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Plant Defense Mechanisms Part 2:

How Soil Microbes Defend Plants from Insect Pests

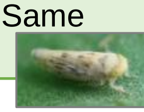
February 16, 2021

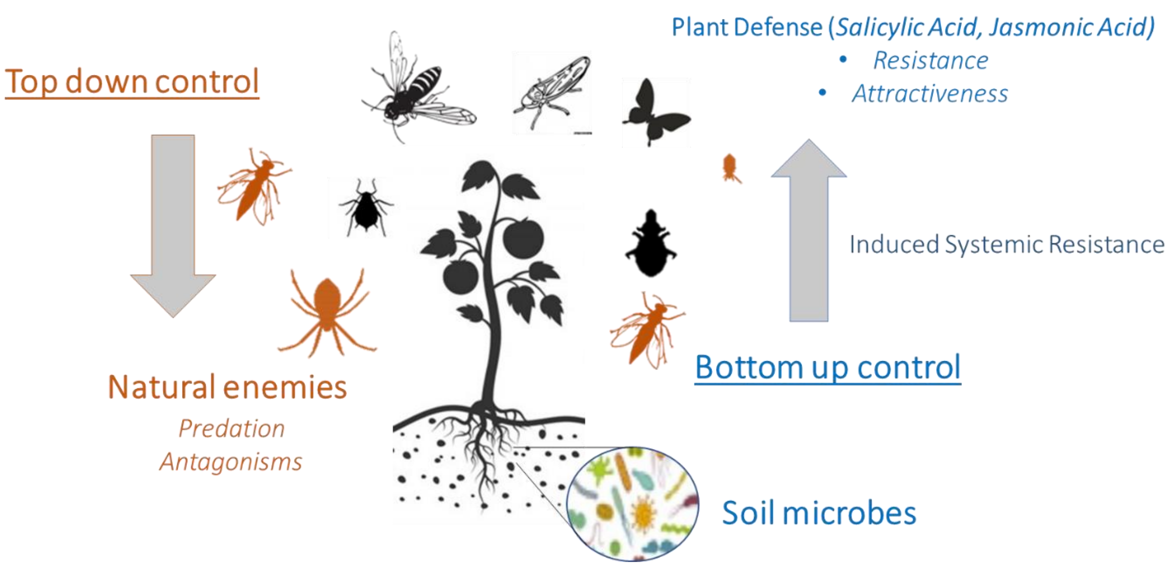
Guest Speaker

Prof. Amélie Gaudin, UC Davis Dept. of Plant Sciences

Is a plant just a plant, or is it also the billions of microbes living on and around it? Last week, Dr. Rick Bostock introduced how plants use the jasmonic and salicylic acid pathways to induce resistance to pest and pathogen attack. This week, agroecology professor Amélie Gaudin guided us through the story of how the rhizosphere microbes in healthy soils may help organic tomatoes use those pathways to become less attractive to insect pests.

It all started with an observation. Scott and Brian Park, of Park Farming in Meridian, noticed that their organic tomatoes had fewer beet leaf hoppers (the vector of beet curly top virus) than the conventional field across the road. Same variety, soil type, transplant date—what was going on?





Dr. Gaudin's team tested two hypotheses:

- **Top down control:** Their first hypothesis was that the organic tomato field at Park Farming hosted more natural enemies than the conventional field, and so kept the leafhopper populations down. But while it did have a more diverse group of insects, it didn't have more beet leafhopper predators. Top down control didn't seem to be a good explanation of the low leafhopper populations.
- **Bottom up control**: Over the years, the Parks had invested heavily in building healthy soils. What if the soil microbes were helping the plants resist the leafhoppers?

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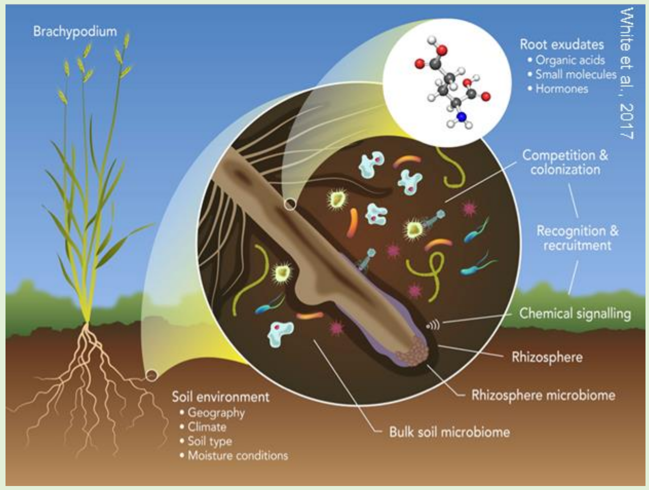
The rhizosphere is the zone of influence directly around the plant roots. In the rhizosphere plants emit carbon and nutrient rich exudates, supporting a diverse and active group of microbes. In exchange, these microbes help cycle nutrients, deter pathogens, and help the plant sense changes to its environment. Dr. Gaudin's team hypothesized that the tomatoes in the organic field were able to recruit a team of microbes that made them less tasty to the leafhoppers.



- **Organic and conventional rhizosphere microbes were different.** DNA analysis of the rhizospheres of plants from the two tomato fields showed that while both were equally diverse, very different microbial species were present.

- **Leafhoppers preferred leaves from tomato plants that were grown with microbes extracted from conventional vs organic fields.** The team grew tomato plants on sterile media that had been inoculated with microbes from either conventional or organic fields. When given a choice between leaves, the leafhoppers chose the "conventional microbe" leaves more often. Leafhoppers reared on the "conventional" leaves survived better and reproduced more.

- **Microbes extracted from the organic field affected both salicyclic (SA) and jasmonic acid (JA) pathways.** Tomatoes inoculated with live microbes from the organic soil showed increases in SA. No increases were seen if they were inoculated with dead microbes. When the leafhopper preference experiment was repeated with plants that were unable to express either SA or JA pathways, the distaste for "organic microbe" plants disappeared.

- **Leafhopper preference for conventional over organic appears to be common.** In three out of four paired organic/ conventional tomato fields across Yolo County, leafhoppers given a choice preferred conventionally grown leaves. Statistical analysis found that leaf nutrients and SA concentrations were significantly related to microbial community composition and leafhopper abundance.

Evidence strongly suggests that the microbiome of organically managed tomatoes was stimulating plant induced systemic resistance, making them less attractive to the beet leafhoppers.

What we know, what might be next

- Good science comes when farmers and researchers work together!
- Healthy soils and the microbes they support play a role in deterring insect attacks
- Could soil and fertility management be part of the next generation of IPM strategies?
- Could plants be bred that work better with their microbial partners?
- Even tiny shifts in a microbial population could have important consequences for rhizosphere ecology. The challenging next step is to investigate the mechanistic links between management, community shifts, and plant resistance.

Full details of this study are published in *Nature Plants* (Blundell et al., 2020). Contact Amelie Gaudin at agaudin@ucdavis.edu for more information.

Questions? Stories to share? Contact Dr. Margaret Lloyd at mglloyd@ucdavis.edu

A recording of this talk is available at:

http://ccsmallfarms.ucanr.edu/Events_and_trainings/Organic_Agriculture_Seminar_Series_for_Growers/