Deciphering the Chemical Language of Plants

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By Tim Kalinowski, Staff Writer

Plant scientist Jack Schultz has been around the block a few times. He has had his brushes with fame. He has had an illustrious scientific career, and is currently director of the Christopher S. Bond Life Sciences Center at the University of Missouri. Accolades aside, there is still only one thing Jack Schultz wants to do, and that is talk with plants.

Schultz has been one of the most noted pioneers on this subject for the past 40 years. Plants communicate with each other and their environments by emitting complex and elaborate chemical signatures which activate their defenses against pests, repel potential threats or attract organisms beneficial to their own survival and fertility.

"The odour changes when something happens to the plant, and so far anything anyone has ever done to any plant has been shown to cause this plant to produce a unique scent," explains Schultz. "Think of it, if you can assess the smells, you can tell what happened to the plant. A plant that is under attack by certain insects emits a unique set of odours for each. You could tell what species of insect is doing it that way. The fingerprints are getting to be really well developed."

Plants also have complex chemistries which can change in minutes to ward off pests, and they generally, in the wild, build in survival mechanisms which humans have learned to exploit.

"How many of us are running on coffee?" Schultz recently asked audience members at the Medicine Hat Farming Smarter Conference and Trade Show. "How many of us start the day with coffee? Why is that? Why would a coffee plant make something which wakes you up? It doesn't do anything for (the plant's) photosynthesis. It's not a growth regulator. It doesn't do anything specific in the daily life of the plant. So why does it make this stuff? It isn't to wake you up; it's an insecticide… It just so happens caffeine looks like the signal your system uses to keep you awake… But why would the plant make that? The truth is caffeine, and all its relatives, is a fungicide, a microbialcide and an insecticide. Plants play these kinds of tricks on us all the time."

Schultz gives other examples of this kind of reactive chemistry in plants which humans find appealing for their own purposes.

"Here's another example," he says. "Many of us think that hot pepper is painful. But is pain the right word? Is even heat the right word? Because, afterall, the pepper's (skin) is cold; it's not really hot. But every cell in your body has receptors on it to sample the environment, and see whether it is in danger of being burnt. These receptors open and close and tell the cell what to do if there is a threat of being burnt by something. The pepper activates the painful burning receptor in animal cells. The game the peppers are playing is to get you to stop eating them because your body literally thinks you are going to be burnt."

Just as these chemicals can be read quite easily by our cell receptors, says Schultz, so too can we learn to "eavesdrop" on the odours the plants are creating using a different chemical mix.

"We now know much more now about this kind of communication. What these plants are really doing is talking to themselves… If you are going to do that, then eavesdropping is possible. We are the process of developing our own (artificial) 'nose' which we can let loose in fields, and tell us where there pest infestations, without actually having to go out and fill out a card or run a sweep. We are testing that in greenhouses this summer."

Schultz also points to the example of system called Push/ Pull agriculture happening in Africa right now as a good example of the possibilities at play.

“If you know which plants (smell) attractive to beneficial insects and know which plants repel pest insects, you can manipulate the mix of plants on these small farms. Researchers are using this to great success in parts of Africa and it seems to be working very well.”

While that kind of agriculture might be far removed from the industrial scale farming we do in North America, Schultz sees the repercussions, and potential, for this type of research going forward; especially given the genetic flaws modern agriculture has introduced into the kinds of seed it grows.

“What we have done pretty much consistently is breed both the mechanisms for making chemical defenses out of plants, and breeding plants to use their carbon in particular ways we like, at the expense of everything else,” he explains. “The original tomato, for example, is small, hairy and it tastes terrible. In order to make them taste good, we had to get rid of all the nasty chemical defenses they had… There’s no free lunch.

“This is going to get me in trouble,” continues Schultz, “but people have heard me be critical of the Green Revolution; this basis is, in part, because the breeding of plants for such a heavy investment in productivity (in modern agriculture) has deprived them of the ability to defend themselves. So what that does demands pesticide use. It’s the only way we can manage the situation… I am not bad-mouthing pesticide use. But the reason you don’t have any choice, is, in large part, because we have created plants that are sitting ducks.”