European Grapevine Moth: a New Pest of Grapes in California

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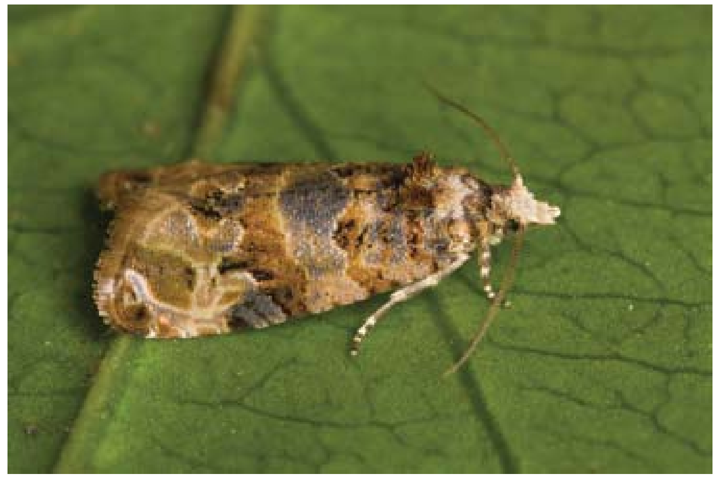
In September 2009, the European grapevine moth, *Lobesia botrana* (Lepidoptera: Tortricidae) was reported for the first time in North America from Napa County, CA. It has since been found in Fresno, Mendocino, Merced, Monterey, Solano, and Sonoma counties, although at much lower densities and more limited geographic distribution. This is a pest of serious concern for grape growers in California. It is capable of moving on any contaminated materials including but not limited to fruit, winery waste, and machinery, as well as dispersing naturally. Larvae are particularly damaging to the grape crop because of their habit of feeding on flower parts and berries. Because numerous other species are commonly referred to as berry and vine moths, verify the scientific name (*Lobesia botrana*) when searching the literature for information on this pest.

Hosts

European grapevine (*Vitis vinifera*), American bunch grape (*V. lambrusca*) and spurge laurel (*Daphne gnidium*), a common shrub in Mediterranean Europe, are preferred hosts. It is considered a pest of economic significance only on grapevines, with larvae feeding on almost all the cultivated grape varieties. Some researchers theorize that *D. gnidium* constitutes the original host and its adaptation to grapes is a relatively recent event. In certain regions or under high population pressure, olive flowers may host larvae during the first generation, although olive fruit is never attacked in subsequent generations.

Damage

Lobesia botrana is considered an economic pest of grapes because larvae feed on all parts of the flower cluster in early spring, on green berries in mid summer, and on ripening fruit in late summer continuing through harvest. Multiple larvae may reside within a single cluster. Infections caused by *Botrytis cinerea* and other fungi are triggered by feeding activity and bunch rot is the main cause of fruit loss. Evidence of larva damage include (1) "nests" of webbing built in flower or fruit clusters, (2) excrement that resembles brown or black sawdust, (3) perfectly round holes in flowers or fruit, through which larvae enter these structures to feed, and (4) shriveled berries in summer, as the fruit is consumed.



European Grapevine Moth, *Lobesia botrana.* Adult moth, female. Photo: ©2010 AgStockUSA / Jack K. Clark

Identification

The adult moth is approximately 0.3 inch (7.5 mm) long, with little notable size disparity between sexes. The mosaic-patterned forewings common to both sexes are tan-cream and mottled with brown and black markings and bluish-gray bands; the widest gray band is in the center of the wing. The hindwings are gray with a fringed border.

The elliptical eggs of *L. botrana* are laid singly and almost exclusively on fructiferous organs (flower buds, berries). Initially, these lentil-shaped eggs (0.03 inch diameter) are creamy white, turning yellow as the embryo develops. Hatch occurs soon after the black head of the developing larva becomes visible inside the egg. The translucent, iridescent shell remains visible on the plant after the larva emerges from the edge of the egg.

Larvae are similar in appearance to other tortricids, and range in size from 0.04 inch (1 mm) at emergence to approximately 0.5 to 0.6 inch (12-15 mm) when fully grown. Both sexes have five instars. The body of young larvae is tan to yellow-brown, whereas the thin cuticle of older larvae is transparent, such that the body takes on the color of its gut contents (from dark green to shades of pink and maroon, depending upon its food source). Fifth instar larvae spin a grayish-white silken cocoon in which they pupate. The male pupa is 0.16 to 0.28 inch (4-7 mm) long and the female is 0.2 to 0.35 inch (5-9 mm) long.

