operators were able to select and seed produce selections in eggplant, pepper, sitao, cucumber and squash. They market their produce from the selected lines in the weekend organic market in Lucena, Quezon. For on-station trials in Region 4, crosses in pole sitao, cucumber, eggplant, and pepper have been evaluated for 2 generations. Continuous evaluation and selection are being conducted for these lines.

Figure 1. The participatory plant breeding process conducted at the cooperators' farms.

Table 1: Characteristics of some selections of cooperators in their respective priority crops

Cooperator/Selection	Characteristics
Aloague Farm	
Cherry tomato -1	Small cherry, round, red fruit skin color
Cherry tomato -2	Large cherry, round, red fruit skin color
Cherry tomato -3	Large cherry, round, sweet, pink fruit skin color
Pepper 10514-1	Light green, non-pungent, wrinkled fruit with blunt end
Pepper 10514-2	Light green, mildly pungent fruit with pointed end, horn-type
Pepper 10514-3	Green, slim, very pungent fruit with pointed end
OISCA Farm	
Pepper 10449-1	Dark green, medium-sized fruits with pointed end
Pepper 10506-1	Green, medium-sized fruits
Pepper 10506-2	Light green fruits with pointed end, horn-type
Pepper 10506-3	Light green, slender, medium-sized fruits
Pepper 10509-1-1	Green, thin/slim, medium-sized fruits
Pepper 10510-1	Dark green, straight and slender fruits

In Region 8, several cooperators are already producing in commercial scale selections in bitter gourd, sitao, squash and eggplant. Potential varieties were also selected on pepper, eggplant, tomato, and sitao from the on-station trials. Some cooperators were also able to make their own crosses which will be undergoing evaluation.

Cooperators from Region 12 also have their own selections which they continuously evaluate, purify, and seed produce. Many cooperators from this region were able to seed increase their selections in different vegetable crops which they used for planting for commercial scale. They were also able to sell organic produce and share their organic seeds with other farmers in their areas. As a matter of fact, one cooperator is already doing negotiations for the marketing of his organic seeds. The same cooperator has also started keeping records of his sales, selections, and seeds produced and distributed.

For this study, the main problem encountered is that many farmers were interested with the training but only a few are willing to participate in the breeding aspect and actually continue the selection and seed production of the crops. And, if ever they do seed produce their selections, problems in terms of labelling and seed storage arise. Also, active cooperators' enthusiasm in breeding has a tendency to decline due to the tedious nature of breeding activities. Thus, focus was given to those cooperators with promising selections and who show interest and initiative in sustaining the project. Other problems met include the failure of farmers to save seeds of their selections (they either give seeds to fellow farmers or sell them to buyers) and the difficulty in monitoring of the on-farm trials since the farms are far from each other.

Discussion

In the course of the study, promising results from active farmer co-operators were accomplished including selections on their priority crops, seeds produced from those selections, and potential varieties which are continuously undergoing purification and trials. But more than these, more significant accomplishments in terms of the cooperators' experiences were achieved. Some farmers learned how to keep records of their produce, sales and selections, as well as the seeds that they were able to produce, sell and distribute to other farmers. Others also get to put into practice the things that they were taught during the trainings, especially in the breeding aspect. Although most of them were discouraged to participate in the breeding works due to the tedious process, there are still cooperators who show eagerness to learn and to continue the breeding works that they have started.

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Efficacy of microbiological treatments and trap crop against pests of winter oilseed rape

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Key words: dark pod spot, Effective Microorganisms, *Trichoderma asperellum*, turnip rape, oilseed plant, organic farming

Abstract

Winter oilseed rape was cultivated in monoculture or in combination with turnip rape as trap crop sown in trap strip. Preventative microbiological treatments for diseases control in winter oilseed rape were tested using Trichoderma asperellum and product based on effective microorganisms. Microorganisms were effective to protect of oilseed rape and allowed to obtain higher yield comparing to untreated plants. No effect of turnip rape as trap crop stripe on infestation by insect pest was observed. There was no statistically significant influence of presence B. rapa on total yield. Statistically higher percentage of infected pods collected from area with turnip rape compared to monoculture area was noted.

Introduction

Winter oilseed rape (WOSR) is mainly grown with the use of conventional farming technology (in particular fertilizers and pesticides). The amount of organic oilseed rape planted in Poland is relatively small. This is due to the demanding requirements associated with rape nutrition and its protection. In the conventional farming many problems can be eliminated by the preventive and curative treatments. Insect pest and pathogens cause in organic crops substantial yield losses. Effective organic strategies to control them are still insufficient (Ludwig et al., 2011). Oilseed rape pests like pollen beetle (*Meligethes aeneus*), rape stem weevil (*Ceutorhynchus napi*) and cabbage stem weevil (*C. pallidactylus*) are very difficult to control. Some effects of natural insecticides and flower oil against these insects pests in the literature are available (Weiher at al., 2007; Ludwig et al., 2011). Unfortunately, these environmentally compatible control measures for pest management did not achieve satisfactory effects. Beneficial microorganisms like *Trichoderma* spp. are known as biocontrol fungal agent and were tried in protection of many crops (Harman et al., 2004, Kowalska 2011). The objective of this project is to develop environmentally-friendly system with methods to regulate pest infestation in WOSR by creating border strips combined with microbiological–preventive treatments of direct control.

Material and methods

The field experiments were carried in the experimental station of the Institute of Plant Protection-NRI in Poland, in the district Poznan. Effects of plant protection preparations have been tested separately. One year before WOSR on experimental area was grown phacelia. During vegetation of WOSR, in the spring, the mineral fertilization NPK has been delivered as trade product Plantos (0-8-18) in dose 150 $kg \cdot ha^{-1}$ where soil nutrient supplied: P_{P2O} 12 $kg \cdot ha^{-1}$, K_{K2O} 27 $kg \cdot ha^{-1}$, Mg_{MgO} 12 $kg \cdot ha^{-1}$ and S 18 $kg \cdot ha^{-1}$. In cultivation method included sowing in wide row distance (25 cm) and mechanical weed control. Monoculture of winter oilseed rape (line var. Californium) was laid on 0.23 ha. Next to this area was another one, where this same variety rape was sown in monoculture and it was surrounded by a strip of turnip rape (var. Brachina, width of strip 2 m). Both experimental surfaces were divided into three equal parts, with three different microbiological treatments: 1) EM - plant strengthener in a dose of 10 $l \cdot ha^{-1}$, 300 l $water \cdot ha^{-1}$, 2) Trifender – plant strengthener with *T. asperellum.* It was used at a dose of 200 g $product \cdot ha^{-1}$, 300 l $water \cdot ha^{-1}$. Both products have been used as plant spraying-three times (one treatment was performed in autumn in BBCH 46 of maturity of WOSR, the second in BBCH 55 and the third in BBCH 61 of WOSR in the following year). The efficacy of treatments was determined by measuring percentage of the affected surface of pods of 50 plants randomly selected and collected from two localizations in each part. The symptoms of dark pod spot (DPS) caused by complex pathogens such as *Alternata brassicae, A. brassicola* and *A. alternata* were observed.
"Efective Microorganisms" (EM) is recommended for many crops to applying to the soil and to the plants. The main purpose of them is improved soil fertility, plant quality and health. Unfortunately, in the literature can we find many ambiguous data on efficacy of EM. Papers either indicated its benefits (especially from tropic countries) or ineffectiveness (Sangakkara et al., 2011; Mayer et al., 2008). Agricultural producers (especially

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amateurs) indicated the positive impact of effective microorganisms on crops. However, the effects of EM are not clear and reproducible. Trade product EM (ProBiotics Polska) is an example of such preparation. “Trifender” it is the product of Biovéd Co., Hungary, where one gram contains $5x10^8$ of conidium isolate T1 (NCAIM 68/2006) of the fungus *T. asperellum.* Influence of protective strip of turnip-rape was assessed as a trap for some insect-pests of WOSR. Against *M. aeneus* two treatments with spinosad as foliar spraying (trade product Biospin 120 SC) at dose 200 $ml \cdot ha^{-1}$at BBCH 53-59 of WOSR were made. The results were statistically analyzed by the variance analysis method using the Statistica 10.0 software. Significant difference were verified using the Tukey’s test at significance level P = 0.05. Data expressed in percentages were arc sin transformed.

Results

In general, we concluded that on the field with the strip trap of turnip-rape a percentage of infested pods by DPS was higher compared to the pods collected from the site experiment without *B. rapa* (Fig. 1). A statistically significantly higher was the percentage of infected surface of pods from the plants treated with *Trichoderma* and with *B. rapa* in comparing to the this same treatment on the area without the protective strip (10.07 and 2.46%, respectively). Statistically higher infection pods collected from area with turnip rape compared to monoculture from untreated experimental area was observed.

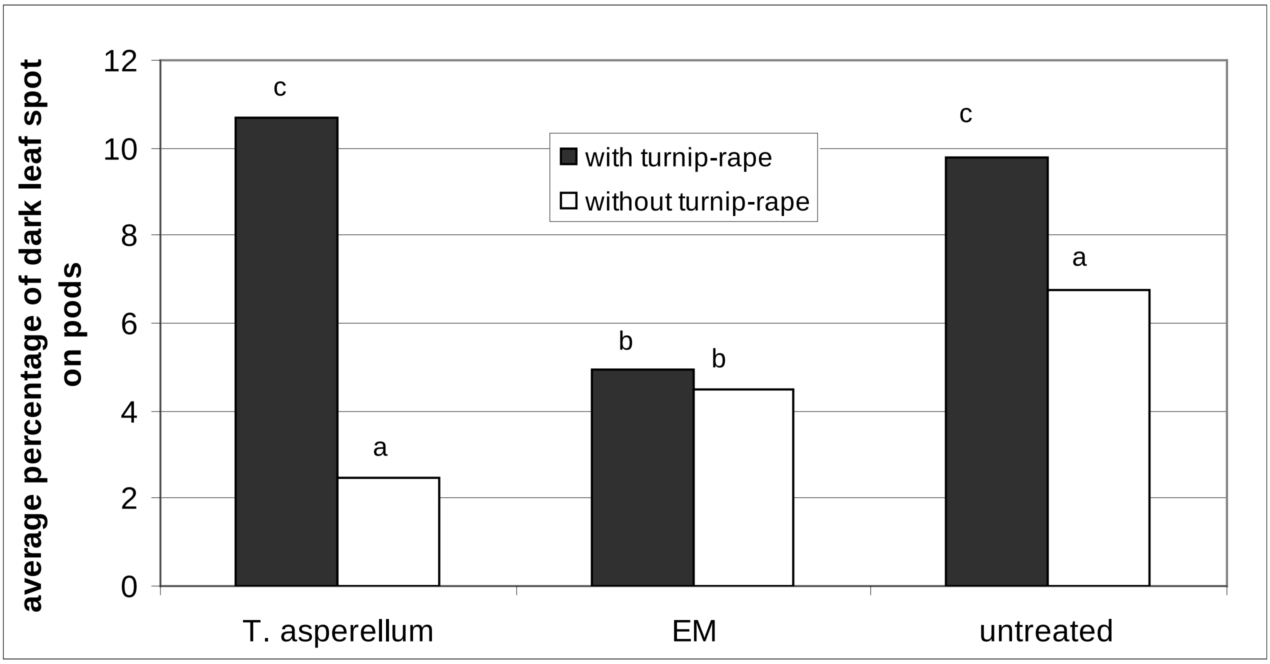

Figure 1. Effects of microbial treatments variants on symptoms of dark pod spot on pods in relation to presence and absence of strips with turnip-rape

Turnip rape as trap crop did not result on yield increase or in limitation of losses caused by insect pests on treated parts of the field. Treatments with *Trichoderma* caused statistically important increase the yield obtained comparing to untreated area, 3.0 t $ha^{\cdot -1}$ and 3.2 $ha^{\cdot -1}$, respectively for presence and absence of turnip-rape.(Fig. 2). In the case of treatments with EM was found the trend increase in harvested yield from the area with trap crop compared to pure WOSR (3.3 and 2.9 t $ha^{\cdot -1}$, respectively). The lowest yield was obtained from untreated plants with and without turnip-rape, 2.6 and 2.4 t $ha^{\cdot -1}$, respectively)

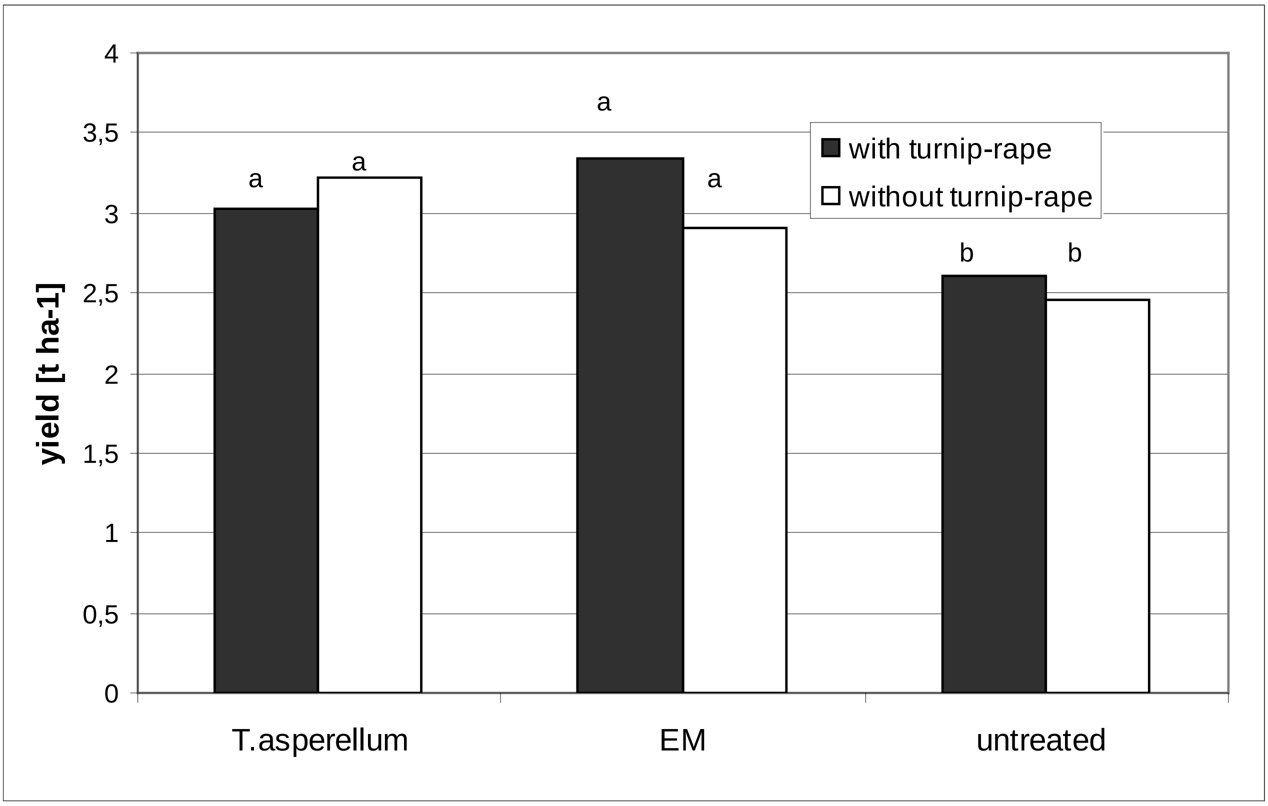

Figure 2. Effects oh microbial treatments variants on total seed yield of winter oilseed rape in relation to presence and absence of strips with turnip-rape

Discussion

Oilseed rape is a plant that requires intensive fertilization, this problem tried to solve by intercropping of oilseed and faba beans (Kießling and Köpke, 2008). Yield of organically cultivated varieties of winter rape from trials represent up to 70 % of yields achieved by winter rape cultivated conventionally, most however about 50%. This is in line with our obtained yield ranged from 2.4 to 3.3 $t \cdot ha^{-1}$, generally (Fig.2). The lowest yield was harvested from untreated area compared to *Trichoderma* and EM treatments and we can conclude that performed microbiological treatments were useful. Unfortunately the border strip did not influence on infestation by insect pest, in the case of presence of pathogens was observed higher percentage of infected pods compared to pods collected from WOSR without trap strip. Turnip rape probably could be the first host for pathogens, which I next time, can be infesting the plants of oilseed rape. In other studies where monoculture of WOSR was mixed with turnip rape and cereals also not obtained satisfactory results (Ludwig et al. 2011). Additionally, rapeseed yields were reduced significantly when was sown together with cereals in (Paulsen 2011). The preferential infestation of *B. rapa* by stem weevils and pollen beetles was observed only up to 10 days, when the phenology of turnip rape was advanced relative to oilseed rape. After this period not differences in infestation by both pest species were observed. This situation has forced us the use of spraying with spinosad, which was effective against pollen beetle. This effect is in line with the findings of another study (Ludwig et al., 2011).

Acknowledgements

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Analysis of organic and conventional beetroot juice assortment in Warsaw shops and consumer evaluation of selected products

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Key words: beetroot juice, organic production, conventional production, sensory analysis, market analysis

Abstract

Many studies show that organic food as vegetables, fruits and preserves contained more dry matter, C and B group vitamins, total sugar, indispensable amino acids, and minerals. At the same time organic plant foods usually have been in general better evaluated in terms of taste and smell than conventional ones. The aim of this study was to analyze the assortment of beetroot juice from organic and conventional stores in Warsaw, Poland and to perform a consumer sensory evaluation of selected products. Analysis of the products was carried out in the grocery stores in terms of the origin of the products - organic vs. conventional. The results showed that the market of beetroot juices was diverse - organic juices were available mainly in specialist organic stores, while conventional juices were available in all analysed places. Consumer sensory evaluation showed that consumers did not have an explicit preference for the taste, smell, colour and consistency of beet juice due to the origin of the product.

Introduction

A growing risk of lifestyle diseases, e.g. hypertension, atherosclerosis, obesity, diabetes, and most of all cancers, stimulate the society to take steps towards rational nutrition with high-quality products. Informed consumers are more often looking for organic food, the production process of which guarantees high quality, which is confirmed by corresponding certificates. In addition, it is really vital to consume fruit and vegetables regularly. To encourage the society to do so, producers better and better provide the Polish market with fruit and vegetable products. One can see the growing popularity of beetroot juice as a source of betalains, phenolic acids, flavonoids and other antioxidants vital in health prevention (Gawlik-Dziki 2004, Young et al. 2005, Majewska and Czeczot 2009, Kazimierczak et al. 2011, Georgiev et al. 2010).

The aim of the study was to analyze and compare the assortment of organic and conventional beetroot juices and to perform a consumer sensory evaluation of selected products.

Material and methods

The research material consisted of beetroot juice from organic and conventional production, available in retail stores in Warsaw, Poland. The study on the available assortment of beetroot juice was carried out in selected conventional retail chains, small local shops and organic food stores. A semi-consumer sensory evaluation of selected products was performed among students living in Warsaw, in the age group 20-25 years.

An assortment analysis was performed by the field study. The study included ten retail chains, taking into account the division in terms of floor area and specific character of available products. Among the large space stores there were selected: Alma, Auchan, Biedronka, Carrefour, Leclerc, Lewiatan, MarcPol, Piotr i Paweł, Real, and Tesco. The stores of smaller floor area included: Super Sam, Perełka, Fresh Market, Skarbek, Top Market, Tradycyjne Jadło, przy Fontannie, u Małgosi, Żabka, Odido. In turn, the organic shops where the study was conducted are as follows: Organico, Organic Farma Zdrowia, Żółty Cesarz, Eko–Kraina, Eko–Żywność, Free Delikatesy Ekologiczne, Bio Sfera, Smaki Natury, Rajski Ogród, Zielarska Medycyna Zioło.

To assess the assortment of beetroot juice there was prepared an author's questionnaire containing certain analysis determinants. They included: the store name, product/producer name, product volume, expiry date, storage conditions, the form of product preservation, and the name of the certification authority (in the case of organic produce). Attention was also drawn to the type of packaging and the location among other food products.

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A semi-consumer sensory evaluation of selected juice was performed by linear scaling method in order to express quantitatively the quality differentiation (ISO 4121:1998). The analysis was performed using a 9-point graphic scale with the edge markings: undesirable (I don't like it very much) and very desirable (I like it very much). The evaluation embraced 50 respondents, including 38 women and 12 men. They were obliged to mark the place on the scale corresponding to their impression at the time of the samples evaluation for colour, odour, taste, consistency and overall palatability. Each respondent received for assessment eight properly encoded samples of previously purchased juices (four organic and four conventional samples) and assessment questionnaires. The juices of different producers were purchased, choosing pure beetroot juices and one type of beet and apple juice – both of organic and conventional quality – due to limited assortment of taste variants.

Statistical analysis

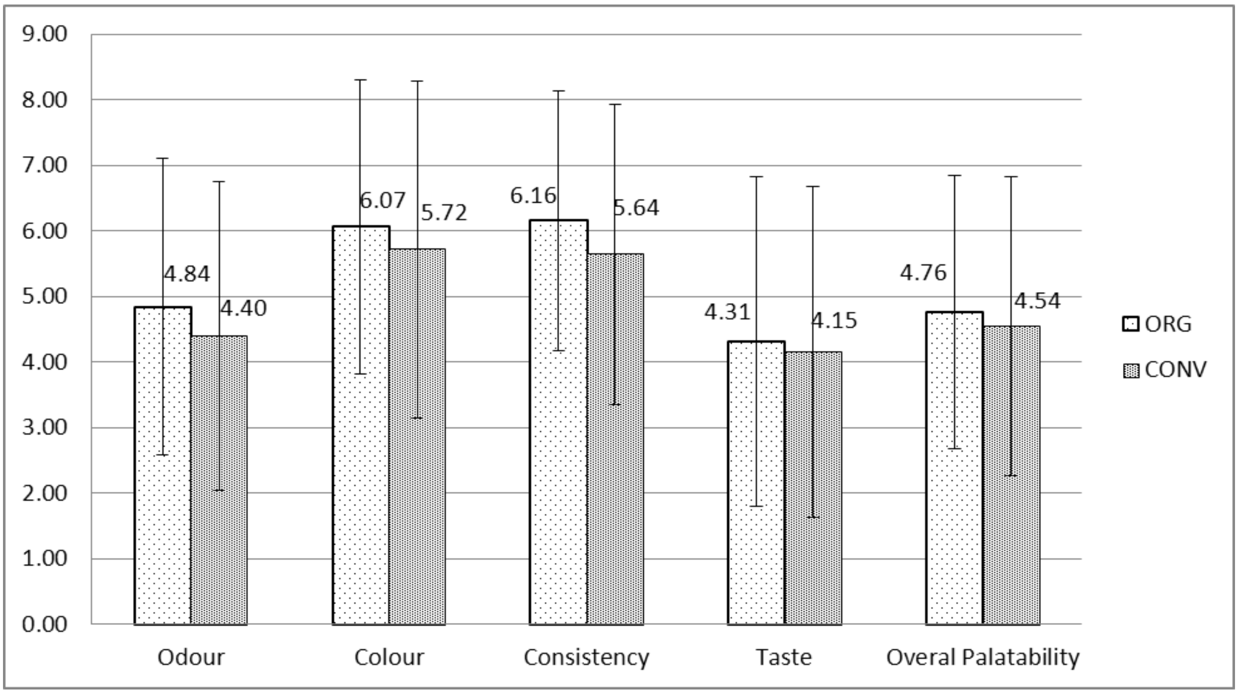
STATGRAPHICS 5.1 program was used for a statistical analysis of the semi-consumer evaluation results; a one-way analysis of variance (ANOVA) was performed using the Duncan non-parametric test ($\alpha = 0.05$). An examined factor was the origin of beetroot juice (organic and conventional processing). The p – values are given below the figure. If the p-value was ≥ 0.05, the result was determined as 'n.s.' (not statistically significant). In addition, the standard deviations for the samples tested were calculated.

Results

Organic beetroot juices were available in all organic food stores and only in two conventional commercial chains – MarcPol and Carrefour. In the first of them, they were placed in the sector of organic products and world cuisines, while in the second one – among organic products. In organic stores, the tested juices were located among other fruit and vegetable products. In conventional stores one could find beetroot juices among other vegetable or fruit juices or fruit and vegetable juices. In a few stores there were refrigerated counters with the juice of some brands, such as one-day juice by Marwit and Ogrody Natury. The juice was sold in glass bottles of different capacities. Organic juices were available in the bottles of 300 ml, 700 ml and 750 ml. Conventional juice packaging was smaller, i.e. 225 ml and 250 ml. All packaging of juices for sale had a label with the information required by law.

All organic food stores offered beetroot juices of at least one producer. Most often there were juices made by: Bio Food, Voelkel Rote Bete Saft and Rabenhorst. A Polish producer Bio Food as the only one offered more than one taste variant of juices, i.e. pure beetroot juice and combined with celery or apple. Smak Natury, offering products of all organic and conventional brands as well as all flavours of beetroot juice, was a top-stocked shop among organic food shops. In conventional stores one could find most often the juice made by: Ogrody Natury, Marwit and Cymes Smaki Victorii. The chains like Lidl, Kaufland and Polomarket did not sell beetroot juice.

A semi-consumer sensory evaluation of beetroot juices showed insignificantly higher marks in terms of odour, colour, taste and overall palatability for organic juices. Only consistency of organic juices was rated significantly higher than of the conventional ones by the respondents. (Fig. 1).



p-value	Odour	Colour	Consistency	Taste	Overal Palatability
juice origin	n.s.*	n.s.	0.0062	n.s.	n.s.

* n.s. – not statistically significant (α ≤ 0,05)

Fig. 1. Results of semi-consumer sensory evaluation of beetroot juice form organic (ORG) and conventional (CONV) production

Discussion

A range of beetroot juices in stores, especially organic ones, is limited to a single brand. Łuczka-Bakuła and Smoluk-Sikorska (2009) confirm this phenomenon on the domestic market, explaining that a vital role is played by such factors as profitability, expected costs and revenues, and the result margin achieved from sale. Żakowska-Biemans (2011) emphasizes that the domestic market for organic products is in its infancy, which results in poor range of processed products. It was found that both organic and conventional beetroot juice had not received a high sensory assessment from consumers. According to statistics, consumers are more likely to choose fruit juice than the vegetable one – they prefer orange, carrot and apple juices and nectars (The AIJN Report, 2010). Consumers find no fundamental sensory differences between organic and conventional juices. This is confirmed by other sensory studies on fruit and vegetable products, which may result from minor experience in organic food consumption by the majority of consumers (e.g. Bourn and Prescott 2002, Zhao et al. 2007, Hallmann and Rembiałkowska 2010).

