Photo by T. Weeks

Figure 1A. Raised fruiting lesions of algal spot exhibit a brick-red color and donut morphology.

Photo by T. Weeks

Figure 1B. Bark cracks from a limb affected by agal spot.

Algal spot: A re-emerging disease

By Megan M. Dewdney

Algal spot has not been seen frequently for many years, but in the last few years I have been getting more questions about identification and management. The disease is caused by a green alga, *Cephaleuros virescens.* The alga is not considered a parasite, as it grows superficially, but it does cause damage to trees if left unmanaged.

Historically, the disease has been minor on most citrus types, other than lemon and lime, and if problematic, was resolved with better routine grove maintenance. However, how severe the disease becomes and the citrus type affected appear to be changing, although the reasons are unknown. Sweet oranges are the most frequently affected trees brought to my attention.

DISEASE SYMPTOMS

The tree symptoms are important. The disease is on the branches and most visible when the algae are producing fruiting bodies from approximately June to September. When fruiting, the colonies are orange red to dark red with a velvety texture. The lesions often have a donut appearance with a gray center surrounded by red (Figure 1A). The rest of the year, the lesions are a much more subtle gray-green color.

The initial symptoms are thickened sections of bark around the lesions. Eventually, the lesions will crack (Figure 1B), and the bark will fall off in small pieces or in shreds. The individual lesions usually are approximately 0.5 inch in diameter. These lesions can coalesce in severe cases to cover the entire branch with the appearance of a sheath. If conditions favor algal growth, the disease can kill scaffold branches of 2 inches in diameter or stunt the growth of a branch, resulting in chlorotic leaves and leaf drop.

The fruit and leaf symptoms are less severe. Fruit symptoms are usually seen on overripe fruit in the grove, which would be considered

Photo by T. Weeks

Figure 2A. Algal spot fruit symptoms on an over-mature Valencia orange include dark black lesions.

Photo by T. Weeks

Figure 2B. When you look at the lesions with a hand lens, they have a feathery appearance.

unmarketable. The lesions are dark black and circular to irregularly shaped (Figure 2A). If inspected with a hand lens, lesions appear highly branched (Figure 2B). The diameter ranges from 1/16 to 1/4 of an inch. Brushing easily removes the lesions. Little damage is caused by leaf lesions. The raised lesions can occur on either side of the leaf; occasionally there is chlorosis around the lesions (Figure 3, page 20). The spots eventually dry and flake off the leaf surface with a small depression remaining.

UPDATED MANAGEMENT METHODS UNDERWAY

Most of the information about algal spot management is from the late 1960s and early 1970s. Historically, the routine use of copper for other foliar diseases such as greasy spot, melanose or canker was enough to control algal spot. It has become apparent that this

Photo by J.W. Miller

Figure 3. Leaf symptoms of algal disease on Tahiti lime include mild chlorosis around some lesions.

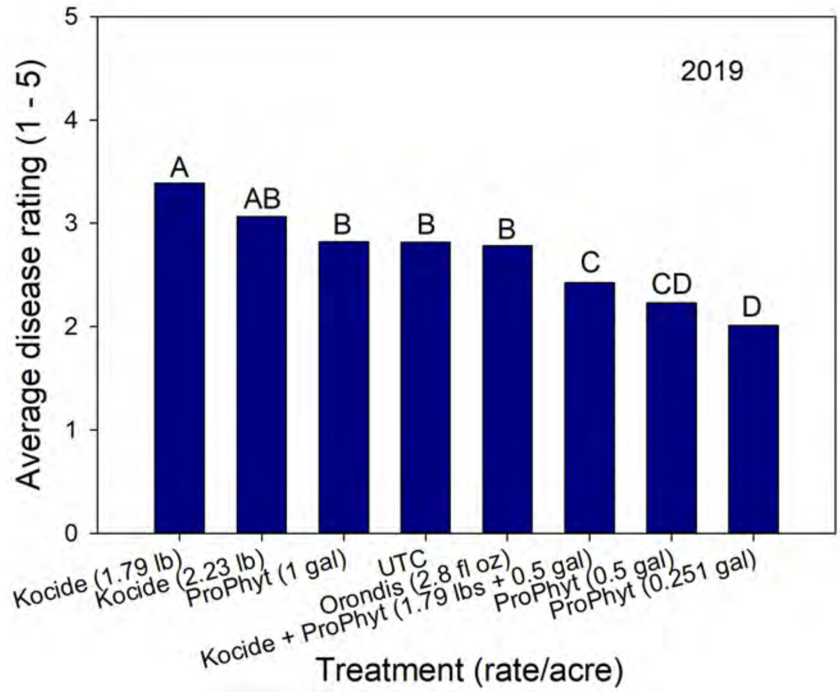

Figure 4. Results from an algal spot field trial on Valencia in 2019

is no longer the case, although the cause is unknown.

The ineffectiveness of copper applications is consistent with recent findings in other agricultural systems like blueberries and blackberries. It may be an unexpected side effect of the changed growth pattern in trees as a consequence of HLB. More blind wood (no side branches or leaves over part of the branch) and a thinner canopy is observed in HLB-affected canopies, and often algal spot occurs on branches under these circumstances. Potentially, the effect of copper was indirect, and by better managing other defoliating diseases, algal spot was shaded out and no longer occurs with the new citrus tree growth patterns.

