An unexpected protein connection in maize growth and defense could enhance crop resilience

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Maize (corn) is one of the most important staple crops in the world and has been extensively studied. Yet, many aspects of the genetic

mechanisms regulating its growth and development remain unexplored.

Recent research revealed that a family of proteins called COI1, previously associated with defense mechanisms in other plant species like Arabidopsis and rice, primarily regulates growth in maize. This finding could lead to developing more robust and productive maize varieties.

In plants, growth and defense often conflict. When a plant focuses on defending against pests or diseases, growth usually takes a backseat due to the opposing interplay between proteins that suppress defense genes, known as JAZ (jasmonate ZIM-domain), and proteins that suppress growth genes (DELLA). COI proteins are central to balancing these two processes by degrading JAZ.

The research focused on six COI proteins in maize, divided into two groups: COI1 and COI2. Mutant plants were created missing one, two, or all four COI1 proteins. However, mutants lacking both COI2 proteins could not be produced, as pollen lacking both proved lethal. This indicates that COI2 proteins play a crucial role in male reproduction and pollen development in maize.

The real surprise came from plants missing all four COI1 proteins. "These 'COI1-4x' mutants exhibited significantly reduced growth compared to wild-type maize plants," said Leila Feiz, the first and co-corresponding author of the study recently published in *The Plant Cell*. "This was contrary to my expectations, as COI mutations typically result in taller growth in other species like Arabidopsis and rice."

Feiz elaborated, "In C3 coi mutant plants, such as Arabidopsis, the lack of JAZ degradation by COI leads to DELLA being trapped by JAZ. This induces gibberellic acid-induced growth genes, which are usually suppressed by DELLA in the absence of gibberellic acid. Conversely,

wild-type plants treated continuously with jasmonic acid grow shorter than untreated ones. This is because COI perceives jasmonic acid and degrades JAZ.

"The degradation activates defense genes and releases DELLA from JAZ entrapments, consequently inhibiting growth. Unlike Arabidopsis and rice COI mutants, which show a taller phenotype than their wild-types, the maize quadruple COI1 mutant exhibited shorter growth compared to its double mutants and wild-type plants."

Further analysis revealed that maize COI1 proteins may have evolved a new function: degrading DELLA proteins, which suppress plant growth. Feiz proposes that by breaking down these growth-inhibiting DELLAs, COI1 proteins enable maize to continue growing even while defending itself under high levels of jasmonic acid—abundant in plants grown in hot and arid climates where C4 plants, such as maize and sugar cane, evolved.

This novel role of COI1 in regulating DELLA levels and growth may be an adaptation that has helped maize, and possibly other C4 plants, thrive in such environments—a driving force in C4 evolution. By decoupling growth and defense responses, maize and other C4 plants like sorghum can maintain robust growth even when facing environmental stresses that would typically limit growth.

The research project has an interesting backstory. It began nearly five years ago with a handful of single-mutant plants rescued from an abandoned project. Kevin Ahern, then a field manager and graduate student in Georg Jander's lab at the Boyce Thompson Institute, rescued them by pollinating and collecting their seeds.

A few months later, Feiz, a researcher in Jander's lab, took over the mutant seeds to continue the project. Throughout this research, she

collaborated with several other scientists, including Shan Wu, a postdoctoral researcher in Zhangjun Fei's lab, who helped analyze a large RNA sequencing dataset.

This study opens new possibilities for enhancing crop resilience and productivity by revealing how COI proteins interact with DELLA proteins and other components of the plant's signaling pathways. It highlights how fundamental research in plant biology can uncover fascinating evolutionary adaptations and lead to real-world agricultural advancements.

More information: COI1 F-box proteins regulate DELLA protein levels, growth, and photosynthetic efficiency in maize, *The Plant Cell* (2024). DOI: 10.1093/plcell/koae161

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