Conclusion

Regular consumption of organic vegetable juice by Polish society should be promoted. At the same time, producers, both organic and conventional ones, should strive to improve the taste and odour of beetroot juice.

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Response of Groundnut (*Arachis hypogaea* L.) Varieties to Varying Defoliation Intensities

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Key words: Groundnut foliage, defoliation intensities, time of defoliation

Abstract

Loss of foliage in crops could be due to leaf eating insect, diseases, grazing animals, foliage harvest by humans for consumption and green manuring. The level and intensity of this defoliation could have diverse effect on the crop. An experiment to study the response of groundnut varieties to defoliation intensities was conducted in the wet season of 2012. Treatments which consisted of four intensities of defoliation; No defoliation, (D_1), defoliating 10 plants/plot (D_2), defoliating 20 plants/plot (D_3) and defoliating 30 plants/plot (D_4), time of defoliation, 4 weeks after sowing (WAS) T_1 and 6WAS T_2 and two varieties SAMNUT 21 (V_1) and SAMNUT 23 (V_2) were laid out in a randomized complete block design (RCBD) and replicated three times. Result showed that number of pods/plant; pod yield/plot and haulm yield/plot were affected by time and intensity of defoliation. Similarly varieties differed significantly in their response to time and intensity of defoliation.

Introduction

Groundnut (*Arachis hypogaea* L.) is one of the most important legumes providing significant amounts of oil (50 to 65%, Boye-Goni *et al*., 1990) and proteins (25 to 35%, Anonymous 2002), livestock fodder and improves soil fertility. During production, crops may be damaged by hail, leaf feeders and defoliators, leaf diseases; besides loss in functional area due to wind, drought, grazing of animals, removal of leaves for fodder and as leafy vegetable etc. Degree of yield reduction is directly proportional to percentage of leaf area destroyed and varies depending upon variety, crop growth stage, population and intensity of foliage loss.

Groundnuts were least affected by plant defoliation; percentage reduction in yield being 59.7 79.0, and 86.4% in groundnut, cowpea and soybeans (Enyi, 1975). Knowledge of defoliation that causes slight yield reduction but provides significant advantage to quantity of fodder obtained either for livestock feeding or for green manure is of paramount importance.

Materials and Methods

The experiment was conducted at the Institute for Agricultural Research farm Samaru, Zaria, during the rainy season of 2012. The experiment was laid out in a randomized complete block design with three defoliation intensities and a control (0, 10%, 20% and 30%), two time intervals (4 weeks after sowing (WAS) and 6 WAS) and two groundnut varieties (SAMNUT 21 and SAMNUT 23), replicated three times. After thorough land preparation, groundnut seeds were sown in plots measuring 3m by 4m constituting the gross plot which had four ridges. The two inner ridges constituted the net plot. Weeds on the field were controlled by two hoe weeding at three and six week after sowing. Data was collected on number of days to 50% flowering, pod number, pod yield and haulm yield of groundnut and subjected to statistical analysis using SAS statistical software. Where significant, means were separated using Duncan multiple range test (DMRT) Duncan (1955).

Results

Increasing the defoliation intensity from 10 percent to 30 percent did not have significant effect on pod number per plant of groundnut (Table 1). Similarly pod number at the different sampling times was similar. The varieties used were not significantly different in their pod numbers. The number of days to 50% flowering was also not significantly different with respect to time and intensity of defoliation.

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Table 1: Pod number per plant and days to 50% flowering of groundnut varieties as affected by time and intensities of defoliation at Samaru in 2012

Treatments	Pod number per plant	Days to 50% flowering
Defoliation intensities (%)		
0	20.0	80
10	21.0	82
20	19.0	82
30	21.0	81
Time (WAS)		
4	20.0	81
6	20.0	80
Variety		
Samnut 21	21.0	81
Samnut 23	20.0	82
Interactions		
DxT	NS	NS
DxV	NS	NS
TxV	NS	NS

The effect of defoliation on pod yield indicated a reduction in yield from 742.50g at 10% to 608.33g at 30%. (Table 2). The results show that pod yield was highest where only 10% of the leaves were removed. Samnut 23 produced more yield than Samnut 21. Haulm yield was not significantly different with respect to time and intensity of defoliation. There were no statistical differences between the varieties used with respect to haulm yield.

Table 2: Pod yield and haulm yield of groundnut varieties as affected by time and intensities of defoliation at Samaru in 2012

Treatments	Pod yield (g)	Haulm yield (g)
Defoliation intensities (%)		
0	709.2	1224.8
10	742.5	1228.0
20	688.3	1188.3
30	608.3	1229.8
Time (WAS)		
4	713.8	1185.7
6	660.4	1249.7
Variety		
Samnut 21	635.4	1199.6
Samnut 23	738.8	1235.8
Interactions		
DxT	NS	NS
DxV	NS	NS
TxV	NS	NS

Discussion

Assimilate availability and allocation to reproductive structures is an important factor which determines yield of any crop. Leaf is the major source of supplying assimilates to developing organs, young pods and seeds in crops (Abdi et al., 2007; Mondal, 2007; Barimavandi et al., 2010). Leaf removal may, therefore, influence TDM production and yield through photosynthate production and distribution into different parts depending on the magnitude of leaf removal (Hossain et al. 2006; Gustafson et al., 2006).In this experiment, reduction in yield occured when defoliation increased from 10% (742.50g) to 30% (608.33g). This result is similar to that obtained by Gustafson et al. (2006) in soybean who had the opinion that plant could compensate its leaf loss by leaf regrowth potentials in defoliated plants. At 10% defoliation, it is possible that the groundnut crop has overcome the effects of defoliation better than at higher defoliation intensities.

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Effects of soil, root mycorrhization, organic and phosphate fertilization, in organic lettuce production

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Key words: Organic matter, peat, plant substrates, pine bark, water availability

Abstract

The influence of organic and phosphate fertilization, and root mycorrhization, in organic lettuce production, was assessed with factorial treatment combinations of: soil type (SOP – soil from organic and SCP – soil from conventional production) and organic fertilizer (0, 2 and 4 t ha^{-1}) in the first trial; mycorrhizal inoculation (mycorrhized and non-mycorrhized plants) and Gafsa phosphate (0, 100 and 200 kg P_2O_5 ha^{-1}) in the second. Lettuce yield decreased in the SCP with the application of increasing rates of organic fertilizer due to the very high electrical conductivity (50.1 dS m^{-1}) and lack of maturation of this fertilizer. However, the harmful effects of the organic fertilizer were minimized in the SOP. The application of increasing rates of Gafsa phosphate increased lettuce yield and nutrient uptake. However, the mycorrhization did not increase lettuce yield and, for mycorrhized lettuces, yield did not increase with the highest rate of Gafsa phosphate application.

Introduction

The use of synthetic fertilizers modifies the balance of the soil ecosystem (Lampkin, 1990). Despite the benefits of amending the soil with organic fertilizers, farmers should consider the amount and quality of organic materials to use as soil amendments because its indiscriminate application can cause phytotoxicity problems (Brito, 2001). Lettuce is a vegetable of great importance in Portugal but is seldom cultivated in organic agriculture (OA). To increase organic lettuce yield producers need information to decide on this crop fertilization and there is lack of experimental results to support fertilizer recommendations in OA. This study evaluated the effects of a certified organic fertilizer applied both to a soil from organic production (SOP) and to a soil from conventional production (SOC), on lettuce yield. Simultaneously, the effects of Gafsa phosphate and mycorrhization on lettuce growth and nutrient uptake were quantified to investigate whether the mycorrhization of lettuce may increase lettuce production in different conditions of soil available phosphorus.

Material and methods

Lettuce (Lactuca sativa L.) trials were established in pots inside a greenhouse (unheated). The first trial was a randomized block design with four blocks and six treatments from the factorial structure of two factors: (i) soil of farms with different production methods (organic and conventional); and (ii) organic fertilizer (0, 2 and 4 t ha^{-1}). The organic fertilizer was produced with concentrated vinasse waste and chicken manure. Lettuce variety "Ariel" was transplanted in the beginning of spring and lettuces were harvested 28 and 45 days after transplanting. The SOP showed increased OM content compared to the SCP which in turn showed higher NO_3^--N content (Table 1). Total N content, C/N ratio and pH value, were higher in the SOP compared to the SCP. The electrical conductivity (50.1 dS m^{-1}) and the concentration of NH_4^+-N (18395 mg kg^{-1} DM) of this organic fertilizer were extremely high in relation to the maximum recommended EC less than 3 dS m^{-1} (Soumaré et al. 2002) and NH_4^+-N less than 400 mg kg^{-1}DM (Zucconi and Bertoldi, 1987) for compost use.

The second trial had a randomized block design also with four blocks and six treatments from the factorial structure of: (i) Gafsa phosphate levels (0, 100 and 200 kg P_2O_5 ha^{-1}) and mycorrization (mycorrhized and non-mycorrhized plants). The soil was collected from the same organic farm used for the first trial. Lettuce cv. Maravilla de Verano was sown in the beginning of spring and harvested 28 and 53 days after transplanting. The mycorrhizal inoculum was Glomygel Hortalizas (Mycovitro S.L.) and was applied close to plant roots with the help of a pipette, 7 days after transplanting.

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Table 1. Soils and organic fertilizer characteristics (mean and standard deviation (SD)

	DM	pH	EC	OM	N	NH_4^+-N	NO_3^-- N	C/N	P	K	Ca	Mg
	%		dS m^{-1}	g kg^{-1}	g kg^{-1}	mg kg^{-1}	mg kg^{-1}		g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}
Soil from organic production												
Mean	81.9	7.1	0.6	64.5	2.4	7	46	16.4	0.9	3.8	2.3	2.0
SD	0.9	0.1	0.1	0.5	0.6	0.8	2.1	0.5	0.1	2.9	1.1	1.4
Soil from conventional production												
Mean	89.3	6.3	0.6	26.5	1.7	3	81	9.2	0.9	5.6	2.9	3.2
SD	0.4	0.1	0.1	0.1	0.6	0.4	3.3	0.1	0.5	2.2	1.7	1.5
Organic fertilizer												
Mean	92.2	5.7	50.1	546	39.5	18395	80	7.7	30.3	30.0	23.3	4.0
SD	0.1	0.1	1.4	11.2	11.5	6933	5	0.5	7.7	13.2	8.3	0.2

SD = Standard deviation
Organic matter (OM) and nutrient contents are expressed on dry matter basis.

Results

A negative effect of the highest rate of organic fertilizer application to SCP on lettuce growth (Fig.1) showed that this fertilizer should not be recommended. The SOP had characteristics which allowed lettuce to better resist the harmful effects of the organic fertilizer in comparison to the SCP. It is likely that the detrimental effect of this specific fertilizer resulted from a combination of the extreme value of electrical conductivity (EC = 50.1 dS m^{-1}) found for this fertilizer and other factors such as ammonia toxicity or the liberation of toxic volatile organics which will probably be correlated with E.C (Brito, 2001). Zucconi et al. (1987) suggested an upper limit of 0.4 g kg^{-1} of NH_4^+-N for municipal solid waste composts which is much lower than NH_4^+-N content found for this organic fertilizer (18 g kg^{-1} DM). In the presence of toxic concentrations of ammonia, the plant reacts by lowering its metabolic rate and decreasing enzymatic activities (Sairam and Tyagi, 2004), reducing root respiration and nutrient uptake.

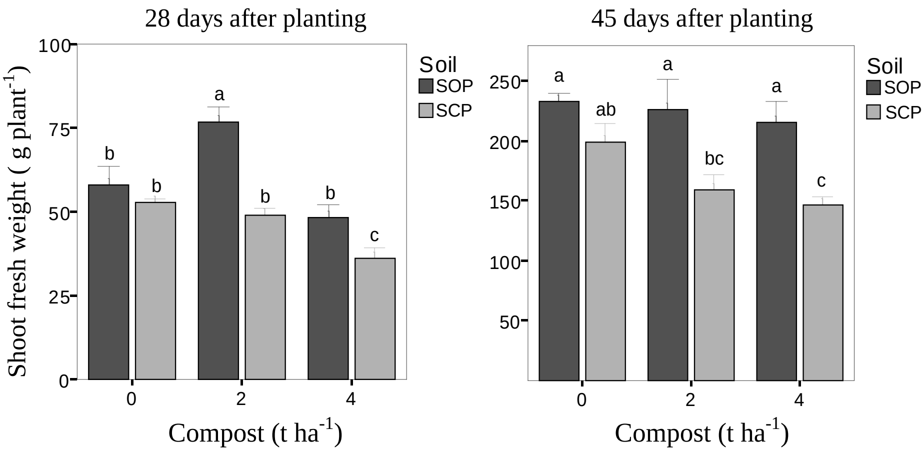
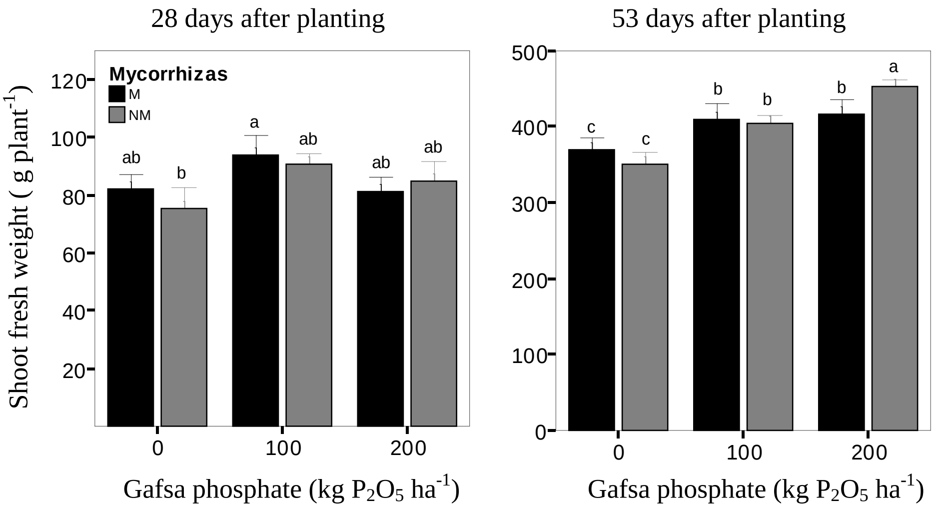


Figure 1. Lettuce shoot fresh weight in soil SOP and SCP with organic fertilizer (0, 2 and 4 t ha^{-1}). Different letters over de bars mean significant weight differences (P <0.05).

The SOP showed greater resistance to harmful effects of the organic fertilizer, probably because of its higher OM content (64.5 g kg^{-1} DM) compared to SCP (26.5 g kg^{-1} DM). The higher OM content, in addition to being a reservoir of nutrients, contributed to increase cation exchange capacity, soil permeability and water retention capacity which favored increased root growth. The harmful effect of the organic fertilizer was not so clear based on shoot and root dry weight as it was on fresh weight. This corroborates that yield loss was related to greater difficulty in absorbing water in the presence of the organic fertilizer. Nutrient uptake with the application of 4 t ha^{-1} of organic fertilizer also decreased for SCP compared with the SOP. Nutrient uptake with the application of 4 t ha^{-1} of organic fertilizer decreased for SCP compared with the SOP because lettuce growth, the water taken up by plant roots and nutrient mass flow decreased in consequence of the high EC of the organic fertilizer.



For the highest rate of Gafsa phosphate application, yield of mycorrhized plants decreased compared with non-mycorrhized. While the increase in lettuce yield with phosphate between 0 and 100 kg ha^{-1} P_2O_5 and also between 100 and 200 kg ha^{-1} P_2O_5 was significant for non mycorrhized plants, for plants inoculated with mycorrhiza the plant fresh weight difference was not significant between the application of 100 and 200 kg ha^{-1} P_2O_5 (Fig. 2). The fresh weight of roots was increased (P <0.05) with the application of the highest rate of Gafsa phosphate in non-mycorrhized plants in the second harvest, but this was not true for mycorrhized plants. These results are in agreement with the findings of Azcón et al. (2003). According to this author, the application of higher rates of N and P to the soil decreased the uptake of N, P and K in mycorrhized compared to non-mycorrhized plants. Lettuce shoot and root nutrient content showed no significant differences (P <0.05) between treatments, except for magnesium in one treatment, nor were there consistent differences either with the application of phosphate or with mycorrhization. Numerically, it was found that the shoot N content of mycorrhized lettuces, in both harvests, was higher than that of non-mycorrhized lettuces, for the same rate of application of phosphate. The same was true for P content, except in second harvest for the highest rate of phosphate.

Figure 2. Lettuce shoot fresh weight in mycorrhized (M) and non-mycorrhized (NM) plants with Gafsa phosphate (0, 100 and 200 kg P_2O_5 ha^{-1}). Different letters over de bars mean significant difference (P <0.05)

Discussion

The very high EC and high ammonia content of this organic fertilizer, decreased lettuce growth, on the SCP but the high quality of the SOP demonstrated ability to withstand disturbances and final lettuce yield significantly increased in this soil compared to SCP. This study shows that there are organic fertilizers on the market that lack quality to be certified for organic farming and should not be recommended either for organic or for conventional vegetable production. The application of increasing rates of Gafsa phosphate increased non-mycorrhized lettuce yield. However, for mycorrhized plants, the application of 200 kg ha^{-1} P_2O_5 showed a detrimental effect on lettuce growth and nutrient uptake. This suggests that high soil available P content may have harmful effects on the activity of mycorrhizal fungi in lettuce. More research is needed for a better understanding of mycorrhizae growth and activity to recommend their use for organic lettuce production.

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Evaluation of invasive Acacia species compost as alternative horticultural organic substrates

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Key words: Acacia, C/N ratio, compost, mineralization, organic matter

Abstract

The physical and chemical characteristics of composts of invasive Acacia longifolia and Acacia melanoxylon shrubs were evaluated to identify compost limitations as a substrate component. The bulk density was <0.4 g cm^{-3} and the total pore space was >85% of the total volume. Air capacity, the easily available water and buffering capacity were also within acceptable recommended values for horticultural substrates. With increased composting time the physical characteristics of the composts improved, but the same was not true for chemical characteristics. It is recommended to use these Acacia composts in mixtures with peat which increases the content of organic matter and the C/N ratio, and decreases the pH and the electrical conductivity, of the final substrates.

Introduction

Pine bark and peat moss have traditionally been used as nursery and greenhouse substrates but there has been increasing environmental concerns against the use of peat as a growing media (Jayasinghe et al., 2010) and pine bark is increasingly costly. Invasive Acacia spp. such as Acacia longifolia and Acacia melanoxylon are highly available and after composting could be considered as an appreciable low cost component for plant substrates. Composts may have physico-chemical properties that make them suitable as peat substitutes, and the combination of peat and compost in growing media may be synergistic as peat often enhances aeration and water retention and compost improves the fertilizing capacity of a substrate. The aims of this work were: (1) to evaluate the main physical and chemical properties of Acacia composts as organic amendments and (2) to ascertain the potential use of these composts as an alternative to widely used substrate components such as peat and pine bark, for organic horticultural substrate production.

Material and methods

Two commercial scale conical composting piles (> 100 m^3, 3 m high) consisted of Acacia longifolia (60% v) and Acacia melanoxylon (40 % v) were established in Mira, Portugal (40º25' N 8º44' W). Acacia shrubs were harvested using a high speed grinder , shredded and screened to provide a particle size of <4 cm. Pile A was turned by front-end loader on day 28, 56, 84, 147 and 263 after pile construction and Pile B was turned only on day 28, 147 and 263. Composts with 147 and 420 days were analysed for physical and chemical characteristics. Bulk density (dry material), texture analysis, total porosity and water retention capacity were estimated using the methods of de Boodt et al. (1974), and volume shrinkage according to Martinez (1992). The pH and EC values were determined according to Gabriels and Verdonck (1991) in the aqueous extract 1:2 (v/v). The cation exchange capacity (CEC) was evaluated by the method of Harada and Inoko (1979). The OM content was calculated by the loss of mass on ignition at 450 ºC for 6 h and the TKN content was determined by Kjeldahl method. The total phosphorus (P) content was measured using molecular absorption after digestion with H_2SO_4. The potassium (K) content was measured by flame photometry and calcium (Ca) and magnesium (Mg) by atomic absorption spectrometry, after nitric-perchloric acid digestion. Contents of NH_4^+–N and NO_3^-–N in 2M KCl extracts (1/5 m/v) were obtained by molecular absorption. Statistical analysis was carried out using SPSS 17.0 for Windows (SPSS Inc.). Analysis of variance (ANOVA) was performed with two factors (type of compost and composting time) by the general linear model SPSS procedure, and a probability level of α=0.05 was applied to determine statistical significance between treatment means.

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Results

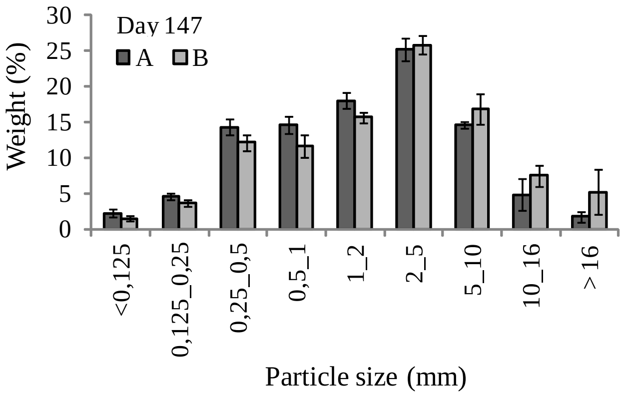
The bulk density and real density increased between 147 and 420 days of composting (Table 1) due to OM degradation and the reduction in particle size which took place during composting (Fig. 1). However, the bulk density was always below the maximum of 0.4 g cm^{-3} recommended for use as growing media for ornamental potted plant production by Abad et al. (2001) and the real density of the composts, was within the recommended range (1.4 to 2.0 g cm^{-3}). Total pore space (TPS) of final composts was above 85% of the total volume of the substrate as recommended by Verdonck and Gabriëls (1992). The volume shrinkage of Acacia composts (22 – 26%) was below the limit value considered acceptable for most substrates (Abad et al., 2001).

Table 1. Physical characteristics of Acacia compost with 147 and 420 days of composting with higher (A) and lower (B) turning frequency (n=12).

Parameter	Pile	Day 147	Day 420
		Mean ± *SD	Mean ± *SD
Bulk density (g cm^{-3})	A	0.13±0.01 b	0.24±0.02 a
	B	0.12±0.01 b	0.26±0.02 a
Real density (g cm^{-3})	A	1.67±0.03 c	1.78±0.07 b
	B	1.74±0.05 b.c	1.96±0.08 a
Total pore space (% v/v)	A	92.0±0.8 a	86.5±1.5 b
	B	92.9±0.5 a	86.6±1.5 b
Volume shrinkage (%)	A	24.0±3.1 a	23.1±2.7 a
	B	25.7±3.0 a	21.7±6.6 a

*SD = Standard deviation
Mean values followed by different letters are statically different (P <0.05)

After 147 days of composting there were more particles >5 mm in compost B compared to compost A, and more particles <2 mm in compost A compared to B (Fig. 1). The coarser material of pile B was explained by lower turning frequency in this pile compared with pile A. Turning contributed to an increased degradation of the organic feedstock material, resulting in a smaller particle size in compost A.



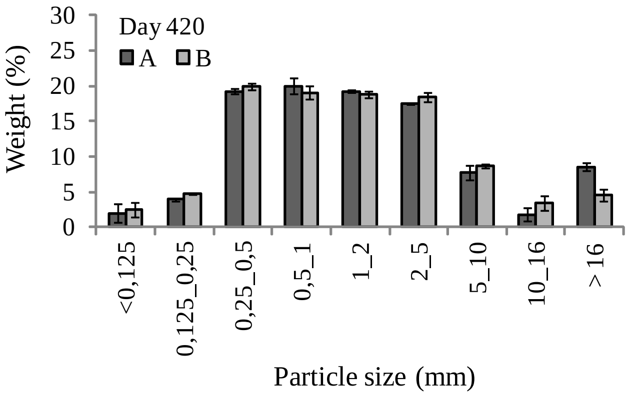
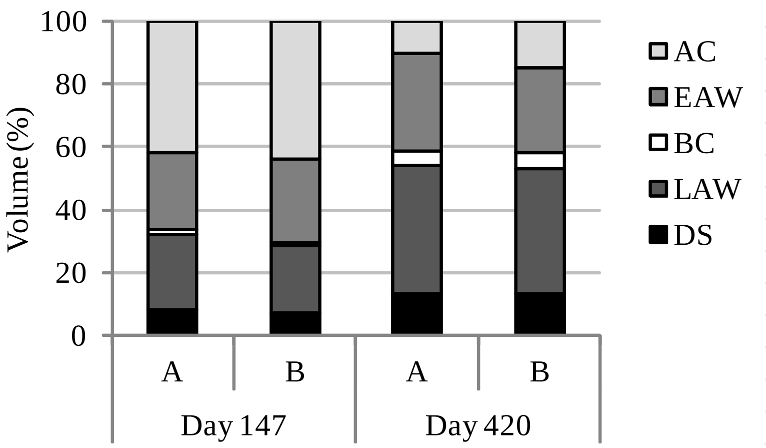


Figure 1. Particle size distribution of Acacia composts with 147 and 420 days of composting with higher (A) and lower (B) turning frequency.

The easily available water (EAW) of composts with 147 days was 24 and 26% and final compost EAW was 31% and 27%, respectively for the compost A and B (Fig.2). Therefore, EAW was above the minimum value of 20% recommended by de Boot & Verdonck (1972). Composts with 147 days buffering capacity (1.3-1.6%) was below the recommended limit of 4%, but rose to values of 5% in both final composts. The total water-holding capacity (TWHC) increased from 49%-50% to 72%-76% between 147 and 420 days of composting. Therefore, final compost TWHC was above the minimum recommended values of 60 % (Abad et al., 2001) and 55% (Noguera et al., 2003) for substrates and close to those reported for peat (Jayasinghe et al. 2010).