Life Cycle

In the Mediterranean region, *L. botrana* typically completes two to three generations per year, although a partial or complete fourth generation is the exception in southern regions. Studies are ongoing, although we expect to complete three generations in Napa. We are presently validating the degree-day model, using a lower development threshold of 50°F (10°C) and an upper threshold of 86°F (30°C). Based on initial calculations, we expect the first generation to develop in 833 ± 54 degree-days Fahrenheit (DDF) (463 ± 30 DDC), and the 2nd and 3rd generations to develop in 904 ± 90 DDF (502 ± 50 DDC).

Adults remain hidden during the day, emerging for mating flights at dusk if temperatures are above 53.6°F (12°C). Most females mate only once in their lifetimes, with the majority (90%) of mating occurring one to six days after emergence. Egg-laying begins one or two days after mating, at temperatures between 57 and 86°F (14 and 30°C). Under optimal conditions (23 to 26°C), a female may lay as many as 35 eggs per day for 6 to 7 days (80 to 160 eggs during her lifetime). Adult lifespan varies from 1 to 3 weeks depending on climatic conditions.

Eggs hatch in roughly 117 to 135 DDF (65 to 75 DDC). Under optimal conditions in the summer, this is equivalent to 3 to 6 calendar days; in the spring, it may be as long as 10 to 11 days. Prolonged cold weather in the spring may cause egg mortality. Larva development may be completed in 20 to 30 days. Pupation occurs inside a webbed cocoon that may be found in the cluster, in a folded leaf lobe, or under the bark, depending on the time of year. Adults emerge 6 to 14 days (234 DDF or 130 DDC) after pupation.

Pupae overwinter in diapause (a resting state) inside silken cocoons hidden in bark crevices, soil cracks, or in protected locations on trellis posts. Diapause is triggered when nights during egg and/or larval development are longer than 11 hours. Under natural conditions diapause is terminated in early February when pupae enter post-diapause development. During post-diapause, adults of the 1st generation may emerge when air temperatures exceed a threshold of 50°F (10°C) for a period of 10 to 12 days

Eggs of the first generation laid on early spring shoot growth.
Photo: ©2010 AgStockUSA / Jack K. Clark

Management

Insecticides. Monitoring moth flights and egg-laying is critical to correct timing of insecticide applications. Insecticides may target eggs (ovicides) or larvae (larvicides). Ovicides are most effective when applied prior to egg-laying, such that eggs are laid on top of an insecticide-treated surface. Ovicides for the 2nd generation should be applied about 6 days after the first male is caught; applications for the 3rd generation should be made within 3 to 5 days of the first male catch. Timing of ovicide applications for the 1st generation is complicated by the difficulty of maintaining coverage of the rapidly expanding surface of the flower cluster.

Optimal timing of a larvicide, especially an organic product or an insect growth regulator, is against small larvae. Applications should be made at or near egg hatch (10-20% of the egg population with the black head visible). First generation larvae may be easier to control because coverage is better with a smaller canopy and larvae remain exposed over a longer period. Early control of second-

European grapevine moth egg of the first generation laid on inflorescence prior to separation of floral groups.
Photo: ©2010 AgStockUSA / Jack K. Clark

generation larvae, before berries are mid-sized, minimizes damage associated with fruit penetration. The second flight is shorter than the other two flights, and egg laying and hatch during the second generation occur over a shorter interval, making it easier to time a larvicide. Eggs of the 3rd generation hatch after bunch closure and larvae quickly penetrate ripening fruit, complicating control with larvicides. If populations have not been controlled during the first and second generations, treatment of the 3rd generation is warranted, especially since these larvae are considered the most damaging to fruit and are likely to move with infested fruit at harvest. For all applications, spray coverage is critical; aim at the clusters, including second crop, and use enough water to thoroughly wet.

If an insecticide application goes on late, spray coverage is poor, or the insecticide residue is not long enough to cover the entire hatch, some larvae during each generation may escape a single application of a conventional material, resulting in older larvae that need to be controlled. Monitor clusters 2 to 3 weeks after an application: if larvae are found and are confirmed as European grapevine moth, a second application for that generation with a different material is warranted.

There is an array of chemistry available for use against this insect, including conventional and organic formulations. Rotating chemicals with different modes of action will help prevent the development of resistance. The group number assigned to each mode of action by the Insecticide Resistance Action Committee (IRAC) appears on insecticide labels. Access *http://www.mrldatabase.com* for information on minimum residue levels of products for export.

Spray intervals for organic formulations should be shortened, as they generally have shorter residuals than conventional chemistries. Products containing *Bacillus thuringiensis* (Bt) as an active ingredient should target young larvae, and are most effective on warm days, when larvae are actively feeding. When possible, care should be taken to avoid chemistries that are known to be disruptive to beneficial insects. In ongoing studies, UC researchers are evaluating the efficacy of various materials and timing.