University of Florida conducted a trial in 2019 to start to modernize recommendations for this disease, since the existing data are old and no longer helpful. While I cannot make a formal recommendation with only one year of data, the trial points to a new management direction.

Three applications of products were made over the season on Valencia trees in a grove with an algal spot outbreak. The treatments are detailed in Table 1 (page 22). Application dates were a dormant spray on Feb. 5, a post-bloom application on May 9 and an application when the fruiting bodies were present on June 20. The trial was evaluated from July 23 to 26.

Four branches per tree were rated for percent coverage by algal spot with a rating scale of 1 to 5. Level 1 was 1 to 20 percent, level 2 was 21 to 35 percent, level 3 was 36 to 50 percent, level 4 was 51 to 70 percent, and level 5 was 71 to 100 percent branch coverage.

As seen in Figure 4, copper (Kocide 3000) did not provide much control of algal spot. The products that performed significantly better than the untreated control were the lower rates of a phosphite, ProPhyt, and the combination of

Table 1. Treatment details for 2019 algal spot trial

Treatment	Rate (per acre)
Kocide 3000	1.79 lbs. (0.56 lbs. metallic copper)
Kocide 3000	2.23 lbs. (0.67 lbs. metallic copper)
Kocide 3000 + ProPhyt	1.79 lbs. (0.56 lbs. metallic copper) + 0.5 gal
ProPhyt	0.251 gal.
ProPhyt	0.50 gal.
ProPhyt	1 gal.
Orondis	2.8 fl. oz.
Untreated control	—

ProPhyt and Kocide 3000.

While these are only 1-year trial results, the poor performance of copper matches the anecdotal reports from growers in the last few years. With another year of data to confirm results, I will hopefully be able to recommend phosphite applications in 2021.

When treating for algal spot, there needs to be enough water volume (minimum 125 gallons per acre) and application pressure (175 psi) to penetrate the inner canopy and wet the wood. If you have a problem with algal spot, from my trial and those in other crops, copper products do not appear to be effective. It may be worth exploring whether a phosphite with a fungicide label will help reduce algal spot to a tolerable level. This is a re-emerging problem with relatively little information to guide recommendations. So, it will take a couple more seasons to get better data, but I am giving you the best information I have to date.

Megan M. Dewdney is an associate professor of plant pathology at the University of Florida Institute of Food and Agricultural Sciences Citrus Research and Education Center in Lake Alfred.

Genomics to Combat HLB

By Rick Dantzler, CRDF chief operating officer

Many believe long-term solutions to HLB will involve genetically altered citrus cultivars that are HLB-tolerant or even resistant. This field of study is known as "genomics."

A citrus tree's DNA contains information on the tree's characteristics. DNA is found in the nucleus of the cell. It is double-stranded and coiled, like a twisted ladder. Other organelles (specialized structures inside the cell) also contain DNA, but most of the plant's functions are controlled by the DNA in the nucleus.

The DNA contains all the information necessary to sustain life. This information is stored in certain segments of the DNA known as genes. The genes are responsible for all functions within a tree. However, the genes present in the DNA cannot function on their own as they remain trapped in the nucleus, unable to move.

The specific genes in the DNA can, however, be copied into single-stranded mRNA, which are mobile in nature. The mRNA moves out of the nucleus into the cytoplasm (the part of the cell outside the nucleus) and goes to another organelle in the cytoplasm called the ribosome. This ribosome takes the information from the mRNA and produces proteins. Proteins are molecules that ultimately move out of the cell, performing certain predetermined functions, like combating HLB.

Genomics can be used in the fight against HLB. For example, in 2015, University of Florida Institute of Food and Agricultural Sciences researcher Manjul Dutt and his colleagues determined that inserting the NPR1 gene from Arabidopsis (a small flowering plant used by the scientific community as a model) into Valencia and Hamlin trees exhibited enhanced resistance against HLB.

The NPR1 gene is a key regulator of a process known as systemic acquired resistance (SAR). With SAR, a localized exposure to a pathogen (a bacterium, virus or other microorganism that can cause disease) results in whole-plant resistance to that pathogen. The SAR process in plants is similar to the innate immune system found in humans.

This year, Dutt, with CRDF funding, will test rootstocks containing the NPR1 gene to determine if the HLB resistance can be conferred to the budded, above-ground non-transgenic scion. Our hope is that the resistance in the rootstock will successfully reduce bacterial populations and prevent their subsequent upward transmission. Additionally, since SAR is a mobile process, we hope that the scion will be ready to defend against infection. If successful, not only would resistance to the scion be delivered, but one could argue that the fruit was not transgenic because the scion was not transgenic.

Early results indicate that resistance has moved to the scion, but this was detected only at the molecular level, not in *C*Las titer levels. This spring, when titer levels are more meaningful and measurable because the trees will be older, new samples will be taken. This is a project I'm following closely.

CRDF Grower Dollars at work for you

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