AC – Air capacity; EAW – Easily available water; BC – buffering capacity;
LAW – Less available water; DS – Dry solids.

Figure 2. Air capacity, water availability, and dry solids (% v/v) of Acacia composts with 147 and 420 days of composting with higher (A) and lower (B) turning frequency.

The pH was alkaline (7.2 – 7.7) in both composts and dates and above pH values set by Abad et al. (2001) for commercial substrates (5,3-6.5) or established as optimal values (5.2-7.0) for the growth of most greenhouse crops (Herrera et al., 2008). The EC of Acacia composts with 147 days (0.7 – 0.8 dS m^{-1}) increased to 1.0 – 1.2 dS m^{-1} at the end of composting (Table 2), probably as a result of ammonia nitrification. The total N content of final composts A and B was 12.0 and 13.5 g kg^{-1}, respectively. The content of NO_4^+-N was 61 mg kg^{-1} DM in compost A and 120 mg kg^{-1} in compost B. The ratio NO_3^--N/ NO_4^+-N was <1 at the end of the composting period suggesting that the composts were matured (Larney and Hao, 2007) which is a requirement for the use of composts on substrate composition. At the end of composting period the content of phosphorus (P) was similar in both composts (0.8 g kg^{-1} DM) while potassium (K) was 6.6 to 6.1 g kg^{-1} DM for compost A and B, respectively. Calcium (Ca) was the nutrient with higher levels, 27.2 and 32.6 g kg^{-1} in composts A and B respectively. The content of magnesium (Mg) was 2.1 and 2.4 g kg^{-1} DM while the iron content (Fe) was 2.6 and 2.8 g kg^{-1} DM, respectively for compost A and B.

Discussion

Acacia composts were well matured and showed good physical characteristics as partial substitutes for peat, e.g. porosity, air capacity and easily available water within the recommended values for substrates, as well as reduced volume shrinkage and low bulk density. However, these composts showed high values of pH and EC and reduced of OM and C/N ratio that can limit the percentage by which these composts can substitute peat in final substrates. With increasing composting period from 147 to 420 days, the physical properties of the composts improved, but the same did not happen in relation to the chemical characteristics. In further studies, we will evaluate the response of germination, emergence and plant growth in mixtures with increasing rates of Acacia composts in replace of pine bark compost on commercial substrates.

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Nitrogen management in organic horticultural rotation

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Key words: Organic agriculture, compost, field incubation, green manure, nitrogen

Abstract

A field crop rotation with a cover crop of hairy vetch (Vicia sativa, L.) and rye (Secale cereale, L.) followed by potato (Solanum tuberosum, L.) and lettuce (Lactuca sativa L.) was set up with the aim of improving nitrogen (N) management for organic agriculture. N mineralization was determined by field incubation in response to green manure and increasing rates of compost (20 e 40 t ha^{-1}) and organic commercial fertilizer (1 e 2 t ha^{-1}). N mineralization in compost occurred throughout crop rotation, but most of the organic fertilizer was mineralized in the first days after soil application. Consequently, N availability and potato crop yield was increased with 2 t ha^{-1} of organic fertilizer in comparison to 20 t ha^{-1} of compost whereas lettuce yield increased with compost application in comparison to organic fertilizer.

Introduction

Organic farming practices for management of soil organic matter and nutrient availability include crop rotation, cover cropping and soil amendments with composts and/or manures. Nitrogen (N) is usually the limiting nutrient because it depends on the decomposition of organic matter and crops require it in large quantities. If not properly managed, N supply does not match with crop demand (Brito, 2001) and N recovery by crops decreases whilst N loss increases (Jarvis, 1996).

Incubations under controlled laboratory conditions gives us insights into soil potential to mineralize N. However it is unlikely that this approach will accurately reflect the rates of mineralization that occur in the field, due to soil perturbations (storing, mixing and sieving) and the lack of temperature and soil moisture fluctuations (Lomander et al., 1998). Here, N mineralization was determined by field incubation in order to evaluate the availability of mineral N in comparison to crop demand, with the final aim of improving fertilizer recommendations.

Material and methods

A field crop rotation with rye (*S. cereale* L.) consociated with hairy vetch (*V. sativa* L.) as green manure, over the autumn and winter, followed by potato (*Solanum tuberosum* L. cv. Desirée) and lettuce (*Lactuca sativa* L. Maravilla de verano) was set up on a sandy loam soil in the NW of Portugal, as a randomized block design with four replicate plots per treatment. Treatments applied before potato crop included: (i) incorporation of rye and vetch green manure (GM); (ii) and (iii) incorporation of GM with 20 and 40 t ha^{-1} (FM) of compost (C20 and C40); (iv) and (v) incorporation of GM with 1 and 2 t ha^{-1} of a commercial organic fertilizer certified for organic agriculture based on poultry fermented and granulated feathers (OF1 and OF2), and (vi) a reference treatment without soil amendments (T0). The compost was collected from a pile of cow manure aged for 7 months and turned twice.

Chemical properties and composition of compost, organic fertilizer and green manure are shown in table 1. Total N in the soil, composts and crops were measured by molecular spectrophotometry after digestion with sulfuric acid; mineral N from samples of fresh soil and composts was extracted with KCl 1M 1:5 solution and determined by molecular absorption spectrophotometry using a continuous flow auto-analyser. Soluble C and N were extracted with $CaCl_2$ 0.01M 1:10 solution and measured in an elementary analyser.

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Table 1: Organic matter content (OM), dry matter content (DM) and chemical properties (mean and standard deviation) of compost, organic fertilizer and green manure (rye and hairy vetch)

Nutrients	Compost	Organic fertilizer	Green manure
DM (%)	25.9	91.5	20.0
pH (H_2O)	8.0 ± 0.05	6.6 ± 0.1	
EC (ds m^{-1})	4.3 ± 0,3	5.9 ± 0.02	
OM (g kg^{-1} DM^a)	589 ± 63	831 ± 13	
N (g kg^{-1} DM^a)	19.8 ± 0.7	118.7 ± 3.8	21.0 ± 0.9
C/N	17 ± 2.4	3.9 ± 0.1	23 ± 1.1
NH_4^+-N (mg kg^{-1} FM^b)	69 ± 16	7272 ± 545	268 ± 22
NO_3^--N (mg kg^{-1} FM^b)	134 ± 38	2.1 ± 1.0	98 ± 4.8
Soluble C* (mg kg^{-1} DM^a)	7363 ± 489	42704 ± 3002	62418 ± 3773
Soluble N* (mg kg^{-1} DM^a)	1367 ± 3.1	36585 ± 2854	3243 ± 244

* Extracted with $CaCl_2$, ^{a}DM: dry matter, ^{b}FM: fresh matter

The field incubation used during potato and lettuce crops was performed according to the methodology described by Hatch *et al*. (1990). At the beginning of each incubation period two samples of 5 cores each (15 cm long and 4 cm wide) were taken. Five subsamples were frozen and the remaining ones were enclosed in micro-perforated polyethylene bags, buried at 20 cm depth and incubated for 14 days. The difference between the amount of inorganic N in frozen and incubated samples was used to calculate N mineralization. The sum of N mineralized during each incubation provided an estimate of the total mineralized N in the tilled layer. Two models developed by Cabrera and Kessel (1988) and Bonde and Lindberg (1988) were fitted to the results, with either one or two mineralization pools.

$Nm = N_0 [1\text{-}\exp(-k_1 t - k_2 t^2)]$ and $Nm = N_1 [1\text{-}\exp(-k_1 t)] + N_2 [1\text{-}\exp(-k_2 t)]$

In both models Nm (mg kg^{-1} DM) represents accumulated mineralized N at time t; k (one pool model), k_1 and k_2 (two pool model) are mineralization constant rates, and the amount of potentially mineralizable N is given by N_0 (one pool model) and by N_1 and N_2 (two pool model).

Results

Potato yield was not statistically different between the treatments OF1 and OF2 (36 and 42 t ha^{-1} respectively) and C40 (36 t ha^{-1}). However, potato yield increased (P< 0.05) in treatment OF2 in comparison to treatments C20, GM and T0. Lettuce yield increased significantly (P< 0.05) for treatments C20 and C40 (18 and 19 t ha^{-1} respectively) in comparison to all other treatments (Fig. 1).

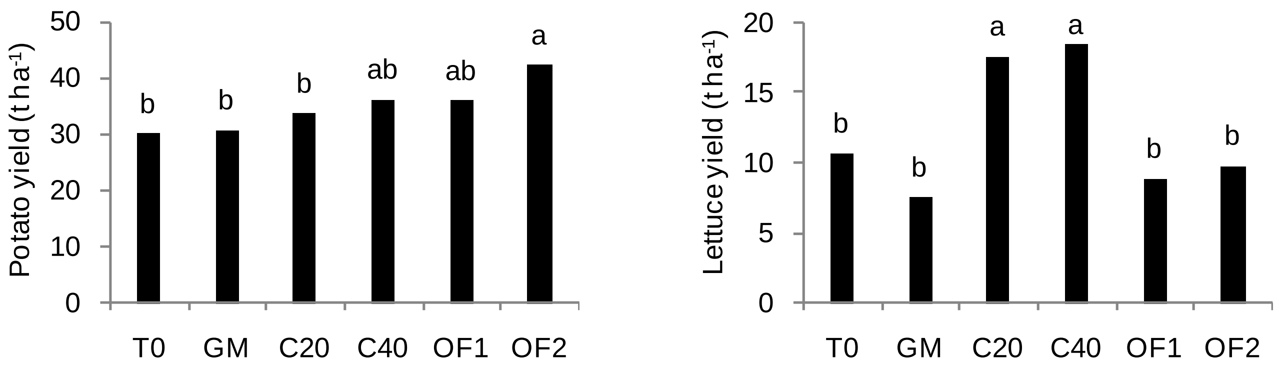

Figure 1. Potato and lettuce yield (t ha^{-1}) for the control treatment (T0) without soil amendments and in response to green manure (GM), GM and 20 or 40 t ha^{-1} of compost (C20 and C40), GM and 1 or 2 t ha^{-1} of organic fertilizer (OF1 and OF2).

The N mineralization of the organic fertilizer in the first 7 days of incubation, was 23 % and 49 % of the total N mineralized during the rotation, for 1 and 2 t ha^{-1} of fertilizer applied, respectively. On the other hand, the application of 40 t ha^{-1} of compost caused an initial N immobilization for 72 days probably due to increases in C (Reddy *et al*., 2008), and so, the N mineralization occurred throughout potato as well as lettuce growth period. N immobilization occurred with the application of green manure because C/N ratio was higher than 20 (Rosecrance *et al*, 2000) and a high content of soluble C (62418 mg kg^{-1}) in comparison to soluble N (3243 mg kg^{-1}) drived microorganisms into the immobilization of N from soil to decompose the soluble C from green manure (Fig. 2).

Discussion

Lettuce yield increased with the application of compost because organic N in the organic fertilizer was mineralized earlier during the previous potato crop. This was probably due to the low C/N ratio (3.9) and a high content of soluble C and N (42704 and 36585 mg kg^{-1}, respectively) available in the organic fertilizer that increased microbial activity, thus releasing a high amount of mineral N in a short period of time. The amount of potentially mineralizable N (N_0) available for the lettuce crop was not enough for an acceptable lettuce yield for this variety. The largest amount of mineral N released during lettuce crop was 22 mg kg^{-1} DM (29 kg ha^{-1}), in a response to the addition of 40 t ha^{-1} of compost, because N remineralization occurred during potato as well as lettuce growth (Fig. 2). A mid-cycle potato (90-120 days) instead of the long-cycle potato (120-150 days) used in this experience could had been more advantageous. In the latter situation lettuce could had been planted earlier when a higher content of mineralizable organic N and higher temperatures would probably increase N mineralization and consequently N availability, thus leading to an increased lettuce yield.

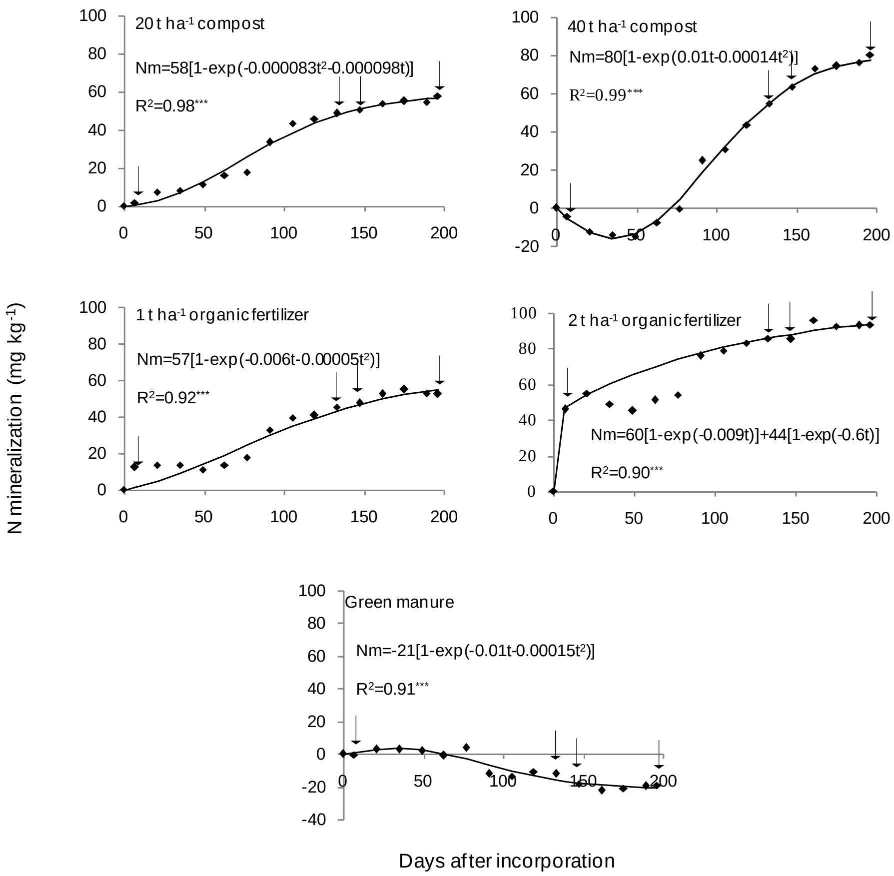

Figure 2. Accumulated mineralized N (mg kg^{-1} DM) from compost (20 and 40 t ha^{-1}), organic fertilizer (1 and 2 t ha^{-1}) and green manure in field incubation. Arrows represent the beginning and the end of crops. *P<0.05 **P< 0.01 ***P<0.001.

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Effectiveness of Organic horticulture training for young people with mental disorders

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Key words: wellbeing, motivation, behaviour, trainees' families

Abstract

The social and therapeutic horticultural programmes within health facilities, social services or vocational training, aim to contribute to the clients or trainees wellbeing and improvement of their physical, mental and emotional conditions. The present study aimed to provide an insight on the benefits of the Training Course in Organic Farming and Gardening, designed for young people over 16 years old with mental disorders, since 1991. The course takes place in the Professional Training Centre, of the Association of Parents and Friends of Children with Disabilities, in Barcelos, Portugal. During a period of three months three questionnaires were performed to the trainees attending the course and the trainees' families were interviewed. The results indicate that horticulture, when used in a group-based setting, has a direct and positive effect on life satisfaction, wellbeing and self-confidence, which are all components of quality of life.

Introduction

Social Agriculture is an umbrella for many different forms of agricultural and horticultural activities that can be performed in commercial farms (social farming), within health facilities, social services or vocational training and in other facilities in the urban context (urban agriculture). The main transversal objective is to contribute to the wellbeing and social inclusion of disadvantaged people, through the activities and the promotion of solidarity and mutual aid. The challenge of a productive activity and contact with nature, for people with physical, mental, psychological, social or economic difficulties, can improve health, facilitate learning and knowledge, increase self-esteem and, consequently, participation in social life (Dessein and Bock, 2010).

The social and therapeutic horticulture (STH) falls into urban gardening programs; environmental education; support for the elderly, disabled or health care dependents; psychosocial rehabilitation and social inclusion. Provides opportunities for participation and socialization, senses stimulation, concentration and creativity and aims to contribute to the wellbeing and improvement of quality of life. The STH have different forms of organization, contributions and goals to achieve (Thrive, 2009), as follows: (i) Therapeutic horticulture (occupational) - through active or passive participation, consists of activities/experiences with plants, gardening and horticultural practices (indoor and outdoor), including alternative education programmes, with the aim of contributing to the clients wellbeing and health improvement; (ii) Horticultural therapy - in clinical practice in health facilities or social service, integrates programs aiming to achieve specific goals other than the horticultural activity itself and requires a trained therapist; (iii) Social horticulture (community) - relates to community gardens, gardening programs, independent living, health prevention and aims leisure and social interaction and the horticultural activities; (iv) Professional training in horticulture - learning and training activities with the goal of integration into the labour market, especially for people with physical and mental disabilities who participate according their capabilities. The present study is contextualized in the last goal and the objective is to provide an insight on the benefits of an organic horticulture professional training course for young people with mental health disorders.

Materials and methods

The Training Course in Organic Farming and Gardening (TCOFG) started in 1991, in the Professional Training Centre of the Association of Parents and Friends of Children with Disabilities (APFCD), in Barcelos, Portugal, which is certified for organic production since 2006 (Sativa). The institution has more three training courses: pottery, table service and laundry. The target trainees of the APFCD are young person's

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older than 16 years with intellectual disabilities or with a disability characterized by significant limitations in intellectual functioning and in adaptive behaviour. The design of the courses is adapted and adjusted to the personal and social needs of the target trainees. Firstly it is established an individual development plan involving the staff, the client and his/her family. This plan includes a synthesis of the initial situation (after a skills assessment), the perspectives of the client, the suitable goals, objectives, methodologies and training skills, in addition to the content that meet the specific training requirements. The TCOFG is organized into three training steps: the basic (600 h), the technological (1100 h) and the practical training (1200 h), the last taking place in companies. The development of the activities intend to train professionals who perform, under supervision, tasks in the organic production of vegetables and fruits and tasks related to the building and maintenance of gardens and green areas, with plain awareness of the environmental protection rules, hygiene and safety at work.

A group of 23 trainees between 16 and 24 years old entered the APFCD in 2011/12. After a trial period of a few days in the activities of the four training courses, the trainees were directed to one, namely, 8 started the TCOFG (1 female and 7 males) and 5 trainees went to each of the other three training courses. Despite the multiple assessment methods and variables in social studies, there is a common variable broadly defined as the perception of the level of satisfaction of clients or trainees, assessed from responses in semi-structured interviews, questionnaires and focus groups (Relf, 2012). Here, during a period of three months (March to May), three questionnaires were performed to the trainees attending the TCOFG and the first questionnaire was also carried out to the trainees of the other courses. The trainees' families were interviewed in May in order to assess their sons' progress at home and the main effects of the TCOFG on them. The semi-structured interviews were designed and conducted with the support of the psychologists of the institution, so that an accessible language and confidence of the parents could be achieved. One family declined to answer. The first questionnaire was intended to understand the motivation of the choice for the training course and the second aimed to find out the relationship of young people to the horticultural practice and what is most important when they are working in the field. The third questionnaire was designed to understand the behaviour changes that occurred with the trainees since they start the course, and if organic horticulture and gardening will be part of their lives in the future. Here, a selection of questions was chosen according their relevance for the aim of the study.

Results

1 - Comments of the trainees who have chosen other training course
Pottery trainees: farming is an activity that gives little money (2), it is very tiring (2), it is boring (1). Table service trainees: farming is boring (3), it is very tiring (1), does not have the required skills (1); Laundry trainees: farming is very tiring (4), does not have the required skills (1).

2 - Motivations of the trainees to select the TCOFG
a) Main reasons to choose the course
Always enjoyed field work (3); enjoy plants, trees and flowers, to care them and to see how they grow (3); enjoy to touch the soil (1); for no apparent reason (1).
b) Familiarity with horticultural activities
Yes, within family farming (5); Yes, within home garden (2); No, not familiar (1).

3 - Personal feelings about horticultural activities
a) The horticulture activities are complex and tiring?
No (3), the activities are easy as they are familiar with them since they were very young; Yes (3), because when they are performing certain field activities they feel tired and breathless; With no opinion (2), some activities are difficult and others are easy.
b) Missing horticultural activities during the weekend?
Yes (4), they miss the daily routine and look for field work; No (3), because at home they usually help parents to work in the field (2) and because the weekend is to rest and not to work (1); With no opinion (1), because likes to be at home doing nothing, although sometimes miss the friends and the things they do together during field work.

4 - Comprehension about organic horticultural production
Organic production (OP) is healthy because it has no chemicals, although there are many people who do not know about this production system and therefore only eat conventional food (1); OP is good for the environment and the food has higher quality, but mainly elder people do not know about it (1); OP is to plant vegetables and flowers so that the soil is well preserved (1); With no opinion (5), as it is a very difficult question.

5 - Effects induced by the horticultural activities
a) Emotional feelings (each trainee selected two feelings)

Freedom (6), good mood (5), happiness/joy (4), sadness (1). Some reasons for joy feeling were the outdoors work environment, the company of friends and the variety of tasks that they learn/perform throughout the day.

b) Health benefits

- Yes there are health benefits (8) since the activities are being practiced outdoors they provide wellbeing through a feeling of comfort and happiness.
- When working in the field they feel free from fears and forget their own problems (6), because they are focused while doing what they like; other, in some days when feels upset or bored, cannot focus and so everything will go wrong (1); with no opinion (1).

6 - Effects induced by the course attendance

a) Changes in behaviour

Yes (6), on a personal (4), social (1) and family level (1), namely, talk more frequently, lost laziness, better organized, better related with colleagues, help colleagues with more difficulties, more involved in household tasks; No (2), there were no behaviour changes since horticulture does not cause this type of changes.

b) Which changes began to emerge

Become more responsible (2), more confidence in themselves (2), more sociable (2), lost shyness (1), nothing has changed (1).

7 - Plans to work in the horticulture sector in the future

Yes (5), they enjoy horticulture since they were younger; No opinion (2), admit they are still young to be sure about their future; No (1), plan to have another profession.

8 - Interviews to the trainees' parents

a) Comments on sons/daughter personal behaviour since they started the TCOFG:

greater willingness to interact with the family (6); increased autonomy in their daily tasks (6); more friends/more sociable (5); more alive (4); more helpful in domestic tasks (4); increased initiative to help at home (3); more confident/responsible (3); cheerful sense of humour (2); more calm and less angry (1); greater concern with their personal image (1); no significant differences (1).

b) Reasons why the course may induce to the professional future of their sons/daughter: they demonstrate motivation and commitment for horticultural activities, which is the most important for their personal development (5); they are happy with the outdoors environment (5); they enjoy the course activities (4); they have skills and willingness (4); they are learning and getting experience (2).

Discussion

The effects described here have been reported by other authors in different programs of social and therapeutic horticulture. For example, the use of horticultural therapy in a residential setting for people with mental illness, showed benefits in terms of promoting social interaction, providing opportunities for the development of creativity and self-expression, and increasing self-esteem and self-confidence (Parker, 2004). Horticulture therapy is associated with a diversity of physical, emotional, cognitive and social benefits, with results in the reduction of stress and symptoms of depression such as sadness and negative mood (Ulrich et al. 1991; Perrins-Margalis et al. 2000), showing a mutual relationship between people and plants. Professional training is one of the key supports of the process of socio-professional insertion. Furthermore, the practice of horticultural activities gave these TCOFG young trainees the opportunity to gain more responsibility, self-confidence, self-esteem, freedom, competences and friends. It was a way to forget their fears, problems and difficulties, helping them to assume their own life and independence and made their families more proud and confident on their sons' future. Results indicate that horticulture, when used in a group-based setting, has a direct and positive effect on life satisfaction, wellbeing and self-confidence, which are all components of quality of life.

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Pruning system effect on greenhouse grafted tomato yield and quality

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Key words: fruit grade, grafting, stems, cotyledon nodes, nursery

Abstract

This study aimed to evaluate the effects on tomato yield and quality of three pruning systems (2, 3 and 4 stems) of grafted plants (cv. Vinicio and Multifort) used to prevent the incidence of soil diseases. It was also investigated if the two stems from nodes of the cotyledon leaves improved crop performance compared to the two stems from the first true leaves nodes. The experiment was conducted in the spring/summer season, under greenhouse conditions at NW Portugal, with a randomized block design with three blocks. Total yield was significantly increased for the double-stem tomato crop, without significant differences between both stem nodes position (26.5 kg m^{-2}), compared to plants with 3 and 4 stems (19.5 kg m^{-2}). The fruit grade between 57-102 mm represented 96.3% of total yield and this was similar for all plant treatments. Fruit quality was not influenced by the pruning systems. Higher yield and fruit quality from double-stem tomato plants offset the increased planting costs.

Introduction

Intensification of vegetable crop production has contributed to increased incidence of soil pests and diseases. However, this incidence can be mitigated by vegetable grafting, which is particularly important for organic production where synthetic pesticides are not allowed. The grafting induce the resistance/tolerance to various soil diseases such as *Pyrenochaeta lycopersici*, *Fusarium oxysporum* f. sp. *lycopersici*, *Ralstonia solanacearum*, *Verticillium albo-atrum* (Louws et al., 2010) and may also provide resistance to nematodes (Rumbos et al. 2011) and tobacco mosaic virus (TMV) (McAvoy et al. 2012). The use of a vigorous rootstock induces robust plants, which allows decreased planting density without changing the harvest period in crops such as tomato, pepper, eggplant and cucumber (Lee et al. 2010). Grafting with specific rootstocks may induce plant tolerance to salinity and/or increase plant nutrient uptake, decreasing the need for fertilizers to match nutrient availability with crop demand (Colla et al. 2010; Savvas et al. 2011). Grafted tomato may also contribute to increase fruit quality under multiple and combined stress conditions (Rouphael et al. 2010). This study aimed to evaluate the effects on grafted tomato yield and quality of three pruning systems (2, 3 and 4 stems) as well as if the 2 stems from nodes of the cotyledon leaves improved crop performance compared to the 2 stems from the first true leaves nodes.

