Wheat can't stop Hessian flies, so scientists find reinforcements

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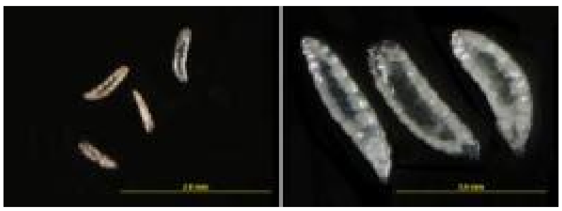

Hessian fly larvae that have consumed snowdrop lectin with an artificial diet (left) are less developed than those given a control diet (right). Credit: Photos provided by Richard Shukle

(PhysOrg.com) -- Wheat's genetic resistance to Hessian flies has been failing, but a group of Purdue University and U.S. Department of Agriculture scientists believe that other plants may soon be able to come to the rescue.

The Purdue and USDA research team developed a method to test toxins from other plants on Hessian fly larvae. The test simulates the effect of a transgenic plant without the lengthy and costly procedures necessary to actually create those plants.

"For years, people have tried to develop a bioassay, but that hadn't happened until now," said Richard Shukle, a research scientist with the USDA Agricultural Research Service Crop Production and Pest Control Research Unit working in Purdue Entomology, whose findings were published in the *Journal of Insect Physiology*.

Shukle said the 33 genes known to give wheat resistance to Hessian fly attacks have been failing, causing scientists to develop methods to stack those genes together as a defense. But another solution could include adding other plants' toxins to wheat to bolster its defenses.

The problem has been with the unique way in which Hessian fly larvae attack and feed off wheat. The larvae secrete a substance onto the plants that creates a sort of wound on the plant tissue, opening it up for the larvae to feed on.

Toxins can be tested on other pests by adding those toxins to a plant-based artificial diet and feeding them to the insects. But Hessian fly larvae won't take the bait, meaning that until now the only way to test poisons from other plants was to create lines of transgenic wheat and feed them to the flies.

"This feeding assay is significant. This gives us a way to test these toxins," said Christie Williams, a co-author of the findings and a research scientist with the USDA Agricultural Research Service Crop Production and Pest Control Research Unit working in Purdue Entomology. "A preliminary chemical assay might give us promising results. But then you could go to all the trouble of making a transgenic plant based on that chemical test and have it not work."

To get the toxins into the fly larvae, the scientists allowed Hessian flies to lay eggs on the leaves of seedling wheat plants. When the eggs hatched, the plants were taken from the soil, their roots cleaned and trimmed, and then replanted as hydroponics with the toxic proteins added to the plants' water.

"The plant is just acting like a big straw taking up the toxins," Williams said. "It's just like putting a carnation into a cup of colored water and watching the flower change colors."

When the fly larvae attacked and fed as usual, they were also ingesting the toxins that were taken up through the water.

"We knew they would feed on the plant," said Subhashree Subramanyam, a Purdue agronomy research associate. "So we used the plant as the translocation medium."

Protein immunoblot detection tests, which use antibodies to detect the presence of a particular protein, showed that the larvae had ingested the toxins added to the water.

The team tested nine lectins ╨ antinutrient proteins that disrupt digestive function. In particular, Hessian fly larvae responded to snowdrop lectin, which comes from snowdrop bulbs, a flowering plant.

Larvae that ingested the snowdrop lectin developed only half as fast as the control larvae. There was also evidence of disruption of the microvilli ╨ fingerlike extensions in the midgut that aid in nutrient uptake.

"It is possible that snowdrop lectin, by itself, could give wheat better resistance to the Hessian fly," Shukle said.

The scientists plan to have a transgenic version of the wheat developed for further testing. The USDA funded their work.

More information: Effects of Antinutrient Proteins on Hessian Fly (Diptera: Cecidomyiidae) Larvae

ABSTRACT

One strategy to enhance the durability of Hessian fly resistance (R) genes in wheat is to combine them with transgenes for resistance. To identify potential transgenes for resistance, a protocol for rapidly screening the proteins they encode for efficacy toward resistance is required. However, the Hessian fly is an obligate parasite of wheat and related grasses. Consequently, no protocol for in vitro delivery of antinutrient or toxic proteins to feeding larvae is available. We report here the development of a Hessian fly in planta translocation (HIT) feeding assay and the evaluation of eight lectins and the Bowman–Birk serine proteinase inhibitor for potential in transgenic resistance. Of the antinutrient proteins evaluated, Galanthus nivalis L. agglutinin (GNA), commonly termed snowdrop lectin, was the most efficacious. Ingestion of GNA caused a significant reduction in growth of Hessian fly larvae, disruption of midgut microvilli, and changes in transcript level of genes involved in carbohydrate metabolism, digestion, detoxification, and stress response. These effects of GNA are discussed from the perspective of larval Hessian fly physiology.

Provided by Purdue University

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