Automated delivery system for therapeutic materials to treat HLB-infected citrus

DISEASE MANAGEMENT

Research by Dr. Ozgur Batuman, University of Florida
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Why is this research needed?

The bacterium that causes huanglongbing (HLB), "*Candidatus* Liberibacter asiaticus" (CLas), enters a citrus tree either through grafts or when the Asian citrus psyllid (ACP) feeds. Once inside the tree, the bacterium proliferates in the phloem. The phloem is the portion of the plant vascular tissue that transports sugars from their site of production in the leaves to other plant parts, such as the roots or flowers, that need energy for growth. Phloem can transport sugars up and down the plant. Therefore, once the HLB bacterium is inside the phloem, it has the potential to infect the entire tree.

Thus far, no treatment has been developed to prevent HLB infection or control the bacterium once inside the tree. This is in part due to the difficulty of reaching the phloem through conventional methods. Methods such as foliar spraying or soil drenching are not efficient routes to achieve the needed concentrations. Many chemicals are being investigated, but in order to test them, an effective method of direct or indirect delivery into the phloem is needed.

What is the focus of this project?

Our project focuses on developing an automated method for delivering therapeutic liquid materials containing bactericides, microbial metabolites, small RNAs, or biological control agents, into the citrus vascular tissues. This method could deliver the materials to the phloem, which conducts sugars and other metabolic products downward from the leaves, or to the xylem, which conducts water and nutrients upward from the roots to the leaves. Past delivery methods based on foliar sprays and root drenches have not been successful. We are investigating two alternative methods: 1) diffusion, in which the trunk is punctured and connected with a liquid reservoir, from where the liquid flows through passive uptake and is infused into the vascular tissue of the trunk, and 2) infusion, in which the trunk is actively injected with the liquid using a low pressure application.

Who is working on the project?

The project is led by plant pathologist, Dr. Ozgur Batuman, with colleagues at the Southwest Florida Research and Education Center (SWFREC) at the University of Florida in Immokalee. In addition to the research described above, this four-year project will also study the citrus vascular system with a multidisciplinary research team, including UF Plant Pathologists Drs. Nabil Killiny and Amit Levy at Lake Alfred, SWFREC UF Plant Physiologist Ute Albrecht, Citrus Horticulturist Fernando Alferez, Precision Ag. Engineer Yiannis Ampatzidis, Agricultural and Natural Resources Economist Tara Wade, University of California-Davis Extension Specialist Louise Ferguson and Texas A&M-Kingsville Citrus Center Plant Pathologist Veronica Ancona as well as a number of graduate students, postdocs, and Florida, Texas and California citrus industry members.

How is the research being done?

Currently, the research is focused on optimizing the delivery method. Earlier research that compared delivery methods including foliar sprays, soil drenching, and trunk injection, determined that **Needle-Assisted Trunk Infusion (NATI)** was the best potential delivery method (Figure.1).

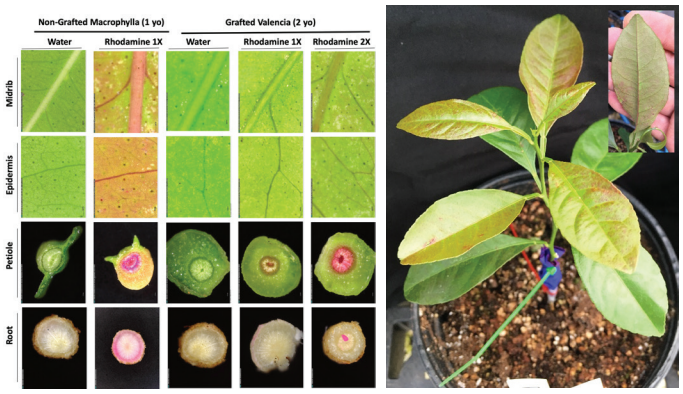

Fig. 1. *Distribution of rhodamine (red dye; 1%) applied by NATI in various tissues (left) of non-grafted and grafted young citrus plants grown in the greenhouse (right). Photos taken 2 weeks after the treatments. Treatments and tissues observed are indicated. Yo = year-old.*

In initial experiments, a tracking dye, rhodamine (1%), was injected into the trunks of one-year-old citrus seedlings using NATI. A visible red color, indicative of rhodamine uptake and movement, was detected in the upper-most leaves within 30-60 min and an increase in color intensity was observed within 24 hours. Similar results were observed in two-year-old grafted Valencia plants within 48 hours.

If the NATI delivery method can be automated, large numbers of trees could be treated quickly. Our proposed automated delivery consists of a robotic arm with several modules at the end of the arm, installed on an all-terrain vehicle or tractor. One module with needles would grip and puncture

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the trunk, a second module would wrap a reservoir around the trunk below the punctures and a third module would fill the reservoir (Figure 2).

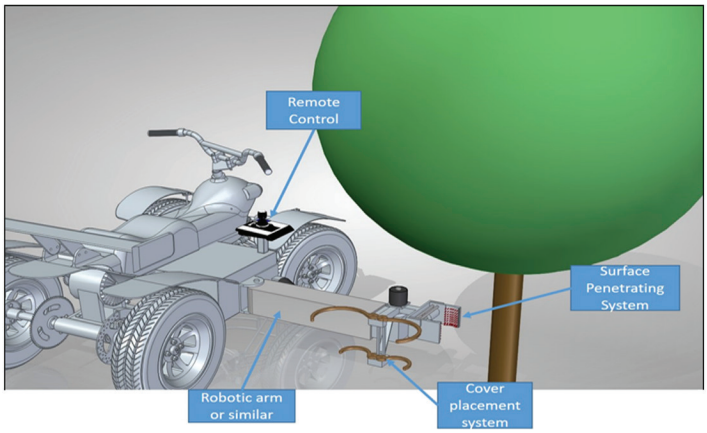

Fig. 2. *Projected automated delivery system (ADS); an ATV with extendable arm with NATI and the cover placement systems on the arm guided onto the tree trunk.*

In addition to curing the targeted disease, automated delivery could aid disease prevention through the application of prophylactic chemicals that prevent infection. In this case, the system would be used to treat healthy young trees with bactericides or chemicals that boost their immune system. We envision the possibility of such treatments acting in an analogous fashion to vaccinations used to prevent diseases in humans and animals.

What are the challenges and opportunities?

The greatest challenge is successful, economical automated delivery of chemicals to the phloem. The greatest opportunity is the potential to develop a method that will allow much more precise delivery of treatments to citrus trees. In addition, this method could be used to control insects that feed on citrus plant parts; to deliver plant growth regulators, nutrients, and fertilizers, to roots and fruits to increase growth, development, and fruit quality; much like an intravenous injection functions in an animal.

For more information, please visit this project's dedicated website: https://swfrec.ifas.ufl.edu/programs/citrus-path/automated-delivery/

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