Materials and methods

The experiment was conducted with tomato (*Lycopersicon esculentum* Mill.) during spring/summer under greenhouse conditions, at Santo Tirso, Portugal (41º 20' 41.6'' N, 8º 28' 18.4'' W). The soil was a cambisol with a sandy loam texture with high organic matter (OM) and nutrient contents and high electrical conductivity (EC) (Table 1). A randomized block design experiment with three repetitions and four treatments was carried out to evaluate crop yield and quality. The four treatments were three pruning systems of grafted plants with 2, 3 and 4 stems from the first true leaves (P2, P3, P4) and one pruning system of grafted tomato plants with 2 stems from the nodes of the cotyledon leaves (P2c). The organic fertilizer applied was produced from vinasse, molasses, bone meal and feather meal and was applied at a rate of 3 t ha^{-1}.

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Table 1. Soil characteristics of the greenhouse

pH	EC	OM	P_2O_5 $_{ER*}$	K_2O $_{ER*}$	Ca	Mg
H_2O	(dS m^{-1})	(g kg^{-1})	(mg kg^{-1})			
6.2	3.6	54	579	368	2810	117

* ER - Egner-Rhiem method.

The beef type tomato cv. Vinicio (E27.33490) was grafted on the inter-specific rootstocks Multifort. The spacing between stems was 0.5 m and between lines was 0.8 m, resulting in a plant density of 1.25, 0.83 and 0.63 plants m^{-2}, respectively for plants with 2, 3 and 4 stems. The soil was covered with a fabric film and the nylon strip tutors were 2.5 m height. The plant protection included the application of the predator *Nesidiocoris tenui* (Heteroptera: Miridae) to control 45 days after planting; sulphur to control the mite *Aculops lycopersici*, compatible with the auxiliary *N. tenui*. The irrigation was performed by a drip system. Bumblebees (*Bombus terrestre*, Beeline bb Bioline Syngenta) were used for pollination. The first harvest took place on the 25th June 2013 (104 days after planting) and the last harvest on 24th September (195 days after planting). Over this 91 day period two plants for each treatment repetition were harvested weekly (14 harvests). The number of fruits as well as fresh weight for each of the following grades: ≤ 57, 57-66, 67-81, 82-102 and > 102 mm were recorded. The firmness, pH, total soluble solids content, titratable acidity and dry weight were evaluated for five harvests during the harvesting period. The fruit firmness was determined with a penetrometer (TR Snc), the soluble solids with an ABBE refractometer (Vitrilab), the pH with a potentiometer and the acidity by titration at pH 8.1 with a solution of 0.1N NaOH and expressed as a percentage of citric acid. Fruit dry matter content was determined after drying the fruit in a ventilated oven at 70°C for 48 hours. The analysis of variance and least significant difference tests were used to test for significant differences between mean data. Statistical analysis was carried out using SPSS 17.0 for Windows (SPSS Inc.). A probability level of α=0.05 was applied to determine statistical significance.

Results

The number of fruits and total yield were significantly higher for the double-stem tomato plants from both nodes position (first true leaves and cotyledon leaves) (26.5 kg m^{-2}), compared to plants with 3 and 4 stems (19.5 kg m^{-2}) (Table 2). Tomato grade between 57-102 mm represented 96.3% of total yield and this was similar for all plant treatments (Fig.1). The percentage of unblemished fruits was similar for all plant treatments, with a mean of 90.9%. However, the fruits with healed cracks were higher in P2 and P4 (8.0%) compared to the other crops treatments (5.6%). Fruit quality was not influenced by the pruning system and mean characteristics were as follows: fruit firmness (1.0 kg), content of soluble solids (5.1°Brix), acidity (1.0 g 100 g^{-1}), pH (4.4) and dry mater content (4.9%) (Fig.2). Taking into account the unit price of grafted plants (0.71 € $plant^{-1}$), the differences between plant density of 2, 3 and 4 stems (respectively 1.25, 0.83 and 0.63 plants m^{-2}), the yield increase (7.0 kg m^{-2}) and the mean price of tomato (0.50 € kg^{-1}), it can be concluded that the gross income with the double stem tomato could be about 3.0 € m^{-2} higher compared to 3 and 4 stems grafted plants.

Table 2. Total number of fruits (m^{-2}) and total crop yield (kg m^{-2}) for grafted tomato with 2, 3 and 4 stems from upper nodes (P2, P3, P4) and with 2 stems from nodes of the cotyledon leaves (P2c).

Treatments	No of fruits (m^{-2})	Yield (kg m^{-2})
P2c	121.5	25.79
P2	125.0	27.22
P3	82.9	18.79
P4	89.0	20.15
LSD	*9.8*	*2.01*

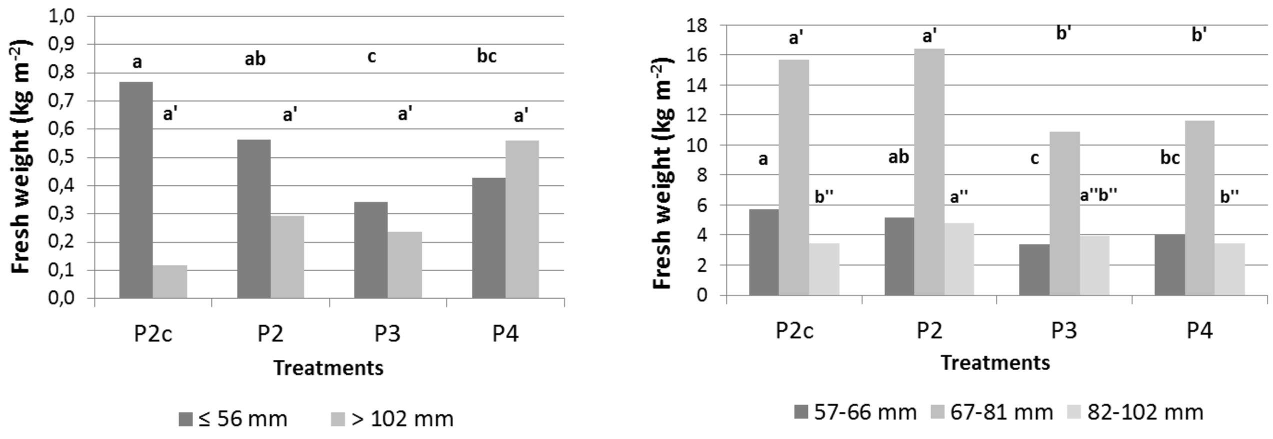

Figure 1. Tomato fresh weight (kg m-^{2}) for fruit grade ≤ 56, 57-66, 67-81, 82-102 and > 102 mm, for grafted tomato with 2, 3 and 4 stems from the first true leaves (P2, P3, P4) and with 2 stems from nodes of the cotyledon leaves (P2c). Different letters for the same series means significant differences between crop treatments (p <0.05).

Discussion

Higher yield and fruit quality of double-stem tomato plants offset the increased planting labour and higher plant cost, compared to the 3 and 4 stems grafted plants. Similar results were obtained for double-stem plants grown from cotyledon leaves nodes compared to those grown from the first true leaves, suggesting that the former plants should not be recommended as they need higher nursery pruning care. Perspectives include further evaluation of vegetable grafting (tomato, cucumber, pepper, melon, water melon and green beans) to improve yield and fruit quality under biotic and abiotic stress conditions in organic production and with vegetable cultivars that are suitable for organic production due to their higher fruit quality but often with soil diseases susceptibilities.

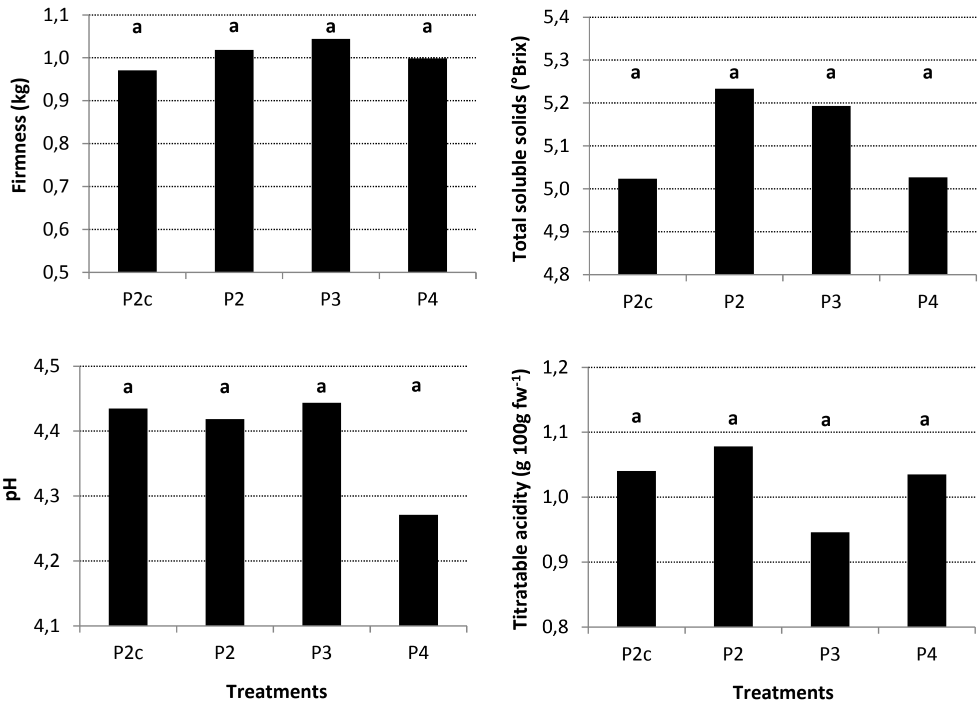

Figure 2. Fruit firmness (kg), total soluble solids (g 100 g fw^{-1}), pH and titratable acidity (°Brix), for grafted tomato with 2, 3 and 4 stems from the first true leaves (P2, P3, P4) and with 2 stems from nodes of the cotyledon leaves (P2c). Different letters for the same series means significant differences between crop treatments (p <0.05).

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Ecological footprint as a method for evaluation different agriculture production systems

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Key words: footprint, organic, biodynamic, integrated, conventional production

Abstract

Ecological footprint could be a tool for evaluating impacts of different agricultural production systems (PS). Based on more years field experiments producing vegetables and field crops ecological footprint of conventional (CON), integrated (INT), organic (ORG) and biodynamic (BD) farming systems in Maribor, and CON, INT and ORG in Dolenci was calculated and interpreted using the SPIonExcel tool. Results showed a markedly lower ecological footprint of ORG and BD systems compared to CON and INT which are not significantly different. Identified were possibilities for reducing ecological footprint – for CON and INT by reducing mineral fertilizers and pesticide inputs; for ORG and BD by changing fuels and reducing machinery use.

Introduction

The agro-food sector itself considerably contributes to environmental pressures like emission of climate change gases. It has however the potential to reduce its emissions as well as help society meet its sustainability targets e.g. by providing renewable resources and sequestering carbon in soils or using more sustainable agricultural production systems like integrated and organic farming (Bavec et al. 2009). National and regional policies, the Common Agricultural Policy and Rural Development Reform increasingly include high environmental standards including climate change aspects. Different "green" measures for assuring sustainability of agriculture are planned for CAP in a new EU financial perspective. "Ecological intensification" is a new term in research and professional community which means designing sustainable production systems that save on inputs and are less harmful to the environment. The aims are comparison of different agricultural production systems (PS) on the base of their ecological impact and identification of "ecological hotspots" in the supply chain of agricultural goods and services.

Material and methods

One of the frameworks to apply evaluation methods of sustainability is life cycle assessment (LCA), which assesses the environmental burden caused by a product.

Comparability of the results is a critically scope of the LCA, which may differ from study to study as there are used different tools for calculating (Bavec et al. 2012). One
of these tools is the environmental or ecological footprint (Haberl et al. 2001). It aims to estimate the biologically productive area needed to produce materials and energy. The calculations for comparison of different PS were done based on the data from two field experiments.

Experiment 1. The experimental site is located at the University Agricultural Centre near Maribor (46°28N, 15°38E, 282 m a.s.l). The annual mean air temperature of the area is 10.7 °C; where the mean monthly minimum is in January at 0.4 °C and the average monthly maximum is in July at 20.8 °C. Average annual rainfall in the area is around 1000 mm. Sixty 7m×10m experimental field plots were established on a dystric cambisol (deep) (average pH value 5.5 [0.1 KCl solution], soil soluble P at 0.278 g kg^{-1} and soil soluble K at 0.255 g kg^{-1} in ploughing soil layer), and are maintained within two different five-course crop rotation designs. Four PS + control plots were arranged in a randomised complete block split-plot design with four replicates. PS differed mostly in plant protection and fertilization strategies and are defined by the valid legislation and standards – conventional (CON), integrated (INT), organic (ORG), biodynamic (BD) and control plots, where no fertilization/plant protection was used. Also, the same varieties were used in all PS under study of

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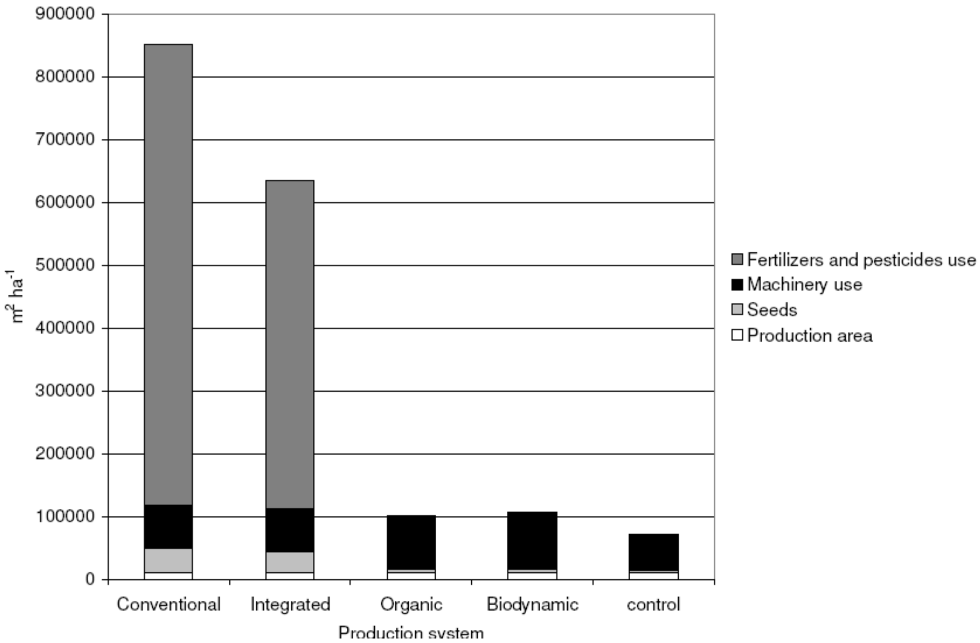
conventional origin for CON and INT systems and of organic origin for ORG, BD and control systems. Presented are results from 2008 to 2010 for spelt and winter wheat.

Experiment 2. The field trial was laid out at the research station in Slovenia, Dolenci near the Hungarian border (46°51'4.43''N 16°17'15.45'' E, 302.1 m a.s.l) over a period of three years (2009-2011). The annual mean air temperature of the area is 9.7 °C and average annual rainfall in the area is 749 mm. The field trial was established on sandy loam (average pH value 6.3 [0.1 KCl solution], soil soluble P at 0.13 g kg^{-1} and soil soluble K at 0.34 to 0.56 g kg^{-1} at the ploughing soil layer (40 cm) was determined using AL-method. The three PS (CON, INT, and ORG) were managed in accordance with EU and national legislation and rules. In the paper are only results for red beat and white cabbage. For calculation of ecological footprint the Sustainable process index was used (SPI©) - it includes the conversion of mass and energy flows into the surface area required by the process (Sandholzer and Narodoslawsky 2007). The software SPIonEXCEL was developed to bring this methodology into an easily applicable form. It calculates the ecological footprint of a process, product, or service with an eco-inventory by summarizing the mass and energy flows to and from the environment over the life cycle in question. We calculated the total ecological footprint (A_{tot}), which is the area necessary to embed the whole life cycle generating a product. Partial footprints were calculated directly from the experimental field trial data with the help of the software SPIonEXCEL, which is available on the internet (http://spionexcel.tugraz.at). The areas are computed on the basis of mass and energy flows, and the infrastructural requirements for the reference period, one year. Within this period, a number of system units were supplied by the process in questions. The specific area was defined as the total area divided by the system units. This specific area is a possible comparative measurement of sustainability and can be related to the area that is statistically available to each person, and this defines the SPI index. Also the efficiency of a PS was calculated using ecological efficiency index (EEI). EEI gives information on how much surface area is needed to produce one unit of a product or what is the ecological footprint of the yield (y) is EEI=Atot/y (m^2/kg).

Results



Ecological footprint of wheat is on average higher compared to spelt which is concerning inputs not demanding field crop (Figure 1). Producing 1 ha CON winter wheat over 85 ha of area is affected and in the case of spelt 65 ha. INT production which is considered as environmentally friendly (Bavec et al. 2009) had slightly lower values (63 and 45 ha, respectively), but real impact on environment had ORG and BD farming practice with 10 to 11 ha use of area for both field crops. In the case of CON and INT the most important impact are using pesticides and mineral fertilizers. Concerning BD and ORG some reductions of ecological footprint could be achieved changing machinery use and using alternative energy sources (plant oil instead of fuel), but due to the spraying of biodynamic materials consumption of machinery is higher in BD production compared to ORG.

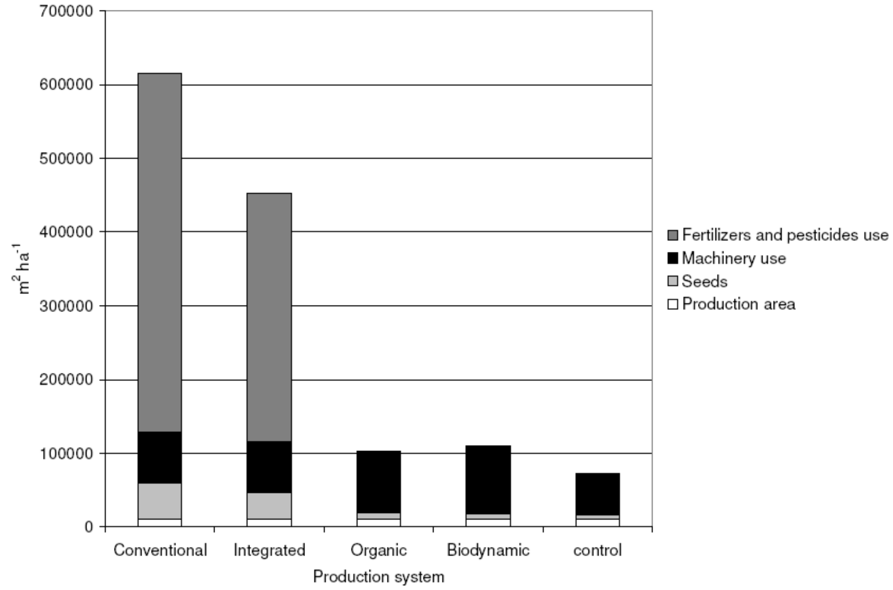


Figure 1: Average yearly ecological footprint (m^2 ha^{-1}) of winter wheat and spelt 2008-2010 in experiment 1.

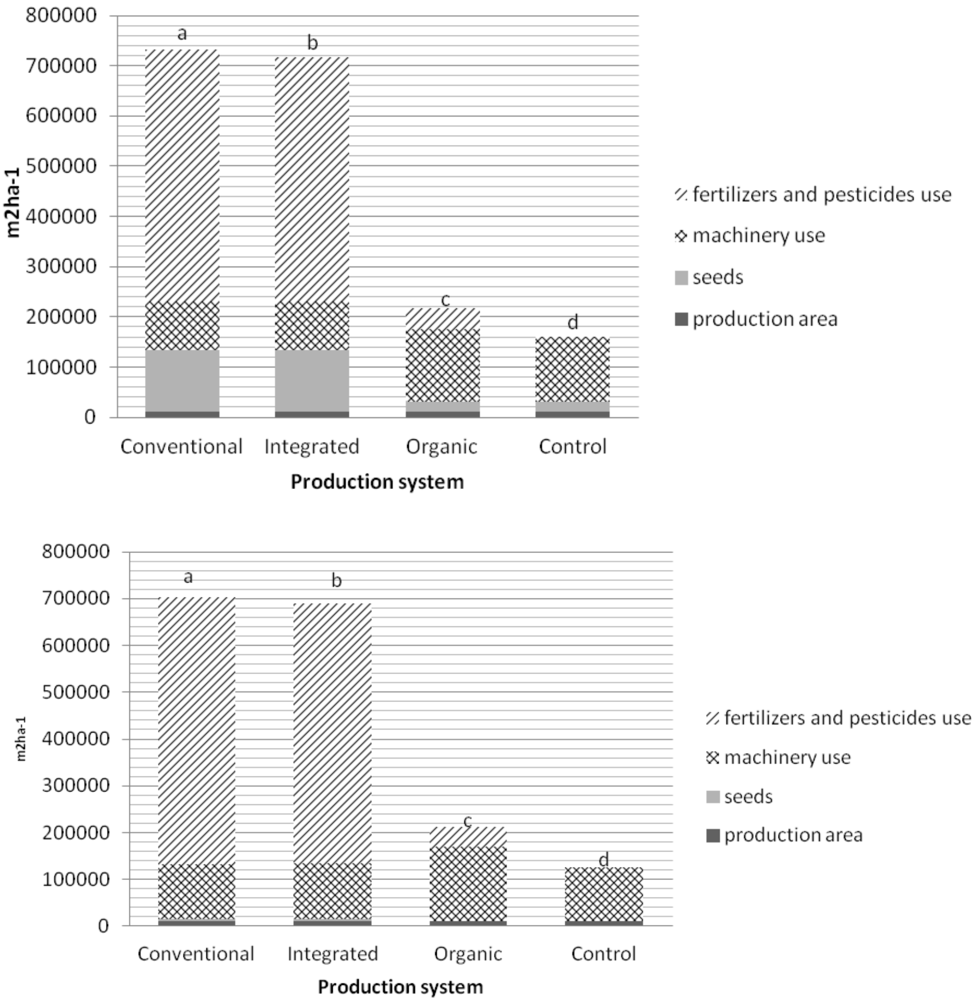


Figure 2: Average yearly Ecological footprint of cabbage and red beet (m2 ha-1) for years 2009-2011 in experiment 2

In the case of field vegetables produced in three PS similar results came out (Figure 2). There is not big difference in ecological footprint between CON and INT – impact of 1 ha production of white cabbage and red beet is on around 70 ha surface area. Statistically significant improvement is ORG production by 3.5-x lower impact.

The highest yields for cabbage and red beet were attained using the CON production system (68,475 kg for cabbage and 27,879 kg for red beet, respectively), while the lowest was in the control plots where the lack of nutrients was evident (Table 1). But the results of the ecological efficiency production give a more insightful picture when yields are taken into the equation. The EEI shows that the highest values for kg of product both cabbage and red beets are for the INT production system but the difference with CON is not significant. The EEI is the lowest in the ORG production system, it is significantly different from CON and INT, but not from control for cabbage. Furthermore, the control plots have shown that production, despite the low ecological footprint and almost no inputs, is not ecologically efficient, because the yield was very low (only 27% of CON for cabbage and 29% of CON for red beets).

Table 1: Average yield (Y) and ecological efficiency index (EEI) depending on production system (PS) in Dolenci for white cabbage and red beet

	White cabbage		Red beet	
PS	Y (kg ha^{-1})	EEI (m^2 kg^{-1})	Y (kg ha^{-1})	EEI (m^2 kg^{-1})
CON	68,475a	10.3±6.1a	27,879a	26.3±12.9a
INT	53,550b	12.9±5.4a	26,547a	27.0±17.4a
ORG	42,150c	5.0±2.1b	17,955b	12.1± 6.2b
Control	18,825d	6.7±3.5b	8,250c	19.3±11.8c

Different letters (a-d) in column mean differences at P<0.01 Duncan's multiple range test

Yields of spelt did not differ between PS, but in the case for the nutrients and other inputs more demanding winter wheat CON system had the highest yield (Table 2). But ecological efficiency index of both cereals showed similar results as thus in vegetables – use of surface area per kg (EEI) of yield is significantly lower in case of ORG and BD compared to CON and INT. INT production system does not perform much better than CON.

Table 2: Average yield (Y) and ecological efficiency index (EEI) depending on production system (PS) in Maribor for spelt and winter wheat

	Spelt		Winter wheat	
PS	Y (kg ha^{-1})	EEI (m^2 kg^{-1})	Y (kg ha^{-1})	EEI (m^2 kg^{-1})
CON	2,260±141ab	280±19a	4,263±469a	230±22a
INT	2,369±247a	207±21b	3,683±451ab	204±19a
ORG	2,039±125ab	52±4c	2,450±263c	47±5b
BD	2,440±180a	49±4c	3,136±305bc	37±3b
Control	1,807±91b	43±3c	2,467±207c	31±3b

Different letters (a-d) in column mean differences at P<0.01 Duncan's multiple range test

Discussion

The results showed significant differences in PS concerning ecological footprints where really positive effect in reducing negative impacts on environment is in ORG and BD system. The experiments demonstrated that INT production which is advertised as environmental friendly and sustainable production system does not perform much better than CON. There are also some possibilities to reduce ecological footprint also in ORG and BD production system.

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Availability of hairy vetch (*Vicia villosa* Roth) as leguminous green manure crops for organic rice cultivation in reclaimed saline land

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Key words: Organic agriculture, hairy vetch, rice, green manure, salinity, seedling

Abstract

In this study we evaluated the availability of hairy vetch in reclaimed organic rice production systems. The response to increasing salinity was analyzed by means of the germination rate and seedling growth of hairy vetch. Results showed that seed germination of hairy vetch decreased insignificantly up to concentration of 0.6% NaCl. However, shoot and root growth of hairy vetch showed significant reduction at salinity concentrations higher than 0.1% NaCl level. In these results we were considered that hairy vetch can be use below concentration of 0.1% salinity as green manure crop in reclaimed saline rice production.

