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Researchers picture key to plant growth

■ UI scientists use camera to capture bug bites

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News-Gazette photos by Robert K. O'Daniell

Above, Evan DeLucia, a University of Illinois plant biology professor, and his colleagues developed the device next to him to image the photosynthesis process in plants. At left, the photosynthesis imager is demonstrated on Wednesday afternoon at Morrill Hall on the UI campus.

A mosquito bites you and feasts on your blood and all it does is itch, but when plants are bit, they may stop growing.

Maybe not entirely, but bites from leaf-munching insects, caterpillars and the like cause a shutdown in photosynthesis activity in plants far beyond the impact of the bite itself, University of Illinois researchers say.

The UI scientists have the pictures to prove it, thanks to a high-tech camera booth they've invented to capture images of photosynthesis.

In essence, the device — developed by a multidisciplinary team including plant and pest experts, chemists and computer specialists — allows researchers to map the location and intensity of photosynthesis activity, UI plant biology Professor Evan DeLucia said recently.

Photosynthesis is the process by which plants, including agricultural crops and trees, turn carbon dioxide and light into sugar to fuel their growth.

DeLucia, an ecologist who specializes in studying photosynthesis in nature, was working on plants in North Carolina when the need for a different way to measure the process hit him.

The traditional method, called "gas exchange," is to place a leaf inside a chamber with a measured amount of carbon dioxide gas. The leaf uses some of the gas for photosynthesis. The amount is measured again. The difference gives a good measure of photosynthetic activity.

But gas exchange, while a tested and reliable method, has a couple of drawbacks, DeLucia said.

The system requires a whole leaf or a large part of a leaf, which is the problem that started DeLucia thinking about measuring photosynthesis another way in North Carolina, where the plants he was studying had been badly chewed.

"I couldn't find a leaf with enough clear area," he said.

In addition, gas exchange doesn't provide anything like a map of photosynthesis activity.

"You can't tell which part of the leaves are working better than the other parts," DeLucia said.

Plants also leak, in a sense, fluorescent light as part of the photosynthesis process. The less light used in photosynthe-

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sis, the more fluorescence.

DeLucia worked with UI colleagues, including biochemists Antony Crofts and Timothy Miller, entomologists May Berenbaum and Arthur Zangerl, and scientists in England and New York, to develop a new way to use plant fluorescence to study photosynthesis.

The device created by the team looks like a black box with what DeLucia described as a "giant spaghetti colander turned upside down" and attached to the roof inside. The bowl-shaped hood contains 1,000 light-emitting diodes that momentarily blast a specimen with light 10 times brighter than the sun's.

A specially filtered high-speed camera captures the plant fluorescence in the wake of the light bath and shuttles the data to a custom-built computer with two processors so it can control the diodes and work on imaging at the same time.

The researchers end up with a high-resolution picture that clearly shows where, and to what degree, photosynthesis is happening and not happening in the plant.

In an initial lab study using wild parsnip plants and hungry cabbage loopers, plants that Berenbaum and Zangerl often work with, the scientists uncovered previously unseen damage ranging three to six times beyond the area of the caterpillar's bite.

"It's not just the leaf area that's being removed," Berenbaum said. "The caterpillar damage is basically dewiring the entire plant."

The study was published in the Proceedings of the National Academy of Sciences.

Berenbaum and DeLucia said it appears, at least in the case of wild parsnip, that the plant shuts down photosynthesis around a wound to devote more resources to producing a defensive chemical.

The development, construction and testing of the prototype device was funded by a UI Critical Research Initiatives grant and the Illinois Council on Food and Agricultural Research. But the research has now attracted federal funding, and the device itself is going into commercial production.

DeLucia, Berenbaum and colleagues just received a U.S. Department of Agriculture grant for a study on the UI South Farms exposing soybean plants to levels of carbon dioxide and ozone expected in 2050, to see how such changes in atmospheric composition may affect photosynthesis and insect damage.

Meanwhile, the device itself is being produced as the FluorImager by an English company, Technological Limited. Commercially, the technique is of particular interest to biotechnology companies, which can use it to more quickly screen genetic changes marked by fluorescent proteins.