Research progress for integrated canker management

By Jim Graham, Barrett Gruber and Clive Bock

Crop losses from citrus canker in 2013 for Hamlin oranges due to premature fruit drop or for grapefruit from unacceptable levels of fruit lesions were substantially higher than in the 2012 season due to more rain coincident with early fruit development from late April to early May. During this period, fruit are at the most susceptible stage of expansion — 0.25- to 0.5-inch diameter for Hamlins and 0.5- to 0.75-inch diameter for grapefruit.

In 2013, huanglongbing (HLB) caused premature fruit drop in Hamlins that overshadowed loss due to canker. Far less HLB-induced fruit drop occurred with grapefruit, but higher canker incidence in 2013 was among the major challenges for pack-out of fresh grapefruit.

To protect fruit against losses from canker, disease management for the most susceptible cultivars of grapefruit includes windbreaks, stringent leafminer control, and copper sprays to protect fruit during the entire expansion period from April to October. The purpose of this report is to update growers on performance of these tactics in grove trials testing integrated canker management.

EFFICACY OF WINDBREAKS FOR CANKER AND WIND SCAR CONTROL

For grapefruit, the objective is to maximize pack-out by minimizing canker incidence and severity on fruit. Despite above-average rainfall each month of the growing season in the Indian River district, windbreaks were as effective for reducing wind speed and fruit infection as in the drier season of 2012. In 2013 we evaluated 5- and 6-year-old red grapefruit blocks surrounded by 20- to 30-foot tall *Corymbia torelliana* windbreaks. In each block, weather stations deployed in east-west and north-south directions measured far fewer wind gusts in excess of 11 miles per hour in proximity to the windbreak, and less than 5 percent incidence of fruit with lesions compared to 75 percent incidence in the middle of the block most distant from the windbreak (Figure 1). Incidence of wind gusts and canker was also greater next to a gap in the windbreak where vehicles entered and exited the pump station in the block. The relationship between number of wind gusts and canker was similar to that measured in 2012 — the greater the number of gusts, the higher the fruit disease incidence.

In addition, as the number of wind gusts increased with distance from the windbreak, incidence of unsightly wind scar also increased. Each season, wind scar blemishes rank among the top grade defects for fresh grapefruit. These results confirm that windbreaks are a highly effective strategy for protection of fruit from physical damage as well as for reducing canker infection.

IMPROVING PERFORMANCE OF COPPER FORMULATIONS

Reducing wind speed below 18 miles per hour greatly increases the efficacy of the copper film for protection of the fruit surface from infection through natural openings and rind wounds. In our trials of fixed copper formulations (e.g. copper hydroxide and copper oxide) sprayed at 2 lb. to 4 lb. of product per acre (0.75 lb. to 1.4 lb. per acre of metallic copper) every 21 days, canker control does not vary greatly until the metallic copper drops below 0.5 lb. per application. At this rate and frequency of copper applications, the total metallic copper to achieve control may limit the number of copper applications per season. Alternatively, application of Nordox®75WG at 1.33 lb. per acre for the first five sprays followed by five sprays of Magna-Bon at 100 ppm per acre is as effective as the full rate of Nordox®75WG season-long (Figure 2). The higher metallic concentration in the fixed copper in April and May is necessary for protection of fruit against melanose (*Diaporthe citri*) and scab (*Elsinoe fawcettii*) until they become more resistant to these fungal diseases in June. The program that includes soluble Magna-Bon at

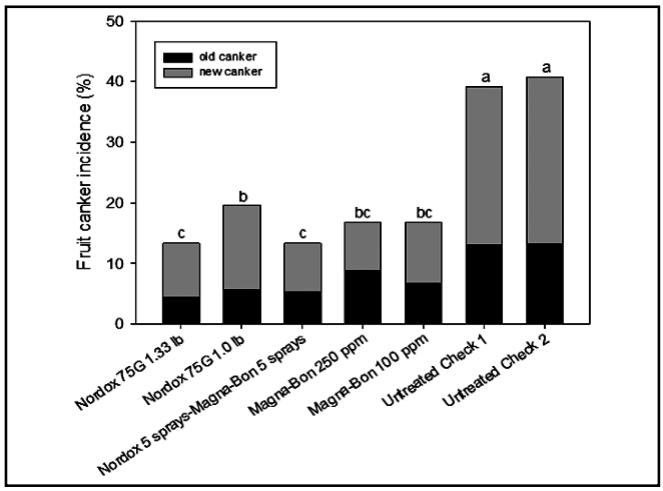

Figure 2. Applications of Nordox®75WG at 1.33 lb. per acre to 5-year-old Ray Ruby grapefruit for the first five sprays followed by five sprays of Magna-Bon at 100 ppm per acre was as efficacious as the full rate of Nordox®75WG season-long, and was more effective than Magna-Bon at 100 ppm. Black area in each bar is the percentage of fruit with older lesions and the gray area is the percentage of fruit with young lesions. Bars with different letters are significantly different according to Student-Newman-Keuls multiple range test.