Introduction

Hairy vetch (*Vicia villosa* Roth) is playing an important role to improve soil physical properties and soil fertility for the supply of crop nutrients. A hairy vetch cover crop can supply especially nitrogen (Carrera et. al., 2007; Giacomo Tosti et. al., 2012) and also suppress weeds (Enio Campiglia et. al., 2012). Therefore, cover crops are well known for improving soil organic matter, soil structure, water holding capacity, reducing soil erosion, and increasing crop yield (Sainju et al., 2006). This crop is used as a representative legumes green manure for the production of organic agricultural food and grown from October to June as a winter cover crop in the upland and rice paddy fields of South Korea. However, a hairy vetch has not yet been utilized due to high salt accumulation in reclaimed rice production systems. Soil salinity is one of the major abiotic stresses affecting plant growth and crop production. The area of reclaimed saline land amounts to about 9% (135,100ha) of the total area of agricultural land in South Korea. We were conducted to investigate the impacts of the salt-resistance on seed germination and growth of hairy vetch under laboratory condition.

Material and methods

Although seedlings are vulnerable stage in the life cycle of plants, their assessment is very important. This experiment was conducted to investigate the salinity resistance on seed germination and seedling growth of hairy vetch and rice. Seed germination is affected by several environmental stresses such as drought, extreme temperatures, heavy metals and salinity. The trails were tested in a growth chamber controlled with 25 ± 0.5℃ under laboratory condition. Seeds were sown in three replications in 11 cm diameter Petri-dishes lined with two discs of Whatman No.2 filter paper. The seeds were surface sterilized with 2% sodium hypochlorite for 2 minutes then rinsed five times with distilled water. Each replication contained 100 seeds. Germination rate and seedling growth of rice (*Oryza sativa* L.) and hairy vetch in relation to salinity was examined with seawater, natural salts, sodium chloride and reclaimed saline soil. The concentrations of the salinity were from 0.05 to 1.0 percent. The obtained data was evaluated by the Duncan test.

Results

Germination of seeds kept in *in vitro* started within 1~2 days. *In vitro* conditions were found to quicken the process of seed germination. Results demonstrated clear differences in patterns of germination and seedling growth of rice between the different salinity concentrations. All treatment materials showed a decreased lag in germination with increased amounts of salts. Maximum rice seed germination occurred at the concentration of 0.05% salinity. However, no significant differences were detected with other salinity levels. In contrast, salinity appears to play an important role in seedling development. The length of the primary root and the maximum length of shoot of seedlings were significantly reduced with increased salinities.

Germination of hairy vetch was assessed under various salinity concentrations of seawater, natural salts, sodium chloride and reclaimed saline soil: 0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0%. Significant

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decreases in germination percentage were observed above the concentration of 0.6% salinity. Salt tolerance at the seedling stage was analyzed in 10 day old seedlings, grown in petri-dish. The high seedling survival percentage for the trial was observed in the treatment with seawater. Increasing salt concentration was delayed germination. Furthermore, seed germination was inhibited by natural salts and sodium chloride solution to a similar degree to seawater. These results are in agreement with those previously reported by WANG Zhou-fei *et.al*.

Table 1. Comparison of the rice germination rate of rice after 10 days of treatment at different salinity concentration levels

Treatment materials	Concentration of salinity (%)											
	0	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
seawater	85[a]	97[a]	87[a]	87[a]	86[a]	86[a]	85[a]	85[a]	82[a]	78[a]	67[a]	65[a]
natural salts	86[a]	88[a]	84[a]	83[a]	78[a]	78[a]	75[b]	71[b]	76 [a]	54[b]	23[b]	22[b]
sodium chloride	84[a]	84[a]	82[a]	83[a]	82[a]	82[a]	76[b]	48[c]	47[b]	21[c]	3[c]	2[c]
reclaimed soil	56[b]	46[b]	45[b]	41[b]	41[b]	38[b]	37[c]	37[c]	35[bc]	31[c]	31 [b]	31[b]

* significant at P<0.05

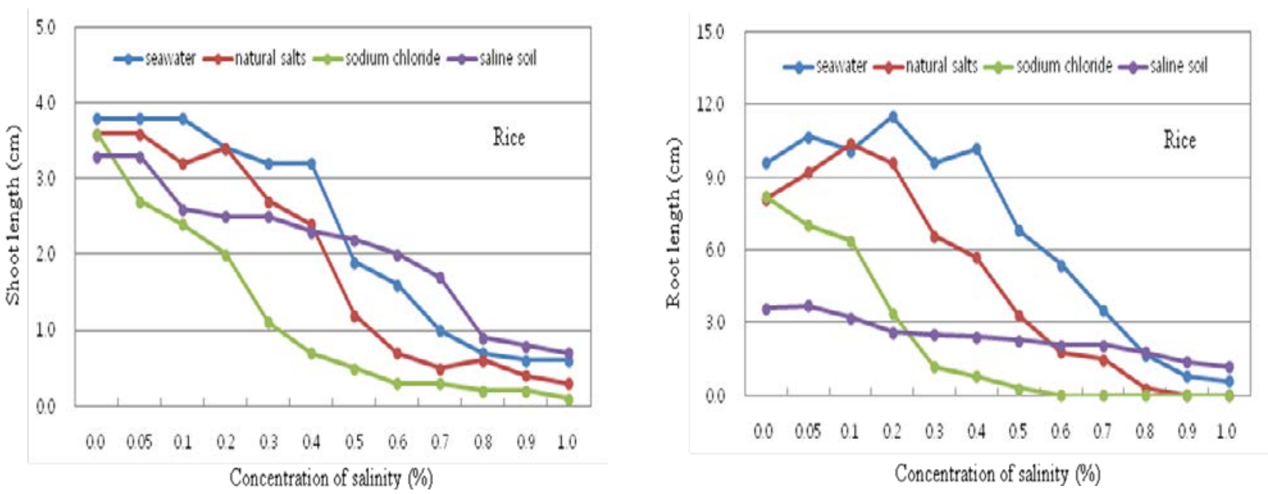

Figure 1. The seedling growth of rice after 10 days of treatment at different salinity concentration levels

Table 2. Comparison of the germination rate of hairy vetch after 7 days of treatment at different salinity concentration levels

Treatment materials	Concentration of salinity (%)											
	0	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
seawater	81[a]	79[a]	74[a]	73[a]	72[a]	71[a]	69[a]	56[a]	47[a]	43[a]	43[a]	43[a]
natural salts	84[a]	78[a]	77[a]	71[a]	70[a]	70[a]	69[a]	68[b]	55[a]	40[a]	18[c]	15[b]
sodium chloride	81[a]	77[a]	73[a]	71[a]	70[a]	65[a]	63[a]	63[b]	48[a]	28[b]	27[b]	12[b]
reclaimed soil	52[b]	29[b]	24[b]	17[b]	16[b]	14[b]	12[b]	10[c]	7[b]	6[c]	3[d]	2[d]

* significant at P<0.05

Seedlings of hairy vetch were tested for their tolerance to combined salinity. Salinity at 0.05% concentration of seawater enhanced seedling growth in this crop. Reductions in seedling establishment showed from 0.3% levels with increases of salinity. Significant negative correlations were identified between salinity treatment materials. Salinity may be one of the possible reasons for decreased seedling growth of hairy vetch plants under saline conditions. We suggested that the negative effects of salinity in this crop were mainly due to Na^+ and/or Cl^- toxicity. Salt-induced inhibition of seed germination could be attributed to osmotic stress or to specific ion toxicity (Bajji et al., 2002; Zhang et al., 2010).

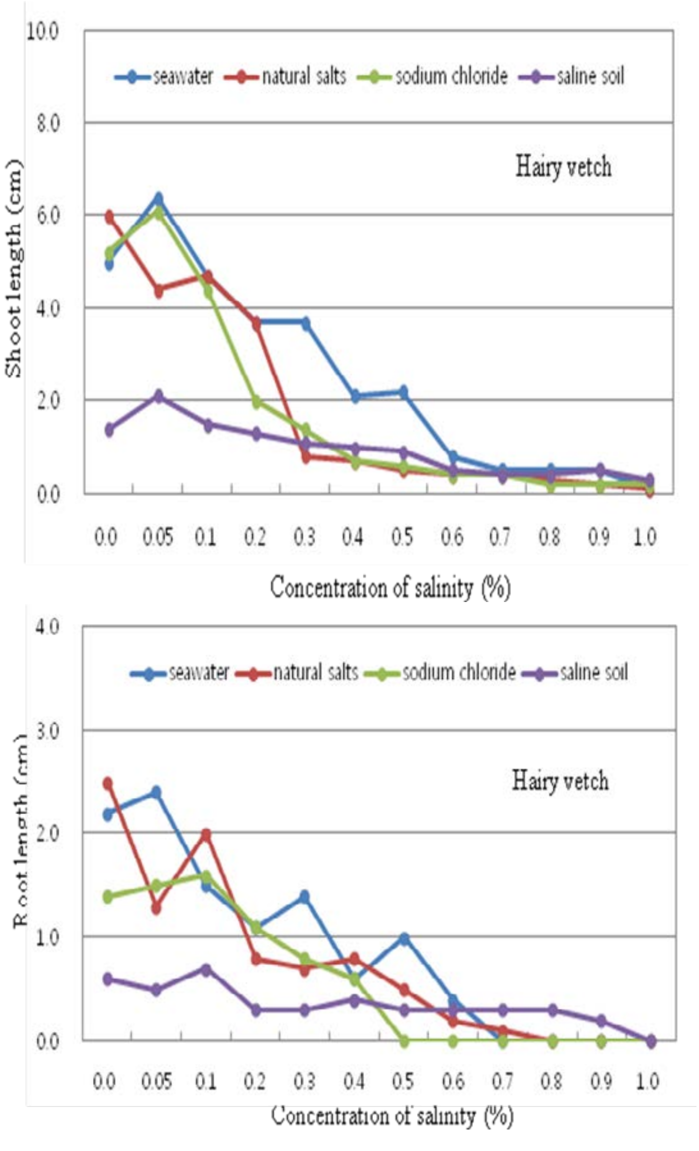

Figure 2. The seedling growth of hairy vetch after 10 days of treatment at different salinity concentration levels

Discussion

Hairy vetch (*Vicia villosa* Roth) is an important cover crop world-wide for weed management and improving nitrogen fertilization. The objective of this research was the evaluation of the response of hairy vetch to conditions of high salinity. Hairy vetch has demonstrated the lower tolerance to salinity variability than rice. The current study suggested that the germination percentage of hairy vetch (*Vicia villosa* Roth) seeds was strongly reduced when 0.6% concentration of salinity was treated. We also observed the differences in salinity resistance to salt sources. Hairy vetch may be able to utilize below the concentration of 0.1% salinity in reclaimed saline land. Therefore, we could be determined the degree of salt resistance in hairy vetch and rice plants. Rice and hairy vetch were decreased in germination rate and seedling growth with increasing salinity.

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Utilization of Organic Farming for *In Situ* Conservation of Biodiversity

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Key words: Organic farming, in situ conservation, Biodiversity, Arthropod

Abstract

Organic farming is potentially useful approach for in situ conservation of biodiversity when the farming technologies are effective and economically sound. Functional rate of arthropod biodiversity as an index of biodiversity quality was assessed according to some organic farming methods, such as landscape management and using companion plants in rice and soybean fields. In this study, it is important to select effective farming technologies for in situ conservation and utilization of functional biodiversity even in organic farm.

Introduction

Conservation of biodiversity is an international norm and issue. Korean government also joined the Convention on Biological Diversity (CBD) and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). FAO Global Plan of Action emphasizes the conservation of biological species as well as *ex situ* and *in situ*, especially on farm (ITPGRFA Secretariat, 2011). However, practical policies and technologies for the conservation on farm have not been developed properly. *In situ* conservation of biodiversity will be available when the landscape management of organic farm is effective and the productivity is economically sound (Altieri and Nicholls, 1999; Fuentes-Quezada, et. al., 2000). We investigated impact of organic farming technologies, especially landscape management and push-pull strategy using companion plants, on arthropod biodiversity in farm land. Thus, more effective organic farming technologies are suggested for *in situ* conservation of arthropod biodiversity in this study.

Material and methods

Impact of the management of paddy field levee on arthropod biodiversity in rice cultivation

Width of rice paddy field levee was compared between 0.6m and 1.0m in order to investigate the impact of the landscape management on arthropod biodiversity in organic rice cultivation. In addition, weeds on the levee were managed differently by various companion plants and treated control. Monitoring of arthropod species and densities of each species were conducted with sweeping method (20 sweeping times per plot) or vacuum pumping ($0.5x0.5m^2$) on each levee plot. Biodiversity of arthropod was assessed by functional groups; natural enemy, pest and neutral insect. Biomasses of total plant on each levee plot and of rice were investigated after harvesting.

Impact of companion plants on arthropod biodiversity in soybean cultivation

Monitoring of arthropod biodiversity was investigated over 2 years among the non-chemicals (fertilizer and pesticides) and minimal input farming (Organic I), the companion planting using marigold near field border line and crop rotation with winter rye (Organic II), and the conventional farming for soybean. Biodiversity index of arthropod was assessed by functional groups such as natural enemy, pest and neutral insect. Each species was monitored and analyzed as potential indicator for biodiversity balance influenced by farming management.

Results

Impact of the management of paddy field levee on arthropod biodiversity in rice cultivation

Increase of levee space was act as biotope or habitat for many arthropod species (Figure 1). Rate of neutral insect species was over 22% higher in the wider levee (1m) than the smaller (0.6m). Thus, rates of insect pest and natural enemy were decreased respectively 17% and 4% according to increasing the width of levee. According to decreased rate of insect pest, damage of rice plant by *Lissorphoptrus oryzophilus*, was significantly low in the wider levee and healthy rice grains were produced more near to the wider levee than the narrow levee (Table 1).

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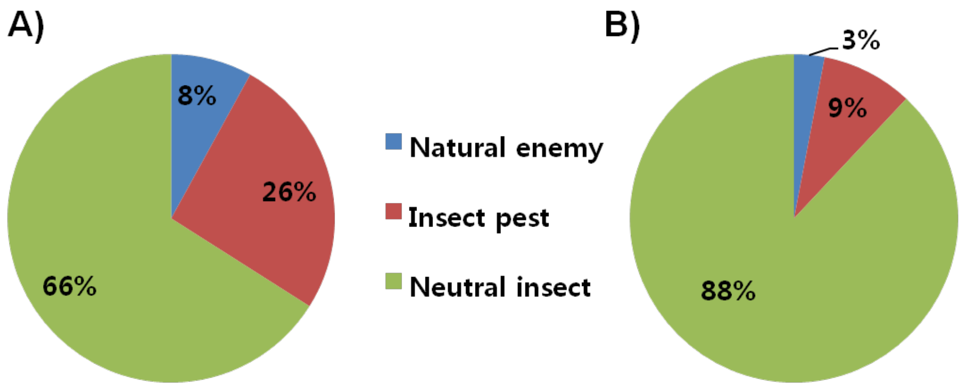

Figure 1. Rate of arthropod species number by functional group (%) between the narrow (A, 0.6m) and the wider (B, 1m) paddy field levee in organic rice cultivation.

Table 1. Damage rate of rice plant (leaves) by insect pests, rate of healthy grains and density of spider according to width of levee in organic rice paddy field*

Width of levee	Damage rate (%) of rice plant by *L. oryzophilus*	Rate (%) of healthy rice grain	Density of spider (N/plant)
0.6m	8.8±5.8a	87.1±0.8b	0.3±0.1b
1m	6.3±3.3b	95.8±0.6a	1.0±0.1a

*$P<0.05$.

Impact of companion plants on arthropod biodiversity in soybean cultivation
Even the non-chemicals (fertilizers and pesticides) and minimal input management is one of the organic farming, it caused arthropod biodiversity decline (Table 2). More active organic practices for nutrient and pest management, such as crop rotation with winter rye and field border management using companion plants, increased arthropod biodiversity. In relation to increased arthropod biodiversity which means the relative decrease of insect pest rate, healthy soybean productivity was increased (Table 3).

Table 2. Total number of arthropod species collected in each soybean farm field investigated

Farming method	Number of arthropod species				
	Class	Order	Family	Genus	Species
Conventional	2	10	102	115	116
Organic I	1	9	43	96	97
Organic II	2	11	108	139	139

Table 3. Yield and infection rate of soybean in each farming*

Farming method	Weight of 100 soybean seeds (g, mean±SE)		Infection rate (%, mean±SE)
	Total	Healthy soybean	
Conventional	32.9±0.2a	28.6±0.2a	14.5±0.7a
Organic I	27.2±0.3b	22.6±0.3c	16.2±0.5a
Organic II	26.5±0.2b	24.1±0.1b	10.4±0.6b

*P<0.05, **Most damages of soybean seeds were caused by 2nd infection from Hemiptera such as *Riptortus clavatus*, *Paraplesius unicolor,* etc.

Discussion

In conclusion, rate of arthropod species by functional group is important as an index of biodiversity quality and it is able to be managed by organic farming methods (Gurr, et. al., 2003) for biodiversity conservation and crop productivity. However, it is needed to select effective farming technologies for *in situ* conservation and utilization of functional biodiversity even in organic farm. In organic rice cultivation system, it is suggested that increase of levee space is an effective method of landscape management for biodiversity conservation and productivity of high quality rice, combined with planting companion plants impacting on the rate of arthropod functional group on the levee. Especially, in this study, *Ocimum basillicum* decreased rate of insect pest and increased rates of natural enemy and neutral insects on the levee of rice paddy field (data omitted). Managements for functional biodiverisity and in situ conservation of biodiversity were synergistic also in organic soybean farm. Crop rotation with winter rye as green manure and field border management using companion plants were effective for increasing arthropod biodiversity and productivity of high quality soybean. Thus, it is important for each organic farming method to be assessed on biodiversity impact.

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A sensitivity analysis of organic versus conventional systems of sheep-farming

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Key words: production function, gross output, sheep.

Abstract

The progressive decline of traditional farming systems of small ruminants in Spain has an interesting alternative in organic production. This communication is involved in a research project that addresses these issues. One of the aims of this project is to analyze the evolution of a group of milk sheep farms consisting of conventional farms and organic farms. The results presented in this paper are a case study of the differences in the production function of the two types of farms. The main result indicates that the rate of change of gross production of organic sheep is 53% greater than the conventional, if all other factors remain constant. This result supports the effectiveness of a more respectful and sustainable production system in rural areas.

Introduction

The decline and practical disappearance of the traditional farming model of the Mediterranean Basin is an outcome of a decrease in its population and of legislation on land use (El Aich et al. 1996). Simultaneously there has been a slow but steady movement towards greater intensification in milk production systems (Chassany et al. 1996). In this situation, organic production constitutes a possibility for sustainable development because it is strongly linked to the environment; it has the potential to keep a population in place with a decent work. This system could offer a solution to those depressed areas that they still maintain traditional systems for small ruminants. The peripheral zones of Castilla y León have the best characteristics for matching the needs of organic production (Palacios 2010). The aim of this paper is to attempt to establish differences between the conventional systems, as opposed to organic farms. Across the analysis of these differences we would obtain conclusions about the level of efficiency of one system as against the other.

Material and methods

A group of researchers from the Universities of Leon and of Salamanca has been analysing the situation of the farms of small ruminants of Castilla y León through the research project: "Impact on the quality of products and the environment of the different systems of livestock with small ruminants of milk production. Use of economic, social and environmental indicators and characterization of systems". This project was financed by the Spanish National Institute for Agricultural Research with the reference code RTA2010-00064-C04. The project made it feasible to monitor a group of seventeen milk sheep for a whole year. The group includes fifteen conventional farms, and two organic farms. The information gathered covered all the data relating to technical and economic management, and other questions like social and environmental features. This procedure was carried out with great thoroughness, so that the information obtained was of extremely high quality. Despite this, we know that the results must be interpreted as a case study because of the limitations from the amount of data available.

In a productive sector, there can be different techniques for production, with specific technical installations, different production processes, differing forms of organization, business management and division of labour. Each situation can be represented functionally by the relationship that links the value of output to the quantities of the production inputs used. These relationships make it possible to investigate aspects connected to economic efficiency. This information may be used to establish feeding and management strategies, even it may be used to determine how one input can be partially replaced by another (Grossman and Koops 1988).

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The variables that we have used to analyse the productive systems are:

- Gross Output (GO): Total output of the farm, obtained by adding all the farm products destined for sale (expressed in euro).
- Worker Units (WU): Number of workers, permanent or hired, employed full time on the farm (expressed in units).
- Surface Area (SA): Total area owned or rented by the farm (expressed in hectares). This variable did not include common pasture because of the difficulty of quantifying individual uses in such land.
- Number of Sheep (SHEEP): Size of the flock. Number of productive sheep (expressed in head of sheep).
- Assets (ASSETS): Value of the buildings and machinery own by the farm, less the accumulated depreciation (expressed in euro).
- F_i: Dummy variable. It takes the value 0 for conventional farms and 1 for organic systems.
- u_i: Random variable.

The model specification is linear and defines the link between production and inputs. The independent term of the model includes an element which gives us the differences between the two systems of production under supervision.

This specification is an approximation to a Cobb-Douglas function (a very interesting overview of the functional forms for the production functions can be found in Griffin 1987). The original variables have been transformed into logarithms, so that the coefficients approximate to the elasticity concept. The estimation was carried out by the Ordinary Least Squares (OLS) method.

Results

The estimated model is:

$$\mathbf{LGO_i = \beta_1 + \beta_2 LWUS_i + \beta_3 LSA_i + \beta_4 LSHEEP_i + \beta_5 LASSETS_i + \beta_6 F_i + u_i}$$

Table 1: Results of Estimation

	Coefficients	Student's t	VIF
β_1 (constant)	3.45	0.90	
β_2 (LWU)	0.47	0.85	4.14
β_3 (LSA)	0.11	0.60	1.76
β_4 (LSHEEP)	0.65	1.03	4.64
β_5 (LASSETS)	0.26	1.68	1.38
β_6 (F)	0.43	0.94	1.43

R^2=0.672229; $F_{(5.11)}$=4.51; F_{RESET}=0.78; JB= 0.14

The small size of the sample implies few degrees of freedom for statistical tests. Because of this reason, the tests reach modest levels of significance. Nonetheless, the results are of great interest from the viewpoint of a case study, as they lead to some interesting conclusions. The signs for the parameters were as expected and to complete the analysis, a collinearity test (Variance Inflation Factor VIF), a specification test (Regression Equation Specification Error Test F_{RESET}) and a test of normality of residuals (Jarque-Bera JB) were performed. The model did not show multicollinearity because the VIF factors are under 10. The F_{RESET} test points out that the model is valid at a 0.05 significance level; and finally, the JB test indicates that residuals follow a normal distribution. As we can see in the figure 1 the degree of fit of the model is very high.

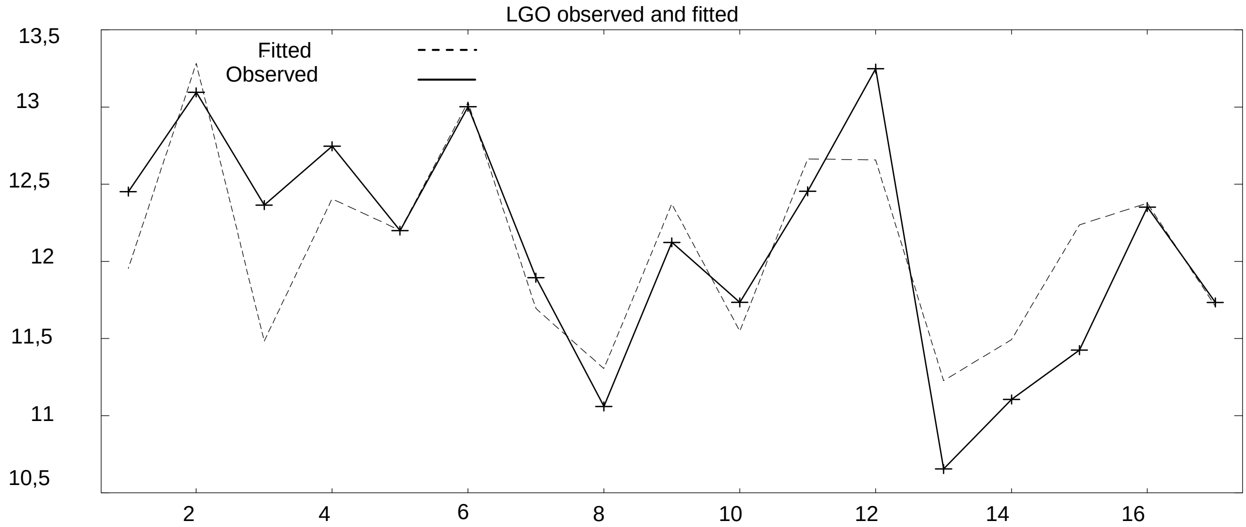

Figure 1. Fit of model

The parameters β_2 (WU) and β_4 (SHEEP) have the greatest influence on GO. As we worked with elasticity, an increase of 1% in one of these variables, ceteris paribus, implies a rise of β_i% in the GO of the farm. For example, an increase of 1% in WU means a growth of 0.47% in GO and an increase of 1% in the SHEEP means a rise of 0.65% in GO.

The interpretation of the dummy variable coefficient (β_6) (Table 1) in a model with logarithms is the percentage variation of the variable GO between organic and conventional farms when they have the same input combination (Uriel, 2013). It is calculated as: 100 x ($e^{0.43}$-1) = 53%. This percentage shows that the organic system has a 53% more GO than a conventional one.

Discussion

Over the last thirty years, the transhumance systems have suffered a progressive decline (Manrique et al. 1996) and processes of intensified production replaced the traditional farm management of small ruminants. Intensification has caused environmental degradation and depopulation. In this scenario, organic production becomes an interesting alternative. This type of production might be sufficiently viable; it can offer an alternative that would contribute to retain population, to generate business activity, to attract tourism and to guarantee jobs. At the present time, there is a growth in certified farming products in Spain. Since 2008, Spain has been the European Union country with the greatest totals of certified land and of certified farmers (Palacios et al 2008). The previous results let increase the viable possibilities for the organic farms and they allow guaranteeing the future for the sector.

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Quality of live and quality of work life in organic versus conventional farmers

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Key words: organic farmers, conventional farmers, quality of live, quality of work life

Abstract

Quality of life (QOL) and quality of work life (QOWL) play a key role in the overall concept of sustainability. In this paper we analyze QOL and QOWL variables in relation to the type of livestock farm (organic/conventional) and the use of some quality label (PDO Protected Designation of Origin, PGI Protected Geographical Indication).

Data were collected through regular visits in 2011 to 70 small ruminant farms in Spain using five-point Likert items with 1-5 range. Of all the 70 farms, 6 are organics, 39 have a quality label and 17 use traditional manufacturing methods.

