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PARSONS
ON CITRUS

Goin' With The **Phloem**

We have learned a lot about HLB (or greening) since it was first discovered in Florida in 2005. While we still have much to learn, it is thought greening in Florida is caused by the bacterium *Ca. Liberibacter asiaticus*, the same bacteria associated with greening in China. This bacteria appears only in the phloem, the vascular tissue that carries sugars from a source, such as leaves, where sugar is produced by photosynthesis, to sinks, such as roots and fruit, where it is utilized and stored. When phloem cells are infected with the bacteria, the cells produce callose, a polysaccharide made of glucose molecules linked together. Callose can be produced in response to wounding and infection by pathogens.

It appears that callose, in combination with a protein called phloem protein (p-protein), and the bacteria itself start to plug up the phloem. The details have not been completely worked out, but it is thought this blockage slows or prevents the movement of sugars from the leaves to the roots. When phloem is sufficiently plugged, the roots are presumably starved for sugars and begin to die off. Ultimately, the root system dies, and then the tree canopy collapses.

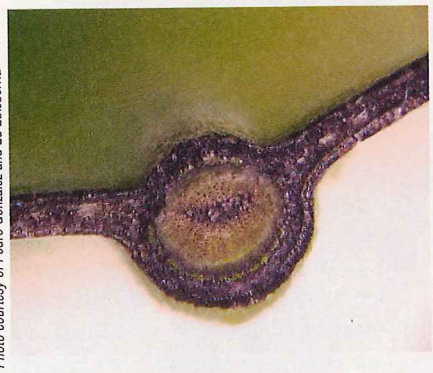

Photo courtesy of Pedro Gonzalez and Ed Etxeberria

The dark-blue color shows the amount of starch accumulation in this greening-infected leaf.

Stuck On Starch

With the phloem plugging, excess sugars start to build up in the leaves, and these sugars are converted to starch, a carbohydrate that consists of many glucose units joined together. Over time, large quantities of starch can build up and disrupt the leaf structure. Iodine is used as an indicator of starch, and it turns starch a dark blue. Dr. Ed Etxeberria, a UF/IFAS professor who studies starch, has produced iodine-treated leaves from greening-infected plants that are almost black from the excessive starch buildup. Dr. Etxeberria is trying to determine if starch buildup in the leaves can be used as a rapid indicator of greening.

Starch accumulation has causes other than greening. Some plants accumulate small amounts of starch in response to bark wounding (caused by breakage of branches) and zinc deficiency. Dr. Etxeberria was interested if starch generated by greening is different from starch accumulation due to other causes.

Starch is made up of amylose, a single chain polysaccharide, and amylopectin, a highly branched polymer of glucose. At the recent Florida State Horticultural Society meetings, Dr. Etxeberria showed the ratio of amylose to amylopectin was substantially different in greening-infected leaves than in healthy leaves that had accumulated starch because of other causes. This unique difference in ratio may be able to be used as a quicker way to determine if a tree is infected with greening. This altered ratio appears to be definitive. Hence, it should be possible to develop a test using this ratio to supplement the more laborious and expensive PCR test currently used as the definitive indicator of greening-infected trees.

Buoyed By Boyd

Maury Boyd has been a pioneer in developing foliar applied nutrients as a way to maintain citrus trees infected with greening. While this nutrient therapy is not a cure, when combined with good psyllid control, it has kept his trees productive for five years in the face of heavy HLB pressure. UF/IFAS scientists Drs. Bob Rouse and Ron Brlansky have been studying the leaves of trees receiving the Boyd nutrient cocktail. It appears something(s) in the nutrient therapy allows for phloem function to remain operating and reduces starch accumulation in the leaves. We will have more to say about this interesting area of research in the future.