Biological control agents contribute to control of *L. botrana* in other regions of the world and their role in California must be explored. Trichogramma species are known egg-parasites of many species of Lepidoptera. In France, Italy and Spain the highest parasitism is reported on the diapausing pupa stage. In Europe, green lacewings are among the main predators in summer and spiders are important predators of larvae and diapausing pupae.

A **mating disruption** product (Isomate-EGVM) has been registered, and dispensers were deployed in portions of Napa County before the start of the 2nd generation. Female reproductive output is drastically reduced if mating is delayed to 16 days (from 1-8 days). Therefore, pheromone disruption programs that effectively delay mating have the potential to affect fecundity (egg production).

Mating disruption programs in Europe are most effective when *L. botrana* populations are low and the treated area is at least 10 acres in size. Dispensers are deployed before or at the beginning of the flight (preferably the first flight) and are effective throughout the season. Mating disruption is less effective on slopes and tends to break down at the edges of the treated area. If populations are high,

Male moths caught in traps are indicative of population size. This Napa County vineyard had a large overwintering population, resulting in high trap catches during the first flight, before larvicides were used to reduce the population.
Photo: ©2010 AgStockUSA / Jack K. Clark

Young larva comes out of its nest to feed on grape flower cluster.
Photo: ©2010 AgStockUSA / Jack K. Clark

supplemental insecticide applications may be needed.

Although traps deployed in areas under mating disruption will catch very few moths ("trap shutdown"), they can be used to monitor the effectiveness of mating disruption if placed accordingly. Traps placed at the edge of the area give an indication of movement from outside the vineyard. If traps placed in the center of the area are catching a significant number of males, then the mating disruption product is breaking down and supplemental insecticide applications may be needed.

This year, the use of mating disruption outside of Napa County is actively discouraged in regions where *L. botrana* adults have been trapped. The California Department of Food and Agriculture has requested that growers and PCAs refrain from deploying mating disruption to enable state trappers and county agricultural commissioners' staff to place pheromone traps and delimit current finds as well as continue to locate additional infested areas. The extent of infestation in the state cannot be determined if mating disruption is used in 2010.

Egg of *Lobesia botrana*: The black head of the larva is visible through the egg shell, indicating that the larva is ready to hatch. Photo: Monica Cooper, UCCE Napa County

In areas of Napa County where delimitation has been completed, mating disruption is being utilized. This encompasses a large area of the Napa Valley floor, in which over 90,000 moths were trapped in the first flight. Due to extremely high population levels, both insecticide applications and mating disruption are used to drive down the population.

Sanitation of equipment will be critical to minimize movement of this insect from infested vineyards, and to avoid spread to other areas of the state, county, or continent. Equipment should be washed prior to leaving an infested property, preferably with a high-pressure sprayer and hot water. This is especially important for all machinery and containers that come in contact with fruit during harvest. Larvae can hide in tight places, and fully formed larvae may form a cocoon and pupate in any protected place. Compliance agreements developed through local Agricultural Commissioner's offices contain procedures that must be followed for moving plant material and equipment from quarantined areas.

The Future

If *Lobesia botrana* becomes established in California, infested vineyards will require at least one application of a product to reduce the population and have marketable fruit for wine, table and raisin use. In Europe, many grape growers utilize mating disruption, supplementing as necessary (depending on the weather and pest population), with one or more foliar treatments to prevent larvae from infesting clusters. Control by natural enemies is not sufficient to bring population levels below an economic threshold in Europe or in other countries where *L. botrana* is established. ❧

For Additional Information on Biology and Management of *Lobesia botrana:*

UC IPM: ***http://www.ipm.ucdavis.edu/EXOTIC/eurograpevinemoth.html***

UCCE Napa: ***http://cenapa.ucdavis.edu/Viticulture/European_Grapevine_Moth.htm***

UCCE Sonoma: ***http://ucanr.org/egvm&leafrollers***

Subscribe to the UCCE Napa newsletter: ***http://cenapa.ucdavis.edu/newsletterfiles/newsletter2084.htm***

For regulatory and scientific information from USDA, including reports by scientists in the Technical Working Group on *Lobesia botrana*, visit *http://www.aphis.usda.gov/plant_health/plant_pest_info/eg_moth/index.shtml*

For information from CDFA on the state and federal quarantines, maps of quarantined areas, laboratories approved to handle quarantined material, and approved nursery stock treatments, visit *http://www.cdfa.ca.gov/phpps/PE/InteriorExclusion/egvm_quarantine.html*

If you are in a regulated county, visit your local Agricultural Commissioner's website for information on compliance agreements.