The possession of quality labels in the small ruminant farms analyzed seems not to be related with the quality of life and work. Farmers with traditional production show higher valuation of quality of life but not of quality of work. Organic farms provide quality of life and quality of work significantly better than conventional ones.

Introduction

There is not a rigid and unique definition of sustainability concept and when it must be applied in practice some remarkable difficulties appear.

The study of sustainability of livestock farms can be approached from an economic or environmental point of view. A third element was added later: social sustainability. Sustainability was initially represented by three overlapping circles. Earlier on, Elkington (1999) provided the triple bottom line sustainability considering that it is not possible to fix a desired level of ecological, social and economic sustainability without taking into account the relationships. Quality of life (QOL) and quality of work life (QOWL) play a key role in this overall concept of sustainability.

In this paper we analyze QOL and QOWL variables in relation to the type of livestock farm (organic/conventional) and the use of some quality label (PDO Protected Designation of Origin, PGI Protected Geographical Indication).

Material and methods

Data were collected through regular visits in 2011 to 70 small ruminant farms in Spain within the research project "Effects on the quality of the products and the environment of the different systems of small ruminant farms with dairy type. Employment of economic, social and environmental indicators and final classification systems (RTA2010-00064-C04)" funded by the Spanish National Institute for Agricultural and Food Research and Technology (INIA) involving four research groups from the País Vasco, Navarra, Andalucía and Castilla y León.

QOL and QOWL were collected using five-point Likert items with 1-5 range. Of all the 70 farms, 6 are organics, 39 have a quality label and 17 use traditional manufacturing methods.

A first normality analysis using Kolmogorov-Smirnov test shows than the null hypotheses are not rejected for QOL (p-value 0.315) and QOWL (p-value 0.310), but both are rejected using the less conservative test of

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Lilliefors (0.016 and 0.015 p-value respectively). Therefore, we preferred to use the nonparametric independent samples Mann-Whitney U test (Mann and Whitney, 1947).

Results

The group of farmers value their QOL (3.63) and QOWL (3.59) slightly above the average of 3 into the 1-5 Likert scale (Table 1).

No significant differences were found when farmers have quality labels (3.72 for QOL and 3.51 for QOWL).

Farmers performing traditional production have higher QOL (4.06) but not a higher QOWL (3.82).

There were statistically significant differences in the QOL and the QOWL analyzing conventional versus organic farms.

The assessment of quality of life in organic farms is 4.67 versus 3.53 in conventional farms. The same is found for quality of work (4.50 in organic versus 3.50 in conventional).

Table 1: Quality of life and quality of work life in different kinds of farms

Likert 1-5 points Quality of	Organic		Quality indications		Traditional production		Average
	Yes	No	Yes	No	Yes	No	
life (QOL)	4.67**	3.53**	3.72	3.52	4.06*	3.49*	3.63
work life (QOWL)	4.50*	3.50*	3.51	3.68	3.82	3.51	3.59

* significant differences Mann-Whitney U test at P<0.05 and ** significant at P<0.01

Among the three kinds of farms analyzed, higher values of QOL (4.67) and QOWL (4.50) were found on organic farms, almost one point above the overall average (Figure 1).

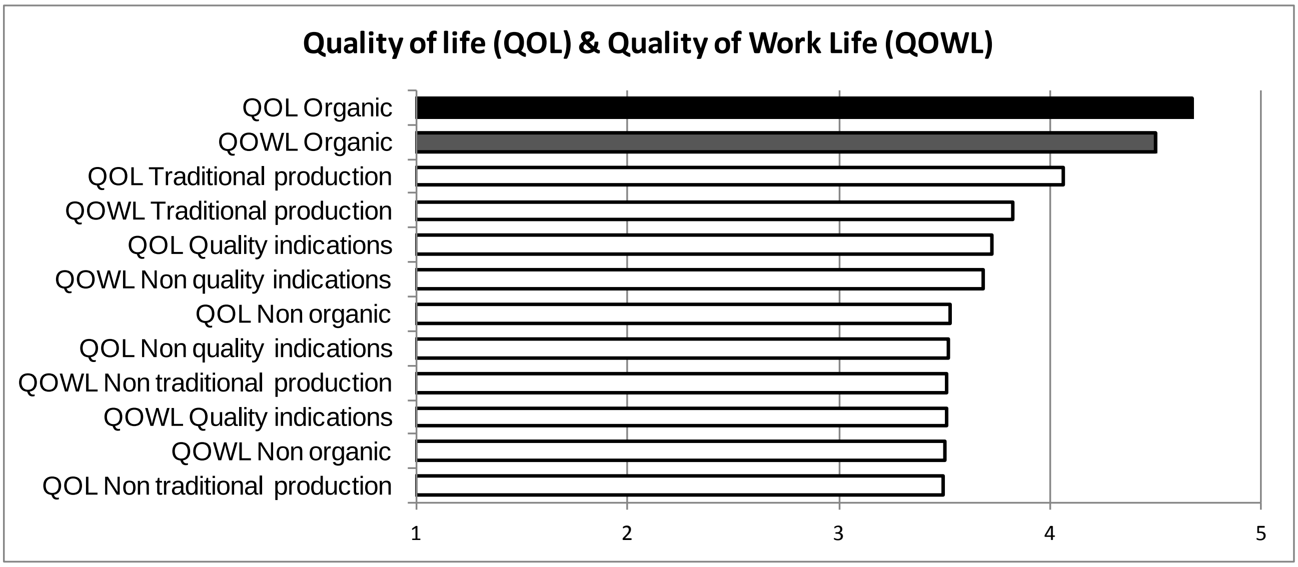

Figure 1. Quality of life and quality of work life in different kinds of farms

Discussion

The study of sustainability of farms or livestock from an economic point of view has traditionally been linked to short-term analysis, seeking to obtain enough income.

The environmental sustainability has been more related to the expected impacts of decision-making in the medium and long-term (Park and Seaton 1996), such as the destruction of non-renewable resources, pollution and the use of fertilizers and chemical products.

Smith and Sharicz (2011) point out that a lack of a precise definition of sustainability will lead us to "not having clear guidelines on how to adopt or implement sustainability" in the triple bottom line concept (economic, environmental and social). At this moment, the economic bottom line remains as the first corporate decision making (Steger et al. 2007). Fresh and Kroonenburg (1992) speaking about the land merged these two approaches: "...in order to be sustainable, land use must display a dynamic response to changing ecological and socio-economic conditions... to ensure that over time no net quantitative or qualitative loss of natural resources occurs".

Quality of life and quality of work life are very important indicators of long-term sustainability. They gather economic, social and environmental aspects but also subjective perceptions and styles of life for helping understand the different strategies of conventional and organic farmers.

The possession of quality labels in the small ruminant farms analyzed in Spain seems not to be related with the quality of life and work.

Farmers with traditional production show higher valuation of quality of life but not of quality of work.

Organic farms provide quality of life and quality of work significantly better than conventional ones.

The results of the study lead us to think that when a farmer decides to manage an organic farm he take into account not only economic, social and environmental factors, but also a different life style searching to obtain greater job satisfaction and a better quality of live.

Suggestions to tackle with the future challenges of organic animal husbandry

Studies on sustainability in livestock management should consider economic, environmental and social aspects, but their interpretation must be related to the different kinds of farmers.

Organic farms show better sustainability than conventional ones. Organic farmers point out higher quality of work and higher quality of life.

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Short-term effects of different techniques to prepare an organic citrus soil for replanting on its microbiological and biochemical properties

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Key words: citrus, vegetal cover, Phytophtora, solarization, biofumigation, soil enzymes

Abstract

Conversion is a critical period for organic cropping since soil must reach optimal levels of fertility, structure, and biological activity to work properly under organic management. In this work, different management techniques to raise levels of organic matter, to disinfect or to increase soil suppressivity in soil are being evaluated in a replanted organic citrus orchard. These techniques are solarization, use of composted manure (alone or combined with solarization) and incorporation of a disinfectant vegetal cover. Results warn of negative effects of solarization on soil organic matter and biological and enzymatical activity, together with changes in microbial populations mainly because of the temperature increase. Given that the experiment is still ongoing, the duration and final extent of these changes are still being investigated, although it has been seen already that the effects on living organisms are faster to recover than those affecting the organic matrix of soil.

Introduction

Adopting measures to increment soil levels of organic matter and biological activity is key when an agrosystem is to be converted to organic management. Nutrient reserves are increased and more easily mobilized, and soil suppressivity is enhanced. This last aspect is particularly relevant in replantations given that chemical disinfection treatments cannot be used and plantlets are very sensitive.

It is well known that levels of soil organic matter and biological activity are highly correlated, and that soil suppressivity derives from biological mechanisms: ecological competition, release of biocides, and resistance induction in plants. Organic matter is also used directly for disinfection by taking advantage of the volatile compounds released during its degradation, such as ammonia from N-rich residues or isothiocyanates from glucosinolate-rich plants such as brassicaceae. All 'biofumigation' treatments rely on these mechanisms, although relevance of ammonia is limited by the strict limits on N applications in organic farming management. Aiming for higher effectiveness, they are often combined with solarization, although the effects of the heat and derived changes on the biological condition of soil are not fully investigated. A field trial is therefore being carried out to study the effects on soil biochemical and microbiological properties of different techniques to prepare the soil for replanting in a citrus orchard in convertion to organic management. This work discusses the results obtained six months after the application of all treatments was finished.

Material and methods

The field trial is set in a 1.2 ha orchard within an old farm sited at Gandía (Valencia), wherein citrus have been cultivated for more than a century and many *Phytophtora* attacks have been recorded in the last decades of intensive management. Before replanting and converting the orchard to organic management, different techniques to fight against soil-borne pathogens based on disinfection and/or enhancement of soil microbial activity and diversity are being tested:

- untreated control (C).
- solarization (S)
- biodisinfectant vegetal cover (VC): mixture of *Sinapis alba* (at a seed rate of 16.5 kg/ha) and *Brassica carinata*, *B. rapa* and *B. juncea* (at a seed rate of 25 kg/ha). Seed rates were much higher than usual because the experiment schedule imposed a very late seeding and short time to grow before being cut and incorporated to soil.

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- organic amendment (OA): ovine manure at the rate of 16 t/ha (fresh weight)
- solarization + organic amendment (S+OA)

All treatments are evaluated in triplicated experimental subplots, each consisting of eight 1-year old orange trees (*Citrus sinensis* var. *Salustiana*) grafted on Citrange Carrizo rootstock (*C. sinensis* x *Poncius trifoliata*), planted at 6x4 m. Water and nutritional demands of the plantation are being satisfied homogeneously for all trees by means of a fertirrigation system; all fertilizers are certified for use in organic production. For solarization, recently-irrigated soil was covered with 300-gauge transparent polyethylene film and immediately sealed. Soil temperatures reached during the process were monitorized by iButton electronic probes introduced at 15 cm (average sampling depth) just before laying the plastic covers; the data obtained certified successful temperature increases during solarization. All the treatments were finished in early autumn, and a first soil sampling was made; results are discussed in Albiach et al (2013). The following spring 16 subsamples were taken at 0-30 cm depth in each subplot, in both sides of the position the trees would occupy after plantation. All subsamples were carefully mixed into a composite sample per subplot, which was then prepared for biochemical and microbiological analysis. The soil biochemistry parameters studied are: microbial biomass carbon (Vance et al, 1987), alkalyne phosphomonoesterase activity (Tabatabai and Bremner, 1969), phosphodiesterase activity (Browman and Tabatabai, 1978), urease activity (Tabatabai and Bremner, 1972), arylsulphatase activity (Tabatabai and Bremner, 1970), β-D-glucosidase activity (Tabatabai, 1982), N-acetyl-β-D-glucosaminidase (chitinase) activity (Parham and Deng, 2000) and dehydrogenase activity (Casida et al, 1964). The main microbial components in soil determined are: bacteria (YPG agar with cycloheximide, 25ºC, 2 days), fungi (malt agar with antibiotics, 25ºC, 2 days), actinomycetes (Vargas et al, 2009), *Bacillus* sp. (Yi et al., 2012), fluorescent pseudomonas (Simon and Ridge, 1974), denitrifying and nitrifying bacteria (Roux-Michollet et al, 2008), and ammonium oxidation potential (Elsgaard et al, 2001).

Results and Discussion

The effects of the treatments on the soil biochemical parameters (Table 1) were consistent with those found in the first sampling (Albiach et al, 2013), showing a clear, although not always statistically significant, depressive effect of solarization on all parameters but chitinase.

This negative effect is very relevant because it shows that not only living organisms but also the activity of organic components stabilized within the soil organic matrix have been affected, not only by the heat but also by the increased degradation caused by the increment in temperature and moisture at the initial stages of the solarization. Enzyme activity may be very important in soils under organic cropping and its depression may be slower o more difficult to recover from, as the small differences between results obtained after the treatments and six months later show.

Table 1: Effect of the treatments on soil biochemical parameters

Treat	MB	DHA	PA	β -GA	PDA	CHA	UA	ASA
S	151	1,15 a	1,26 a	0,426	0,459 ab	0,105	0,0522 a	0,113 a
CV	311	2,00 b	1,67 b	0,497	0,586 c	0,0955	0,114 b	0,222 b
EO	272	2,24 b	1,64 b	0,613	0,574 bc	0,106	0,122 b	0,229 b
S+EO	112	1,05 a	1,14 a	0,388	0,404 a	0,0965	0,0546 a	0,100 a
C	277	2,11 b	1,75 b	0,651	0,593 c	0,108	0,125 b	0,249 b

MB: microbial biomass (μg C/g), DHA: dehydrogenase activity (μg TPF/g · h), PA: Phosphomonoesterase activity (μmol PNF/g . h), β –GA: β-glucosidase activity (μmol PNF/g . h), PDA: phosphodiesterase activity (μmol PNF/g . h), CHA: chitinase activity (μmol PNF/g . h), UA: urease activity (μmol N-NH4/g . h), ASA: arylsulphatase activity (μmol PNF/g . h). Values followed by the same letter are not significantly different at the 0.05 probability level according to the LSD test. Absence of letters indicates no significant effects.

Regarding the effects on the microbial populations studied in soil (Table 2), the statistical significance of the results was negatively affected by the usually high variability of biological parameters in agricultural soils.

Nevertheless, the changes found immediately after the treatment application (Albiach et al, 2013) have disappeared, suggesting a faster recovery of populations from disturbance, and showing how soil enzymes may be very useful as indicators of changes in soil quality after different management alternatives, since they are more sensitive than modifications in organic matter content but less variable and volatile than purely microbiological parameters.

Table 2. Effect of the treatments on soil microbial populations

Treat	Bacteria (UFC/g)	Fungi (UFC/g)	AM (UFC/g)	FP (UFC/g)	*Bacillus* sp (UFC/g)	AOB (MPN/g)	NOB (MPN/g)
S	$5{,}11 \cdot 10^6$	$1{,}24 \cdot 10^5$	$1{,}42 \cdot 10^6$	$1{,}63 \cdot 10^3$	$1{,}32 \cdot 10^6$ a	$3{,}56 \cdot 10^4$	$4{,}67 \cdot 10^3$
CV	$8{,}00 \cdot 10^6$	$7{,}59 \cdot 10^4$	$1{,}69 \cdot 10^6$	$6{,}54 \cdot 10^2$	$3{,}47 \cdot 10^4$ b	$4{,}05 \cdot 10^4$	$3{,}28 \cdot 10^3$
EO	$5{,}47 \cdot 10^6$	$1{,}06 \cdot 10^5$	$1{,}93 \cdot 10^6$	$1{,}23 \cdot 10^3$	$5{,}97 \cdot 10^4$ b	$3{,}43 \cdot 10^4$	$1{,}33 \cdot 10^4$
S+EO	$5{,}85 \cdot 10^6$	$7{,}67 \cdot 10^4$	$2{,}33 \cdot 10^6$	$8{,}52 \cdot 10^2$	$1{,}65 \cdot 10^6$ a	$7{,}55 \cdot 10^4$	$2{,}20 \cdot 10^3$
C	$5{,}77 \cdot 10^6$	$1{,}39 \cdot 10^5$	$2{,}07 \cdot 10^6$	$1{,}90 \cdot 10^3$	$3{,}20 \cdot 10^4$ b	$3{,}52 \cdot 10^4$	$1{,}23 \cdot 10^4$

AM: actinomycetes, FP: fluorescent pseudomonas, AOB: ammonia-oxidizing bacteria, NOB: nitrite-oxiding bacteria. Values followed by the same letter are not significantly different at the 0.05 probability level according to the LSD test. Absence of letters indicates no significant effects.

Conclusions

Given that soil plays such a central role in organic cropping, every management technique should be checked as for its effects on soil quality. Solarization has been shown to be successful in the fight against soil pathogens, mainly nematodes, but our results suggest that there may be potentially long-lasting negative effects that should be taken into account. Soil organic matter and biological activity are extremely important for soil resilience, nutrient cycling and pathogen suppression, so any negative impact on them is expected to be harmful and should be avoided, especiallly during the conversion period, when their levels are the lowest. Techniques based on active vegetal covers and application or organic amendments are therefore preferable to increase organic matter and biological activity and diversity to build up fertility and resistance to pathogen in new organic farms.

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Weed flora in a long-term reduced tillage trial, "Tilman-org session"

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Key words: perennial and grass species, crop rotation, weed community composition weed species richness

Abstract

Reduced tillage techniques are widely applied, but mainly under herbicide based cropping systems. The potential increase of weed infestation due to the non-inversion of the soil is one of the main obstacles for their adoption among organic farmers. This study analyses the weed abundance and community composition of a nine-year old experiment under conventional and reduced tillage in organic farming. The experiment was settled in Frick (Switzerland) in 2002 and the crop rotation consisted of winter wheat, sunflower, spelt, 2 years of grass-clover, silage maize, winter wheat, sunflower and spelt. The results did not show huge differences in weed infestation between both tillage systems, although they were higher under reduced tillage, mainly in crops sowed in high-spacing rows, such as the sunflower. However, an increase of the perennial species was observed in all the crops over the years under reduced tillage.

Introduction

Reduced tillage may improve the environmental and economic performance of organic farming. Reducing the intensity of soil tillage decreases the energy consumption and the emission of CO_2, and could increase carbon sequestration (Holland 2004). It also may improve water retention and reduce soil erosion (Berner et al. 2008). One drawback of the reduced tillage practices is the potential increase of weed infestation and changes in species composition, sometimes benefiting those species which are more difficult to control, such as perennials and grasses (Peigné et al. 2007, Sans et al. 2011). Organic farmers commonly control weeds by ploughing and by post-emergence mechanical methods, and by an appropriate crop rotation including e.g. grass-clover. Thus, weed management under reduced tillage is more challenging in organics systems. In this study, we present the results on weed abundance and community composition in a 9-year old long-term trial under conventional and reduced tillage.

Material and methods

Site and experimental design

In autumn 2002 a field experiment was settled in Frick (Switzerland). The field was managed organically since 1995. The mean annual temperature and precipitation are 8.9°C and 1000 mm, respectively. On average, the mineral fraction consists of 22 % sand, 33 % silt and 45 % clay. The experiment involved 3 factors: tillage (conventional vs reduced), fertilisation (slurry vs manure compost with reduced quantity of slurry) and biodynamic preparations (with vs without). The three factors and four replicates were arranged in a strip-split-plot design, with tillage as a main factor (in total, thirty-two 12 m × 12 m plots). Conventional tillage used a mouldboard plough operating at 15 cm depth. In the reduced tillage system, a chisel plough with wide sweeps or a stubble cleaner ("Stoppelhobel", German) was used, operating at 5 cm depth, and occasionally (3 times in nine years) a chisel was applied at 15 cm depth. Seedbed preparation was performed by a rotary harrow in both tillage systems. Fertilisation was applied at a level of 1.4 livestock units ha^{-1} in both fertilisation treatments. A detailed description of the experiment is given by Berner et al. (2008).

The crop rotation consisted of winter wheat (*Triticum aestivum* L. cv 'Titlis', 2003), an oat-clover intercrop (*Trifolium alexandrinum* L. and *Avena sativa* L., 2003/2004), sunflower (*Helianthemus annuus* L, cv 'Sanluca', 2004), spelt (*Triticum spelta* L. cv 'Ostro', 2005), a 2-year grass-clover ley (mixture of *Trifolium campestre* L., *T. repens* L., *Dactylis glomerata* L., *Festuca pratensis* Huds., *Phleum pratense* L., *Lolium perenne* L., 2006 and 2007), silage maize (*Zea mays* L. cv 'Amadeo', 2008), winter wheat (*T. aestivum* L. cv 'Titlis', 2009), sunflower (*H. anuus* L, cv 'Sanluca', 2010), spelt (*T. spelta* L. cv 'Ostro', 2011) and two years of grass-clover ley (2012 and 2013). Weeds were controlled mechanically by a tractor-driven flex-tine-

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weeder in cereals and by a rolling cultivator and also by hand within the sunflower and maize rows according local practice.

Data collection and statistical analyses

The percentage of cover of each species was estimated visually (1 % - 100 %) per each wheat, sunflower, spelt and maize crop within the inner 8 m × 8 m of each plot before harvest. The percentage of cover was assigned as the leaf surface projected vertically on the ground, and as integrated over all the weeds and the crop, reaching a maximum of 100 %. Data on maize was not analysed in this study because only one-year data was available.

For each crop, the effect of the tillage treatment, the year and their interaction on the total weed cover, and on the percentage of cover of perennial and grass species were analysed through mixed-effect models. Tillage and plot were introduced as random factors. Data were transformed when necessary to meet the normality and homoscedasticity requirements of the residuals. Previous statistical analysis revealed no significant differences and interactions related to biodynamic preparations and fertilisation treatments. Therefore, the results will neither be shown nor discussed. The data of these two treatments were consequently pooled. The analyses were performed in R 2.7.1 (R Development Core Team 2008), with the lme4 package (Bates et al 2008) for mixed models and language to evaluate the *P* values.

We also performed a multivariate analysis of variance using distance matrices to analyse the effect of the tillage system and the crop on weed composition. The Bray-Curtis distance was applied. Species occurring just once were removed. The significance of the explanatory variable was obtained from F-test based on sequential sums of squares from permutation of the raw data. The permutations were restricted within each plot to incorporate the hierarchical sampling. The analyses were performed in R 2.7.1 (R Development Core Team 2008), using the vegan package for R (Oksanen et al. 2009).

Results

Overall, the mean percentage of weed cover was 16.4 %, being the sunflower crop more infested than the wheat and spelt crops. The perennial species had an average cover of 6.9 %, whereas the cover of the grasses was almost negligible. In general, weed cover was higher under reduced tillage. However, the results did not show a tendency of increase of the weed infestation over the years under reduced tillage, and for the wheat crop no significant differences were observed between both systems in the two years included in the rotation.

Conversely, the cover of the perennial weeds was higher under reduced tillage in all the crops and it was always higher in the second year of each crop type in the rotation, which means an increased infestation over the years in the reduced tillage system, but not under conventional tillage. We did not observe significant differences between tillage systems or a clear trend over the years in the cover of grass species, which was probably related to the very low cover of these species in the field trial.

Weed species richness was not affected by the tillage system, except in the sunflower crop, where a significant lower value was observed under conventional tillage in 2010. However, the analysis of the weed community composition revealed significant differences between tillage systems, between crops and their interaction.

Discussion

Overall, our results showed that reduced tillage was a feasible system in terms of weed management after nine years of tillage system comparison, since not huge differences were observed in the weed infestation. However, especial attention must be paid to perennial species, which were more abundant and increased over the years under reduced tillage, potentially decreasing the performance of this tillage system at the long-term in term of yields. The results also highlighted the importance of the crop selection in the rotation, and of paying especial attention to that sowed in high-spacing rows, such as the sunflower.

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Short-term effects of crop husbandry on the weed community of a cereal-legume rotation, "TILMAN-ORG session"

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Key words: green manures, reduced tillage, weed density

Abstract

The aim of this experiment was to study the effects of two techniques from conservation agriculture, reduced tillage (RT) and green manure (GM) plus fertilization, on weed density and diversity and on community composition in the context of an organic Mediterranean system with a cereal-legume crop rotation. The experiment was carried out in an experimental field near Barcelona (Spain). From 2011 to 2013, weed density per species was evaluated under each crop (spelt, green manure and chickpeas). The seedbank was characterized before the rotation started. Our results showed that total weed density increased under RT, except in chickpea, where tillage had no effect. Also, weed density decreased dramatically while GM was standing, but no carry-over effects could be observed on the next crop, chickpea. GM also prevents the expression of the seedbank, as the effects of previous year tillage and seedbank could only be observed where GM was absent. As for community composition, GM seems to prevent the dominance of few species.

Introduction

The fate of weed seeds and their chances of germination are crucial for weed infestation. Thus, tillage systems which invert soil layers can be used to manage weeds. However, this intensive tillage can cause severe soil losses and alteration. Reduced tillage (RT) is an alternative, but it can increase weed density, and thus other techniques to manage weeds are needed. Green manures (GM) or cover crops can reduce the growth of weeds between main crops. In addition, these intercrops can avoid soil loss and improve soil fertility, although fertilization can seldom be avoided, since GM do not provide all necessary nutrients. RT and GM are two of the main techniques of conservation agriculture. There is little information on conservation agriculture for organic systems, and even less on the combined use of these techniques in Mediterranean agricultural systems. Our purpose is to study the effects of RT (chisel versus mouldboard plough), and of GM, plus fertilization and their interactions, on the weeds, in terms of density and of community composition, in a Mediterranean cereal-legume crop rotation.

Material and methods

A mid-term field experiment was set up in 2011 to test an organic farming system adapted to the Mediterranean conditions using techniques from conservation agriculture. It was set up in Gallecs, an agricultural area 15 km to the north of Barcelona, Spain, which is currently undergoing a conversion to organic agricultural management. The selected field had already been under organic management, with typical dryland Mediterranean crop rotation, alternating cereal and legume. The last crop before the experiment started was *Vicia ervilia*. Thirty two plots, grouped in four blocks, were set up. All plots were 13 m × 12 m, but only the central 9 m × 8 m area was sampled in order to avoid edge effects. Each block comprised the full combination of three treatments: tillage, with mouldboard or chisel ploughing; fertilization, with or without application of manure; and with or without sowing a green manure during winter months).