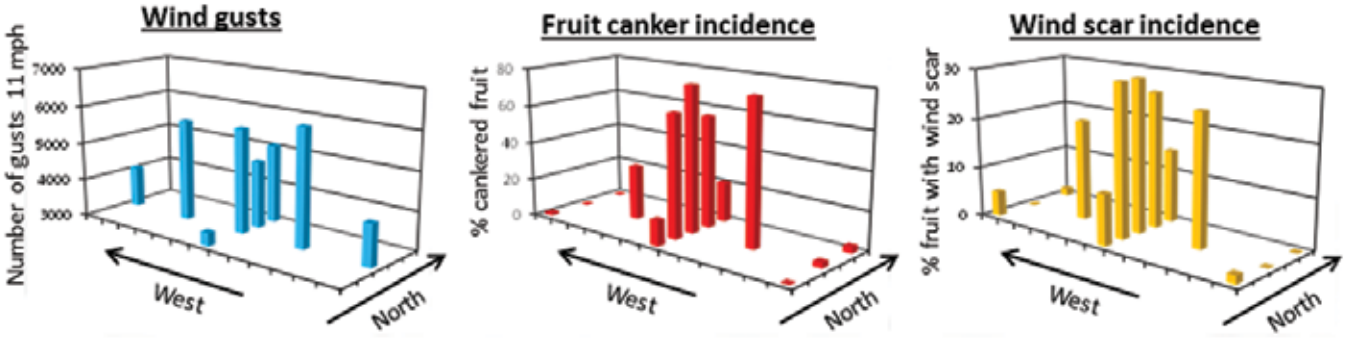

Figure 1. Coincidence of number of wind gusts ≥11 mph with fruit canker incidence (percent infected fruit) and wind scar (percent scarred fruit) in an 11-acre, 5-year-old Ray Ruby grapefruit block surrounded by a windbreak of 20- to 25-foot-tall *Corymbia torelliana.*

20 percent of the copper metal per application results in use of 50 percent less metallic per season, a substantial reduction in copper loading of the grove soils.

CANKER EPIDEMICS IN HAMLINS

In young groves where trees have not yet grown together to form hedgerows, copper sprays are targeted to prevent early-season fruit infection as the stomates (through which the canker bacterium gain access) open at 0.25-inch fruit diameter. Early season spray timing in relation to fruit size and the application of formulations with sufficient metallic copper are recommended to protect the fruit at this most susceptible growth stage.

In 2013, late April and May were relatively wet, but canker-induced premature fruit drop was prevented during this period even though copper sprays ended in early July. Although the incidence of new canker lesions later in the season exceeded 10 percent in copper treatments, fruit greater than 1.5 inches in diameter are more resistant, so that late season lesions are smaller and only induce minor fruit drop. Similar to the results with grapefruit, protecting Hamlin fruit with Nordox®75WG early in the season for the first three sprays followed by two sprays of Magna-Bon was as effective as five sprays of 1.33 lb per acre of Nordox®75WG.

In 2014, our recommendation for young early oranges continues to be four to five copper sprays applied at 21-day intervals beginning when fruit reaches 0.25-inch diameter with follow-up sprays until July when fruit reaches 1.5-inch diameter. The good news is that as the trees develop into hedgerows, the grove becomes its own internal windbreak that reduces early season bacterial infection and fruit drop due to the disease. The bad news is that by the end of the 2013 season, 80 percent of the fruit drop was caused by HLB compared to just 20 percent due to canker. Obviously, crop loss from HLB can be much more serious depending on how soon after planting the trees become infected. Hence, stringent protection of young trees with soil drenches of systemic neonicotinoids and foliar insecticide sprays as recommended in the Florida Citrus Pest Management Guide (http://www.crec.ifas.ufl.edu/extension/pest/ <http://www.crec.ifas.ufl.edu/extension/pest/%20>) is essential.