To study the initial weed seedbank, we collected soil samples in November 2011. Inside each plot we extracted 48 cores, 2.5 cm of diameter × 20 cm deep, regularly distributed. The samples were mixed and spread on labelled trays, kept in a non-heated greenhouse and irrigated daily with sprinklers. The trays were checked periodically to identify and count weed seedlings.

From 2011 to 2013 there have been three crops: spelt (December 2011 - July 2012); green manure (only half of the plots), consisting of a mixture of white oat, mustard, vetch and common vetch (October 2012 - March 2013); and chickpeas (April 2013 - July 2013). Field emergence of weeds was evaluated in April 2012 and February and May 2013. Weed seedlings were identified and counted in 12 randomly distributed samples, measuring 25 cm × 25 cm, on each plot.

The effects of the treatments on the weed community were tested by means of Generalized Linear Mixed Models with Poisson error distribution. Since the application of the treatments (tillage, green manure and fertilization) does not occur simultaneously, some effects are better described as direct effects (tillage and

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fertilization on the succeeding crop; green manure while it is standing on the field) or carry over effects (tillage and fertilization from the first year onto the green manure phase; the green manure on the subsequent chickpea crop). The information from the seedbank and from 2012 densities was used as covariates for weed density analysis to correct for the effects of the pre-existing weed distribution. In order to test the effects of the applied factors on the weed community, the data on specific weed abundances was analysed by means of a Permutational Multivariate Analysis of Variance using a distance matrix based on the Jaccard index.

Results

In April 2012, total weed density responded negatively to mouldboard plough (Z=-3.43, p<0.01, figure 1), but not to fertilization. Tillage also had a significant effect on the composition of the weed community (pseudo-F=2.74, p<0.05).

Weed density during the green manure phase, was very low. There was a significant negative effect on total weed density from the standing green manure (Z=-8.86, p<0.01) and a carry-over effect from plough applied in 2011 (Z=-2.29, p<0.05). A significant interaction between these factors was detected. Density was significantly higher under chisel than under plough (Z=-2.57, p<0.05), but only in the plots without green manure. In addition, we observed that the effect of previous year weed density was significant only in plots without green manure.

The most abundant species also responded negatively to the presence of green manure. The effects of tillage and fertilization applied in 2011 varied among species. Plough had a positive effect on *Diplotaxis erucoides* and fertilization had opposite effects on *D. erucoides* and *Kickxia spuria*.

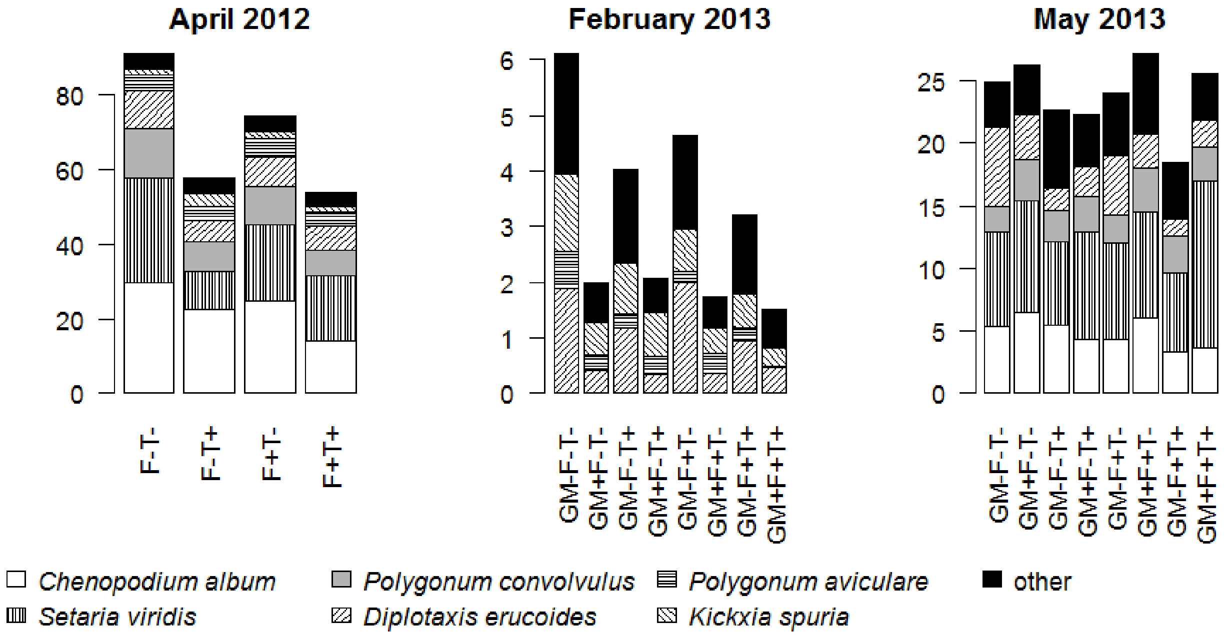

Figure 1. Weed species density (in individuals/m2) in each of the treatments and sampling periods. "Other" summarizes the species with less than 100 individuals across all samples. T: tillage (+ mouldboard, - chisel), F: fertilization (+ with manure, - without manure), GM: green manure (+ with green manure during winter, - without green manure).

Changes in the relative abundances of weeds caused strong differences in the community composition between plots with and without green manure (pseudo-F=8.02, p-value<0.01), although species composition was quite similar.

During the chickpea phase, total weed density was only affected by 2012 densities (Z=5.18, p<0.001), showing a null carry-over effect of the control provided by green manure. For most species, only densities from 2012 were relevant to explain density in 2013. There were some exceptions, however. *Setaria viridis*, *Polygonum convolvulus* and *Kickxia spuria* showed a positive effect of plough. *P. convolvulus* and *Convolvulus arvensis* showed a significant effect of green manure, which had a positive effect on the former and a negative effect on the other one. Finally *P. convolvulus* and *S. viridis* responded positively to the application of fertilizer. In other species none of the fixed effects or covariates was significant. Composition analysis in May did not show any effect from treatments.

Discussion

Our results support that plough is an effective method to manage weeds, as its effects are prolonged in time, causing a reduction in weed density up to two years from its application. On the other hand, green manures standing a few months are very effective while growing, but do not seem to provide control afterwards. This is especially true if the following crop leaves much soil uncovered, allowing the development of weeds independently of the applied treatments (Dorado et al., 2006, Mirsky et al., 2010). Green manures also prevent the expression of the weed seedbank, thus, effects from previous tillage can only be observed where green manure is absent. In addition, green manures avoid the dominance of few species by changing the pattern of expression of the seedbank.

The effects of treatments are variable among species. Disturbance related species, such as *Diplotaxis erucoides*, may respond positively to intensive tillage, and fertilization seemed to favour the earliest germinating ones. Green manure had a greater negative effect on perennial species, such as *Convolvulus arvensis*, that may have used up the resources from rizomes to compete against green manures, thus being unable to resprout after tillage. Our results suggest that it may be completely necessary to adjust the crop husbandry, combining tillage, fertilization and green manures, to have better management options to specific weed problems.

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Effect of conservation practices on functional diversity and assembly of weed communities: a database of functional traits

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Key words: organic arable cropping systems, reduced tillage, cover crops.

Abstract

This work shows the approach used for the construction of a database of weed functional attributes aiming to study the effect of conservation practices in organic arable cropping systems, taking into account both the potential detrimental effects of weeds on crop yield and their ecological services. The database of functional traits includes ca. 250 weed species recorded in 13 on-going European trials, including long, mid and short-term experiments, with reduced tillage and green manures as main factors. The information of the database should help to understand the role of conservation practices in shaping functional attributes of weed communities and to predict the management-induced changes.

Introduction

The incorporation of conservation agriculture techniques (e.g. reduced tillage and green manures) in organic farming brings many benefits to the environment and reduces energy use. One of the main drawbacks of the use of reduced tillage is the potential increase in weed infestation and shifts in the weed community composition, sometimes to the benefit of more difficult-to-control species (Sans et al. 2011). However, weeds have an important role in maintaining farmland functional biodiversity (Bàrberi et al. 2010). In 2012 we started a study with the aim of evaluating the effects of conservation agricultural methods on functional attributes of weed communities, taking into account the potential detrimental and beneficial effects of weeds. Knowledge on the outcome of positive and negative effects will be useful in the context of evaluating soil conservation practices. In this paper we highlight the approach used to build the weed functional traits database, the first step in this study.

Material and methods

The study uses the information on the weed flora of 13 existing trials within the framework of the European project TILMAN-ORG, including 5 long-term trials (> 7 years), 4 mid-term trials (3 to 7 years) and 4 short-term trials (< 3 years) with reduced tillage and green manure as main factors. The partners are: CIRAA and SSSA (Italy), CRP-GL (Luxemburg), EULS (Estonia), FiBL (Switzerland), FiBL AT Austria, ISARA (France), ORC (the United Kingdom), UB (Spain), WIZ (Germany) and WUR-APR (the Netherlands).

The analysis of the effect of conservation practices on the functional traits and assembly of weed communities has been carried out with a step-by-step process. The first step was the development of a database of functional traits which included all the species recorded in the different trials. Seventeen traits were selected, some of them indicators of potentially troublesome effects from an agricultural point of view (Raunkiaer's life-form, growth form, Grime's CSR strategy, lifespan × regeneration form, seed bank longevity, seed weight, canopy height, specific leaf area, beginning and duration of flowering, seasonality of germination) and other indicators of potentially ecological services (support of beneficial arthropods and pollinators, support of arbuscular mycorrhizal fungi, atmospheric nitrogen fixation, root system) or dis-services (support of crop pests and pathogens). Species affinity to soil nutrient conditions and their conservation value (National Red list species) were also taken into account.

Results

A database of ca. 250 weeds was developed, which includes the complete list of weed species found in the 13 on-going field trials. Information on functional traits was obtained from several open access databases such as Biolflor (Kühn et al. 2004), Banc de Dades de Biodiversitat de Catalunya (Font 2013), Ecological

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Flora of the British Isles (Fitter et al. 1994) and LEDA Traitbase (Kleyer et al. 2008). Information on detrimental and beneficial arthropods and pathogens were obtained from the Ecological flora of the British Isles, the United States Department of Agriculture, the University of Davis, the Fungal Records Database of Britain and Ireland, the Natural History Museum of the United Kingdom and several web pages for agricultural consultants are available worldwide. Peer-reviewed literature (e.g. Pignatti et al. 2005) and floras (e.g. the Flora Europaea) were also used to highlight functional attributes.

The next step after compilation of the weed functional traits database will be to assess whether conservation practices (i.e. reduced tillage and green manures) affect functional traits of weed communities. Availability of a large number of experiments, some of them running for a long period, and from different climatic areas of Europe is an excellent opportunity to study the role of conservation practices in shaping functional attributes of weed assemblages, and may help us to predict management-induced changes in weed communities and their expected consequences.

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Organic farming enhances the recovery of ancient crops and segetal weeds in Catalonia (NE of Spain)

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Key words: rare species, cereal and legume crops, weed biodiversity

Abstract

The Area of Natural Interest of Gallecs is nowadays one of the largest areas of arable land organically managed in Catalonia. In 2005 a project was launched to convert fields to organic farming and recuperate traditional crop varieties. The aim of this work is to analyse the changes in weed diversity, including both segetal and rare species, and of crops in 20 fields (ca. 46 ha) after the conversion to organic farming during 5 cropping periods (2005-2010). The number of cultivated crops increased from 1 to 17, including ancient and local varieties of cereal and legumes. Weed biodiversity at regional scale doubled in 5 years, whereas the presence of segetal and rare species increased by 75 % and 136 % respectively. Thus, organic farming contributes to the increase and the conservation of weed diversity in arable agroecosystems, including segetal species which are currently rare or have even disappeared from most of the conventional arable fields.

Introduction

In European arable crops, weed species richness and abundance have diminished due to agricultural intensification at both regional and field levels (Andreasen et al. 1996, Hyvönen et al. 2003, Baessler and Klotz 2006). It is well known that organically managed fields harbour higher weed diversity than the conventional ones (Hole et al. 2005, Roschevitz et al. 2005, Armengot et al. 2012), including segetal flora (van Elsen 2000, Romero et al. 2008, José-María et al. 2010).

The Area of Natural Interest of Gallecs is nowadays the largest arable area organically managed in Catalonia (202 ha). In 2005 its managing body and the farmers of the Agroecological Association of Gallecs, with the collaboration of the Agroecosystems Research Group[1], launched the conversion to organic farming and the recuperation of traditional crop varieties.

The aim of this work is to analyse the changes in diversity of the weed flora and of crops in 20 fields (45.8 ha) after the conversion to organic farming during 5 cropping periods.

Material and methods

Study site

The study was carried out in the "Espai d'Interés Natural de Gallecs" (Area of Natural Interest of Gallecs) of the Catalan Government, in the municipality of Mollet del Vallès, located 15 km north of Barcelona, Spain (2° 12' 7.6" E, 41° 33' 42.8" N). Field samplings were conduced over five seasons (from 2005 to 2010) in cereal and legume crops organically managed in rotations of 3 and 4 years (1 year legume and 2 or 3 years of cereal crop, respectively). The area of 747 ha is dominated by arable land (ca 71 %) and forest stands. Arable fields are both managed conventionally (343 ha) and organically (202 ha). The climate is dry subhumid Mediterranean, with mean annual temperatures and rainfall of 14.5 ºC and 602 mm respectively, and the soil is calcareous.

Sampling

The abundance of the weed flora was evaluated yearly before crop harvest (between the end of June and beginning of July). Along one of the diagonals of each field we visually estimated the percentage of cover of every weed in 15 evenly distributed samples (1 m × 1 m). The richness, the abundance and the frequency of the weed species in each field and year were analysed, focusing on the segetal and rare species in Catalonia following de Bolòs et al. (1984, 2005). In order to detect the presence of new weed species in the area, local farmers were interviewed and the Flora Database of Catalonia (from the Catalonian Biodiversity Data Base –BDBC– 2011) was consulted. Analyses were performed with the SPSS statistics package (SPSS 2009).

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Results and Discussion

The conversion to organic farming increased the number of crops, from a monoculture of barley before 2005, to a total of 17 different varieties (mean of 8 crops per year), including ancient and local varieties of cereals, such as spelt (*Triticum aestivum* subsp*. spelta* L), khorasan wheat (*Triticum turanicum* Jakubz.), some local varieties of wheat (*Triticum aestivum* L. var. *Montcada and T. aestivum* var. *Alcalá*), white and black oats (*Avena sativa* L.), barley (*Hordeum vulgare* L.), rye (*Secale cereale* M.Bieb.), raygrass (*Lolium multiflorum* Lam.) and triticale (× *Triticosecale* Wittm. ex A. Camus.); and some legumes such as bitter vetch (*Vicia ervilia* (L.) Willd.)*,* fenugreek (*Trigonella foenum-graecum* L.), brown Spanish Pardina lentils (*Lens culinaris* Medik. var. variabilis), pea (*Pisum sativum* L.), chickpea (*Cicer arietinum* L.), broad bean (*Vicia faba* L.) and lucerne (*Medicago sativa* L).

The total weed species richness of the 20 sampled fields doubled in five years, from a total of 61 species in 2005 up to 122 species in 2010 (mean annual richness of 66 species). The weed species richness per field increased from 17.9 to 22.4 species in five years (mean species richness per field and year of 16.9). The mean of the accumulative specific cover per field and year was 19 %. The most abundant species in cereal crops were *Convolvulus arvensis* L. (mean cover per sample of 3.6 %), *Papaver rho*eas L. and *Polygonum aviculare* L., while the most frequent was *P. aviculare,* which was present in 59.3 % of the samples of each field. The most abundant species in legume crops were *Diplotaxis erucoides* L. (DC.) (mean cover of 5.7 %), *Cynodon dactylon* (L.) Pers. and *Polygonum convolvulus* L. and the most frequent was *D. erucoides*, which was present in 53.1 % of the samples of each field.

The presence of rare and segetal species at regional scale increased up to 136 % and 75 % respectively from 2006 to 2010. Some of this species such as *Agrostemma githago* L*., Ammi majus* L*., Ammi visnaga* (L.) Lam*, Bromus secalinus* L*., Chrozophora tinctoria* (L.) A. Juss., *Stachys annua* L. and *Vaccaria hispanica* (Mill.) Rauschert had not been observed before in this area. It was remarkable the presence of up to 21 segetal and 26 rare species, that accounts for 17 % and 21 % respectively of the total weed flora. Some segetal and rare species such as *Ammi visnaga, Bromus secalinus, Euphorbia prostrata* Aiton*, Papaver hybridum* L., *Vicia bithynica* (L.) L. colonised few fields or appeared only one year. However, others, such as *Agrostemma githago, Ammi majus, Stachys annua* and *Vaccaria hispanica* increased their frequency in the study area from 2 up to 8 fields in five years.

Thus, crop rotations, lack of application of herbicides and sowing own organic seeds or from other farmers can contribute to the increase and the conservation of the weed diversity in the arable agroecosystems at field and regional scale. This enhancement of weed diversity is particularly relevant for segetal species, which have currently become very rare or have even disappeared from most of the conventional arable fields (Storkey et al. 2012).

Our results support that organic farming in arable areas constitutes an environmentally friendly scheme to face the loss of biodiversity recorded in the last decades (Chamorro et al. 2007).

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Evolution of fat soluble vitamin content of ewe's milk from conventional semi-extensive and organic production systems

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Key words: retinol, α-tocopherol, γ-tocopherol, season, sheep.

Abstract

During a 12-month study, bulk-tank milk was collected once a month from organic (O) (n=3) and conventional semi-extensive (CSE) (n=5) ewe dairy farms. CSE is the conventional production system most similar to the organic one because they both involve a part-time grazing system. Organic ewe's milk had significantly higher contents of α-tocopherol and γ-tocopherol and, consequently, of total tocopherol, possibly due to the higher green pasture intake (1,02 vs 0.48 kg sheep^{-1} day^{-1}) and the lower milk yield (53.5 vs 88.7 L). Although milk from CSE showed higher values for retinol there was no statistically significant difference. The sampling month significantly affected retinol levels, which tended to increase from February to May. Moreover, γ-tocopherol contents were higher in the autumn and winter months and during this period the organic samples showed higher levels of this compound. A seasonal effect was observed for α-tocopherol only in the case of the organic samples that showed an increase from March to June.

Introduction

Previous works have provided contradictory results about the difference in vitamin content between organic and conventional milk and dairy products. Some studies have reported higher fat-soluble vitamin contents in organic milk and milk products (Bergamo *et al*., 2003), while other studies have found higher levels on conventional farms, attributable to increased supplementation in concentrate feeds (Ellis *et al*., 2007), or no differences when both the organic and conventional production system had similar fresh-forage-based diets (Butler *et al*., 2008). Taking into account that all these studies were carried out on dairy cows, the aim of the present work was to quantify differences in the fat-soluble vitamin content of ewe's milk collected from organic and conventional semi-extensive production systems because both involve part-time grazing activities by the animals. A further aim was to follow their evolution throughout the year due to changes in the feeding regime of the grazing animals.

Material and methods

Ninety-six milk samples were collected from eight commercial flocks located in Castile & Leon (northwest Spain) and categorized in two different production systems: conventional semi-extensive (five flocks) and organic (three flocks complying with EC 834/2007 Directive). All farms were visited monthly from February 2011 to January 2012, when farm production data were obtained from an interview and from farm record analyses, including flock management and feeding practices (Table 1). All farms have three-four lambing periods a year and hence all the farms had similar proportions of ewes in early lactation on all sampling dates.

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Table 1: Mean values (SD) of production and management system parameters

	Conventional		Organic	
Herd size (milking sheeps)	743.50	(457.64)	686.50	(301.93)
Live weight of sheeps (kg)	56.75	(5.56)	51.5	(0.71)
% of primiparous sheeps	18.25	(2.87)	19.50	(3.54)
Dry matter intake (kg sheep^{-1} day^{-1})	1.75	(1.94)	1.99	(0.85)
Diet composition				
Forage (proportion DMI)	0.84	(0.07)	0.65	(0.20)
Fresh forage	0.29	(0.45)	0.22	(0.11)
Maize silage	0.00	(0.00)	0.04	(0.05)
Straw	0.01	(0.03)	0.01	(0.01)
Alfalfa	0.35	(0.45)	0.08	(0.11)
Other silage	0.34	(0.42)	0.66	(0.04)
Concentrate (proportion DMI)	0.16	(0.07)	0.35	(0.20)
Cereals	0.49	(0.24)	0.88	(0.16)
Proteic concentrates	0.19	(0.04)	0.00	(0.00)
Other concentrates	0.25	(0.27)	0.12	(0.16)
Supplements (g sheep-1 day-1)	75.98	(63.69)	19.04	(8.68)
Pasture (kg sheep-1 day-1)	0.48	(1.37)	1.02	(0.24)

Conventional semi-extensive (CSE) production is a part-time grazing system in which the sheep pass 54% of their time on pasture land. The diet is based on alfalfa and fresh forage complemented with commercial concentrate. The milk yield is 88.7 L a year per animal. Semi-extensive systems only buy 25% of the feeding material.

Organic (O) production is also a grazing system but differs from the semi-extensive system in that the sheep pass 82% of their time on pasture land. The diet composition is based on conserved and fresh forage complemented, when necessary, with a certified organic mixture, which in our case was mainly cereals. This system has a lower milk yield (53.5 L) and is less dependent on external inputs than CSE.

Samples were taken from stirred bulk milk from all farms between the 27th and the 28th of each month from February 2011 until January 2012. Samples were immediately frozen and kept at -20ºC. To estimate the fat-soluble vitamins, samples were heated (30ºC), homogenized and subjected to alkaline hydrolysis according to the method proposed by Herrero-Barbudo *et al.* (2005) but adding ascorbic acid and using δ-tocopherol as internal standard. The mixture was vortexed and methanolic KOH (40%) was added. The mixture was heated to 70ºC and shaken (200 rpm) for 40 min. Samples were cooled and extracted using n-hexane:dicloromethane (5:1)/isopropanol (4/1) four times. The organic phases were pooled, washed, evaporated under a nitrogen flow, reconstituted in acetonitrile/methanol (85/15), and filtered. Samples were analysed using the UPLC column, equipment, and flow and temperature regimes described in the method proposed by Chauveau-Duriot *et al*., (2010). However, owing to the characteristics of the samples two separate isocratic chromatographic methods were employed. The mobile phase for retinol was acetonitrile:methanol (85:15)/isoporonanol:water (50:50) 80/20, with λ_{exc}=325 and λ_{em}=475nm. The mobile phase for the different tocopherols analysed was acetonitrile:methanol (85:5)/isopropanol 90/10, with λ_{exc}=295 and λ_{em}=390 nm.

The statistical significance of each factor was calculated using the GLM method. (Statgraphics Plus Manugistics, Inc., Rockville MD).

Results and Discussion

Although both organic and conventional semi-extensive production systems involve grazing on pasture land, the yearly mean concentrations of α and γ-tocopherol, and consequently the total tocopherol (Table 2) content, were significantly higher in the organic samples, in agreement with previous works (Slots *et al*., 2008). However, these findings differ from other works that failed to find significant differences in 12-month studies, as in our case (Ellis *et al.,* 2007), or when both the conventional and organic production systems included animals fed with similar diets (Butler *et al*., 2008; Fall and Emanuelson, 2011). In this sense, Butler *et al*. (2008) did not find significantly higher contents of α-tocopherol on comparing organic vs. low-input dairy cow production systems (the latter of which uses production methods similar to those used in organic farming) during fresh forage-based feeding periods, although the organic milk had higher contents of the natural RRR α-tocopherol isomer, the only isomer synthesized by plants. Regarding retinol, although the semi-extensive production system afforded higher contents of this compound the difference between conventional and organic ewe's milk was not significant, as reported by Fall and Emanuelson (2011). Higher contents of retinol (Bergamo *et al*., 2003) and vitamin A (Ellis *et al.,* 2007) have been reported in conventional milk, possibly owing to increased vitamin A supplementation in concentrate feeds.

Table 2: Man values (SD) of vitamin contents expressed in μg/100 g of milk

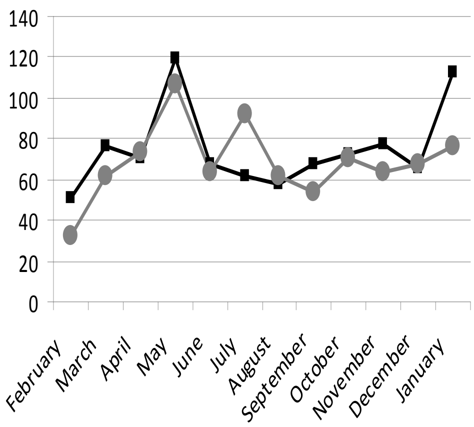
	Production system (PS)		Significance		
	Conventional	Organic	PS	Month	PSxMonth
Retinol	74.90 (3.32)	68.58 (5.94)	ns	***	ns
α-tocopherol	139.77 (13.40)	187.96 (23.98)	*	ns	ns
γ-tocopherol	9.16 (0.75)	12.84 (1.34)	**	**	ns
Total tocopherol	148.92 (13.50)	200.56 (24.16)	*	ns	ns
Total vitamin	223.83 (15.40)	269.14 (27.56)	ns	ns	ns

Ns: not significant, ***p<0.01, **p<0.05, *<0.1

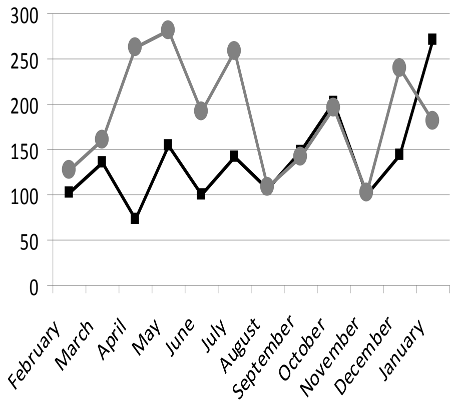
Previous works have reported that vitamin supplements have a relatively minor effect on α-tocopherol contents, and that the 3R isomers from green forage are the main contributors to the total tocopherol content (Butler *et al*., 2008). Others, such as Jensen *et al*. (1999), have suggested that fibre-rich organic diets may improve fat-soluble vitamin concentrations by decreasing milk yield. In this case, although both the conventional and organic systems involved grazing the organic milk had higher tocopherol contents but not lower levels of retinol, perhaps due to both the higher intake of pasture (1,02 vs 0.48 kg sheep^{-1} day^{-1}) (Table 1) and the lower milk yield (53.5 vs. 88.7 L).

The effect of sampling month was also considered and was found to be significant for retinol and γ-tocopherol, while the production system-month interaction was not significant (Table 2). The evolution of retinol, α and γ-tocopherol contents is shown in Figure 1. The retinol content (Fig. 1a) tended to increase from February to May, when there is more green pasture available, after which it underwent a strong decrease. This increase in the retinol content during the spring season was more clearly observed for organic milk samples that also showed minimum values for retinol during the autumn and winter months. Regarding γ-tocopherol (Fig. 1c), its levels were higher from September to February. During those months, the organic samples had higher contents than the conventional ones, but also in some summer months. This could be due to the lower milk yield of organic ewe's herds during this period when there is less pasture available. Indeed, organic milk showed higher levels of α-tocopherol from April to July (Fig. 1b) due to the higher amount of green pasture in the organic ewe's diet. This is in agreement with the higher contents of α-tocopherol found in cow's organic milk in the spring months (Butler *et al*., 2008).

(a)



(b)



(c)

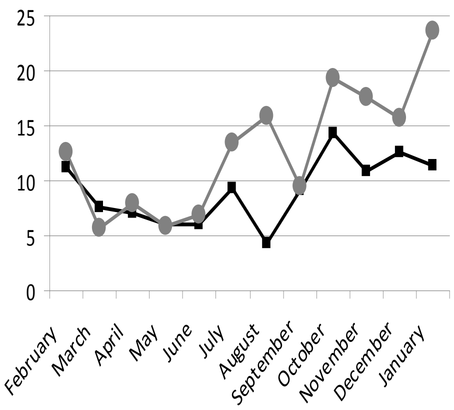


Figure 1. Evolution of retinol (a), α-tocopherol (b) and γ-tocopherol (c) for conventional (■) and organic (●) systems expressed in in μg/100 g of milk

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Soil quality and crop yields as affected by microbial inoculants in nature farming

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Key words: Soil quality, Nature Farming, Inoculation, Crop yields

Abstract

A field study tested the possibility of demonstrating the impact of Nature Farming with microbial solutions on soil quality and crop yields over one year, encompassing tropical wet and dry seasons. Adding green manures or compost was superior to using weeds as organic matter for improving soil quality and crop yields. Among the microbial inoculants, EM had a greater impact than vermiwash or cattle manure slurries on soil properties and yields of the selected crops. The prospects of Nature Farming with EM are presented as a possible method for tropical organic farming.

Introduction

Nature Farming, as advocated by Mokichi Okada in the 1930's as an alternative to the traditional systems of organic farming, relies on organic material available within the farming system to maintain soil fertility and crop productivity (Amano, 2012). However this practice is difficult in most tropical soils, where soil fertility and quality are low due to the rapid decomposition of organic matter. Thus soils in the warm humid tropics, especially those of smallholder farming systems are of low quality and adopting practices such as Nature Farming or conventional organic farming is difficult.

Microbial inoculants help to overcome the problems of low soil quality (Rigby & Caceres 2001), and using traditional inoculants such as manure slurries and vermiwash, which are accepted by the organic world are recommended additions primarily to enhance soil microbial activity, while providing some plant nutrients. However a problem of these solutions is time, labour and skills required for their preparation and applications. In contrast, Effective Microorganisms (EM) (Higa 1991), a microbial solution containing food based organisms and used in over 150 nations worldwide with successful results is used in Nature Farming. The benefits of this solution is reported through scientific studies on enriching soil microflora (e.g. Jilani et al, 2007), and crop production in the temperate and tropical nations (e.g. Daly and Stewart, 1999, Sangakkara *et al* 2011). However a comparison of the benefits of EM as against traditional microbial inoculants has not been reported, especially in the context of Nature Farming. Thus, as a continuation of a series of studies, (Sangakkara *et al,* 2011), a field study evaluated the impact of EM and two other traditional microbial inoculants on some soil fertility and quality parameters using two test crops, over the major and minor season of Sri Lanka, using a low fertility soil. The organic matter used for this study was primarily gathered within the cropping ecosystem, as advocated in Nature Farming.

Material and methods

The study was carried out in 2009/10over a period of 12 months on a farm with a soil of very low quality (pH (1:2.5 H_2O) 5.4, Organic C g.kg^{-1},4.92; N mg.kg^{-1}10.4, Exchangeable K 175 g.kg-1; soil respiration 6.4 µ g CO2 C. g$^{-\ day}$) located in the intermediate zone of Sri Lanka. The rainfall received at the site was 11123 mm and the mean temperature was 29.4°C over the period of study.

In August 2009, a total of 48 plots of 4 x 4m were prepared to cover 3 replicates; each replicate having 16 plots to accommodate the treatments. The 16 plots per replicate were further subdivided into 4 equal lots, and to each lot the following treatments imposed: - The weeds at the inception and throughout the growing periods were incorporated after quantifying the amount using a 50 x 50 cm quadrat (i.e. 50 g.m^2), green manure (Gliricidia leaves obtained from the fences @ 200 g.m^2) at the beginning and middle of each season or compost prepared using cattle manure and dry leaves added at the same rate as the green manure. One lot of 4 plots were left without any organic matter as the control. To each subplot in every group, the following microbial solutions added - . Activated EM; a cattle manure slurry made by mixing 1 Kg fresh cattle manure

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in 15 l water or a solution of vermiwash, added at a rate equivalent to 5 litres per ha, (vermiwash dilution 1:500 @ 6 litres per plot) 1 week before planting and at 4 weekly intervals). The control subplots received the same quantify of water. This was done in both seasons (wet – October – January, dry April – August).Within 7 days of adding the organic matter, in the wet season the maize (*Zea mays* L) variety Ruwan and in the dry season capsicum (*Capsicum annum*)) variety MI 1were planted as per local recommendations. The crops were maintained over the season and seed yields of maize and of fresh pods in capsicum determined.

At the beginning of the study, soil samples were taken from the site and at the end of the study from each plot to a depth of 30 cm and the following determined: pH (1:2.5 H_2O), Soil C (dichromate oxidation) N (Kjeldhal), K (NH_4OAc), soil respiration at 55% moisture and incubation for 7 using NaOH to trap the CO_2 (Salamanca *et al.* 2002), and the data of both seasons were analysed using a GLM procedure.

Results and Discussion

Organic materials and microbial inoculants had a significant impact on most soil properties (Table 1). While the use of organic additives and microbial inoculants had no impact on soil pH, all other measured parameters and crop yields were enhanced by the selected treatments, when compared with the control, The microbial inoculant increased soil N, K, organic carbon and soil respiration, illustrating the benefits of enhancing soil microbial life, irrespective of the organic matter added, thus complementing the recent report on the value of soil life in farming (East, 2013). As expected, among the organic additives, green manure and compost had the greatest beneficial impact on measured soil parameters due to their better quality in terms of C: N ratios (data not presented, when compared to the weeds. However, in traditional Nature Farming, weeds serve as a very valuable source of organic matter in situations where other types of organic manures are not available.

Among the microbial inoculants used, the best results were obtained with EM, made with lactic acid bacteria, phototrophic bacteria and yeast. These results collaborate well with earlier published work (Jilani *et al*, 2007, Sangakkara *et al*, 2011), on the usefulness of this popular microbial inoculant in tropical cropping.

The beneficial impact of vermiwash, although labor intensive in preparation was greater than that of cattle manure slurry on soil parameters, (Table 1), especially soil respiration, indicating its beneficial role in promoting soil life, with all three types of organic matter.However, vermiwash and cattle manure slurry are difficult to prepare when compared to EM, which is available at a low cost and is accepted by organic systems and in Nature Farming as a useful addition for soil quality and life.

Organic farming generally produces lower yields when compared to conventional chemical farming (e.g. Azadi and Ho, 2010), and crop productivity is the final measure of success of organic cropping. Crop yields, as denoted by maize and capsicum in the wet and dry seasons respectively, were enhanced by organic matter and microbial inoculation. As in soil parameters, the most significant beneficial impact of organic matter was in the dry season, when the added material could retain soil moisture. The best impact was with compost and green manure, which collaborates well with the soil measurements. However the use of weeds as organic matter also brought about significant increments in yields over that from the bare soil, again highlighting the usefulness of these “unwanted plants” as advocated in the traditional Nature Farming practices by Mokichi Okada.

Conclusions

Nature Farming places emphasis on a closed system and soil quality is replenished by organic matter obtained within the ecosystem to the greatest posible extent, coupled with microbial inoculation. Weeds, in situ green manures and compost are encouraged in this system with mulching to supply organic matter and retain soil moisture. Microbial inoculation enhances the value of organic matter and EM has become a part of this process. In this study, microbial inoculation, especially EM, followed by vermiwash and cattle manure slurry, enhanced the value of orgainc matter, improved soil quality and increased crop yield, especially in dry seasons when water stress ocurs. Thus Nature Farming could be considered a very suitable system of organic agriculture for resource poor organic farmers in the tropics, as microbial solutions, including EM is available in most nations in all continents and is used widely.

Table 1. Impact of organic matter and microbial inoculants on soil properties in at the end of two seasons (wet and dry) and crop yields in the two seasons

Organic matter	Inoculation	pH(1:2.5 H_2O)	N $mg.Kg^{-1}$	Exch K $g.Kg^{-1}$	Org. C $g.Kg^{-1}$	Resp.µ g CO2 C. g^{-day}	Crop yields $g.m^2$	
							Maize	Capsicum
None (Bare soil)	Water	5.8	21.5	198	8.4	7.8	185	654
	CM slurry	5.6	24.7	224	9.9	9.5	204	704
	V.wash	5.6	26.7	238	9.4	9.7	211	711
	EM	5.5	20.4	207	8.1	10.8	185	652
Weeds ($500g.m^{-2}$)	Water	5.9	29.6	215	10.4	8.4	204	699
	CM slurry	5.7	30.4	249	11.5	10.6	241	725
	V washh	5.5	32.1	268	13.4	11.4	257	784
	EM	5.5	34.5	290	15.2	12.8	268	799
Green manure ($400. m^{-2}$)	Water	5.7	38.9	245	11.9	9.1	211	725
	CM slurry	5.8	42.5	281	13.5	12.7	239	768
	V.wash	5.5	46.8	299	15.4	13.9	258	776
	EM	5.5	49.0	310	17.0	15.7	274	801
Compost ($400. m^{-2}$)	Water	5.8	37.9	239	10.4	9.2	208	715
	CM slurry	5.9	44.5	255	12.8	13.8	243	774
	V.wash	5.7	48.1	280	15.4	15.4	261	798
	EM	5.5	51.2	311	15.9	16.3	278	811
Probability	O.M	0.16	0.03	0.02	0.01	0.01	0.03	0.05
	Inoculum	NS	0.19	0.04	0.41	0.33	0.04	0.04
	Interaction	NS	*	NS	NS	NS	NS	NS

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A Comparison of strategies for weed management in nature farming

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Key words: Nature Farming, Weeds, Crops, Mulch, Intercropping

Abstract

Mulching or growing crop in-between rows of the principal crop offers scope as a means of protecting soil and suppressing weeds in Nature Farming systems. Thus, field studies evaluated the impact of either a mulch or growing two intercrops as possible management strategies for controlling weeds of vegetables grown in major and minor seasons of the tropics under a Nature Farming regime. All three strategies controlled weed numbers and weed biomass while increasing crop yields. However the least beneficial impact was from the dead leaf mulch, while the highest degree of weed control and increments in crop yields was with the green manure intercrop. The effects of these regimes were also greater in the drier season, where weed populations are higher. The potential of these three strategies for weed management in Nature Farming or organic systems are presented on the basis of these results.

Introduction

Weeds are a primary problem in organic cropping, especially in upland crops (Anderson, 2010), and their successful management is difficult, which is a constraint for obtaining optimal yields (McDonald, 2011). The problem of weeds is greater in tropical upland smallholder systems, as the weed species are generally more aggressive than crops, especially in low fertility soils and also in dry seasons (Liebman and Davies, 2000; Major *et al.,* 2005). Thus integrated management of these weeds is vital for successful organic cropping, while maintaining soil fertility and quality to optimize productivity.

Mulching and intercropping organic crops offer possible solutions to reduce weed populations in organic systems (Sangakkara *et al.,* 2011). In Nature Farming, where low external input organic systems are developed to conform to nature's principles, as per guidelines of Mokichi Okada, both practices can be facilitated as there are minimal inputs from external sources (Amano, 2011). However the type of mulch and the intercrop could affect crop yields and the best possible intercrops need to be evaluated to optimize crop production. A field study thus studied the role of mulching with grass leaves obtained from the ecosystem, and intercropping with either a species giving a harvestable product (*Phaseolus* beans) or a green manure (sun hemp *Crotolaria juncea*), in managing weed populations and on yields of common tropical crops in a system managed as per guidelines of Nature Farming, over a major (wet) and minor (dry) tropical season.

Material and methods

Experiments were carried out in 2010/11 at a farm in the intermediate zone of Sri Lanka, located on a Ultisol having the following soil fertility parameters: - (pH (1:2.5 H_2O) 5.8, Organic C $g.kg^{-1}$, 5.55; N $mg.kg^{-1}$12.1, Exchangeable K 244 $g.kg^{-}$1.The rainfall received at the site was 1677 mm (70% in the major season October - December) and the mean temperature ranged between 28 – 31^{o}C over the period of study.

In September of 2010, prior to the onset of the major season, land was tilled and 32 plots, with dimensions of 3 x 3 m were prepared to accommodate 8 treatments in 4 replicates. At first, Compost (Bokashi) was prepared with chicken manure, green leaves and rice husk (C:N ratio18.4), inoculated with a diluted solution of Effective Microorganisms (EM). This was added to each plot at a rate of 200 $g.m^{2}$, and mixed. After 5 days, uniform 20 day old seedlings of tomato (*Lycospersicon esculentum* - variety Thilina) or seeds of long beans (*Vigna unguiculata* subspp. *sesquipidales*) were planted as per local recommendations in the plots in each replicate. Soon after crop establishment, the inter rows were supplied with a mulch using grass leaves or planted with seeds of *Phaseolus* beans (bush beans) or sunhemp.The plant material was incorporated into the soil at the time of flowering in the two main crops, which also corresponded to the harvest of pods in the intercropped *Phaseolus* beans. There was a control treatment having only the two vegetable species without a mulch or intercrop. Thus there were 8 treatments, i.e. two crops and four mulching/intercrop

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treatments. The same process was adopted using Capsicum (*Capsicum annum* variety MI1) and mungbean (*Vigna radiata* variety MI 5), in the minor season (April – August), where planting was carried out in late April.

In both seasons, the crops were sprayed with EM at a dilution of 1: 250 litres of water to wet the plants at two weekly intervals. Weed numbers and dry weights were recorded on three occasions using a 50 x 50 cm quadrat. Crop yields were recorded at harvest and the data analysed using a GLM procedure for a Randomized Complete block design with four replicates per season.

Results and Discussion

The adopted management strategies had a significant impact on weed numbers and dry weights (Table 1), especially in the minor dry season, when the weed population was greater. The use of a mulch had the least beneficial impact on weed numbers as the decay of organic matter, especially with the use of EM, enabled weeds to emerge, in contrast to a live mulch (Erenstein, 2003). The bean crop, which produced an economic yield in terms of fresh pods, had a marginally greater beneficial effect in lowering weed numbers when compared to the mulch, due to its presence for a longer period. The best impact of weed management was with the live green manure, sunhemp, which shaded the ground (80%) within 4 weeks after planting the crops, thus reducing weed numbers significantly. The impact of all three management systems were also greater in the dry season, emphasising the value of these strategies for weed control, which is a major problem in Nature Farming, in such seasons.

The dry weights of weeds also followed that of weed numbers, which illustrated that the presence of a mulch or growing of a live mulch crop in-between the principal crop not only reduced weed numbers but also the growth of these unwanted plants, thus lowering their competitive ability.

Table 1. Weed populations in wet and dry seasons as affected by intercropping practices

Management strategy	Weed dynamics			
	Major (Wet) season		Minor (Dry) season	
	Weeds.m^2	Dry matter g.m^2	Weeds.m^2	Dry matter g.m^2
Mulch	15	4.55	18	5.89
Bean intercrop	17	4.18	24	7.04
Sun hemp intercrop	9	2.15	13	4.67
Control	28	8.32	37	10.25
Probability	0.024	0.043	0.008	0.038

Table 2. Crop yields in Nature Farming as affected by weed management strategies in wet and dry seasons

Management strategy	Crop Yields (g.m^2)			
	Major (Wet) season		Minor (Dry) season	
	Tomato fruits	Long Beans Fresh pods	Capsicum Fresh pods	Mungbean seeds
Mulch	522	1378	712	85
Bean intercrop	485	1455	885	74
Sun hemp intercrop	588	1985	935	99
Control	258	988	357	43
Probability	0.014	0.335	0.007	0.029

Crop yields of all species were benefitted by the adopted management strategies (Table 2), and again the beneficial impact was greater in the dry season. In all crop species, the yields were increased by some 100% due to the mulch, and the productivity of these crops were further enhanced by the other two management strategies. However, as in numbers of weeds, the impact of the bean intercrop was marginally greater on the main crops than the impact of the dead mulch. In the minor season, the bean crop reduced the yields of mungbean when compared to the dead mulch. This is due to the fact that mungbean is also a leguminous species, with the same stature and growth duration as *Phaseolus* beans, thus causing greater competitive effects. In contrast, sunhemp had the best beneficial effect on the harvested main crop, which could be attributed to lower weed populations and the nutritional benefits of this green manure crop being incorporated when compared to the grass mulch or bean crop residue which have higher C: N ratios (Data not presented). This implied that for weed management in Nature Farming, a green manure crop has a dual advantage of suppressing weeds and also as a source of organic matter when incorporated at the time of flowering of the main crop. The benefits of this strategy are greater in the drier minor season. Furthermore, in growing an intercrop, attention needs to be paid to the selection of the crop, as species with similar growth habits could reduce yields of the main crop as seen with mungbean and *Phaseolus* beans. The only advantage of such a system is the yield of the bean crop which is not found in a pure green manure crop such as sun hemp.

Conclusion

Weeds are a major problem in either Nature Farming or conventional Organic Farming and their control is essential for high yields. Mulching with dead or live material offers a possibility and the results illustrate the benefits of a green manure such as sunhemp to control weeds in both major and minor seasons, and the impact is especially greater in the latter season. Using live mulches with a harvestable product offers less scope for controlling weeds although it could provide a harvest which could bring an income. The use of a dead mulch was the least effective among the tested management strategies. Thus, as advocated by the founder of Nature Farming, Mokichi Okada, the use of live mulched offer a good management strategy for controlling weeds and increasing yields of Nature Farming units.

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Successful Potato production in Nature Farming with effective Microorganisms – A case Study

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Key words: Organic potato, EM, Disease incidence, Nature Farming, Yields

Abstract

Field studies evaluated the impact of three common organic materials added with or without Effective Microorganisms (EM)and its derivative EMFPE on yields and disease incidence in organic potatoes (Solanum tuberosum) in major and minor seasons of Sri Lanka. The organic matter was added before planting and EM solutions applied periodically. The three organic materials (cattle manure, green manure and compost) increased yield components and yields and EM increased the benefits to a greater extent. The use of this solution also helped to reduce the incidence of fungal diseases. The benefits of EM in the development of tropical organic or Nature Farming systems for organic potato production are presented.

Introduction

In tropical nations such as Sri Lanka, potato is a luxury vegetable and a high income crop for smallholder farmers, and although the consumption of organic potato is minimal there is a growing demand for exports and for selected markets. However, a major problem in potato production is the heavy infestation of diseases, especially late blight caused by *Phytophthora infestans*, and research (Finckh *et al* 2006) recommends the use of resistant varieties of potato for organic systems. The availability of such resistant varieties is scarce in the developing nations and the technology of Effective Microorganisms (EM) offers potential as its derivatives have reduced the incidence of diseases in organic systems, especially *Phytophthora* (Xu et al, 2001), and the microbial solution is safe and easily available and safe. Thus studies were carried out in a potato growing region to determine the impact of EM and its derivatives for possible production of organic potatoes within a system of Nature Farming in two tropical seasons.

Material and methods

The project was carried out at Hawa Eliya, Sri Lanka, in 2011/12, at an altitude of 1650 m where potato is grown widely. The soil was an Ultisol, with the following soil fertility parameters: - (pH (1:2.5 H_2O)4.6, Organic C $g.kg^{-1}$, 15.4; N $mg.kg^{-1}$20.7,CEC 25.10 . meq/100 g soil. The rainfall received at the site was 2945 mm over the period of study, with 60% received in the major wet season (late August to December). The minor drier season was from February to May. and the mean temperatures were 16 .3°C and 21.3 °C over the major and minor seasons r. The site had not received any agrochemicals for 4 years.

In August 2011 prior to the onset of the major season, land was tilled and plots, with dimensions of 3 x 4 m were prepared to accommodate 8 treatments within 3 replicates. In each replicate, two plots were supplied with 300 g of fresh cattle manure per sq. meter; green manure (1:1 mixture of fresh leaves of *Gliricidia sepium* and *Tithonia diversifolia*) was added at the same rate to another two plots. Compost made of chicken manure, rice husk; green leaves and saw dust was also added at the same rate to another two plots, while the last two plots did not receive any organic matter. Uniform seed potatoes (variety Granola) was planted in all plots as per local recommendations, two weeks after organic matter incorporation, One plot of each organic matter treatment in a replicate received an application of EM at a dilution of 1: 250 at a rate of 100 litres per ha. Furthermore, just prior to planting, EMFPE was prepared as per the APNAN manual (APNAN, 2010) and sprayed to the plots that received the EM, at a dilution of 1:50 to wet the soil. There were 4 organic matter treatments and two EM treatments (1with or without) thus totalling up to 8 treatments within a Randomized Block design with three replicates.

The crop was managed as per local recommendations and at two weekly intervals EM1 and EMFPE were sprayed to the plots that originally received the EM at the same dilutions and rates. The data gathered through destructive sampling were days to tuber initiation, tubers per plant, mean tuber weight and yield per

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sq. meter. In addition, the incidence of diseases was determined by counting the number of infected plants per plot.

In the minor, drier season beginning in February, 2012, the plots were prepared in the same manner and the experiment repeated. The data thus obtained were subjected to statistical analysis using a GLM model and appropriate Statistical packages.

Results and Discussion

Seasonal differences in yield components and yields of potato were clearly evident, due to the warmer and drier climate of the minor season (Table 1).The cooler climate and wet weather in the major season prolonged shoot growth of potato, as seen by the days to tuber initiation irrespective of the organic matter or EM treatments. The lower yields in the drier minor season could be attributed to the warmer climate, as respiration would be higher (Hammes & de Jager, 1990).

Although growth and yields were different in the two seasons, the adopted treatments had a similar impact on all measured parameters (Table 1). The plants in the control treatment took the longest time to initiate tubers and the three organic materials induced tuber development after shorter vegetative periods. The plants in the control plots had the lowest tubers per plant, weights of individual tubers and hence the lowest yields. The three organic materials increased tuber numbers and mean tuber weights, and thus yields to similar extents, and the differences were marginal, which could be attributed to the similar C: N ratios of these three materials (16.6 – 20.4).

The interesting phenomenon was the positive impact of EM in all measured parameters. This microbial solution, approved by most organic systems and made in the respective countries or regions, reduced days to tuber initiation, even in the control. Increments of these traits results in yield increases in all treatments.

The yield increment was lowest in the control plots, and this illustrated the importance of organic matter to realize the benefits of EM. The increments in tuber yields with the other three organic materials and EM ranged from 10 – 16%, highlighting the benefits of this simple technology for organic potato production, and the synergistic effect of organic matter for EM, as recommended for Nature Farming Systems (Amano, 2012).

Table 1. Yield components and yields of potato as affected by organic matter and EM

Organic matter	EM	Yield components and yields							
		Wet season				Dry season			
		Days to tuber initiation	Tubers $plant^{-1}$	Mean tuber weight g.	Yield $g.m^2$	Days to tuber initiation	Tubers $plant^{-1}$	Mean tuber weight g.	Yield $g.m^2$
CM	Yes	49	6.1	54	1484	41	5.5	48	1265
	No	54	5.3	47	1342	46	5.0	40	1154
Green manure	Yes	48	6.0	56	1447	43	5.4	50	1348
	No	56	5.2	47	1264	50	5.2	43	1160
Compost	Yes	46	6.2	48	1395	43	5.3	45	1386
	No	49	5.1	41	1075	49	4.7	37	1249
Control	Yes	57	3.5	36	1199	45	4.2	34	946
	No	66	3.1	31	1010	51	3.4	29	875
Probability	OM	0.004	0.047	0.037	0.084	0.040	0.684	0.041	0.006
	EM	0.027	0.034	0.005	0.155	0.037	0.021	0.039	0.044
	Interaction	NS	*	NS	*	NS	*	*	NS

The incidence of fungal diseases was higher in the major wet season (Table 2), again due to the moist cooler climatic conditions. The disease incidence was highest in the control plots, especially in this major season, and without EM, almost all plants were infected. This could be due to the lower vigour of the plants, even with EM, as no manures were supplied. The use of EM and especially EM Fermented plant extract reduced the diseased plants in the control plots significantly. Plots that received organic matter had a lower incidence of the disease, due to better growth, which was observed with all three materials. EM and its derivative reduced the disease incidence further, and there were no differences between the three manures. This clearly confirmed the results of Xu *et al* (2001) on the impact of EM and its derivatives on the disease reduction in tomato, another Solanaceous crop species.

Table 2. Impact of organic matter and EM on the incidence of disease incidence in potato

Organic matter	EM	Disease incidence (% of plants)	
		Wet season	Dry season
Cattle manure	With	74	5 4
	Without	92	73
Green manure	With	75	55
	Without	90	71
Compost	With	76	57
	Without	88	74
Control	With	85	61
	Without	98	76
Probability	Organic matter	0.014	0.447
	EM	0.039	0.314
	Interaction	NS	*

Conclusions

This field study illustrated the benefits of organic matter EM and its derivative, EMFPE on increasing yields and reducing the incidence of diseases of organic potatoes under tropical conditions.

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