COPPER SPRAYS PROTECT FRUIT

Because fruit grow more slowly than leaves, the copper film can protect

Funding to Support Huanglongbing Research: Getting Solutions to Citrus Growers

By Harold Browning

In recent months, funding initiatives to support huanglongbing (HLB) solutions have been proposed, discussed, debated, and in some cases, approved. These initiatives collectively are intended to support the continued struggle to discover, test and deliver solutions that will protect existing productive citrus trees in Florida, to promote replanting of new trees, and to manage emerging Asian citrus psyllid (ACP) and HLB threats in other citrus states — namely Texas, Arizona and California.

The value of additional breadth of funding is clear, but the details of how these funds will add to what is being done, and how they will be integrated to accelerate, rather than complicate, ongoing research, product evaluation and outreach to growers in each of the states is unclear. Coordination is the challenge that has the attention of all involved, and as the new funding programs are implemented, this will be a major consideration so that the highest and best use of each funding source can be realized. Among the public funding programs that have been enabled to support HLB research and delivery are the following, with some general details associated with the first announced funding.

Congressional appropriation of $21 million to support HLB solutions

Congress, responding to needs expressed by U.S. citrus growers and their representatives, has committed $21 million to be invested in moving solutions to ACP and HLB into growers hands in the most expeditious way. The federal agency named to administer these funds is the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), and the funds are to be invested over the next two years. In announcing this action, the Secretary of Agriculture established a Multi-Agency Coordination Group (MAC) to assist in reaching across agencies and to expedite development and approval of plans to put these funds to use. The MAC system is used when multiple agencies of the federal government are involved, and in this case, the group is composed of citrus industry stakeholders and state department of agriculture representatives from each citrus state, as well as representatives from USDA agencies. Appointees to this MAC group are charged to oversee direction and implementation of the funding in support of the needs of the collective citrus industries of the United States.

Step-wise planning is under way, with several "shovel-ready" topics being developed for first action. The first of these topics focuses on antimicrobial therapies, thermal therapy and biological control. Following this initial step, a second round of delivery topics has been identified for next phase development and initiation. Finally, the balance of effort will be to solicit, review and prioritize suggestions for HLB management tools from stakeholders, turning these into funded projects in the near-term. A more complete overview of this first effort to utilize federal support for citrus HLB solutions can be found at http://www.usda.gov/wps/portal/usda/usdahome?contentidonly=true&contentid=citrus.html. Topics of interest on this site include:

- Multi-Agency Response to Citrus Disease
- HLB Multi-Agency Coordination Updates
- Quarantine Area Maps for Citrus Greening and Asian Citrus Psyllid
- USDA Efforts to Combat HLB
- State Efforts to Combat HLB
- Industry Efforts to Combat HLB
- Multi-Agency Coordination Group Contacts

Subsequent CRDF columns will outline the relationship of this program to the Farm Bill Specialty Crop Research Initiative citrus disease program approved for $25 million per year for five years, and the efforts within the state of Florida to provide legislative support to HLB research and solutions.

Harold Browning is Chief Operations Officer of CRDF. The foundation is charged with funding citrus research and getting the results of that research to use in the grove.

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for 14 to 21 days, after which expansion of the fruit exposes unprotected fruit surfaces. The Citrus Copper Application Scheduler helps determine if the copper residue on the fruit from conventional copper formulations is adequate for disease control. The program output graphically demonstrates reduction in copper residue based on time after application, cultivar and local rainfall. The model (http://www.agroclimate.org/tools/cudecay/) is most appropriate for the period from bloom to mid-summer, but can be used for the entire growing season.

Different copper formulations are equivalent in performance because the residual copper on the fruit surface differs little among those tested, except for Magna-Bon, a soluble product with low metallic copper (5 percent). Hence, applications of Magna-Bon later in the mid to late season lower the risk of copper phytotoxicity, an important fruit blemish in fresh fruit grapefruit and other specialty varieties.

ALTERNATIVES TO COPPER

FireWall™ (streptomycin; Agro-Source, Inc.) is effective for canker control and reduces the risk of copper phytotoxicity for fresh grapefruit. In the 2013 season, FireWall™ received an Environmental Protection Agency (EPA) Section 18 Emergency Exemption for use against canker on grapefruit. FireWall™ is limited to two applications per season at 2 lb. per acre. Timing for the applications is in June after copper sprays for fungal diseases in April and May. If additional fungal control is needed, FireWall™ may be mixed with a strobulirin fungicide to avoid risk of copper phytotoxicity. A request for renewal of Section 18 FireWall™ has been submitted for the 2014 season and EPA approval is pending.

INTEGRATION OF LEAFMINER CONTROL

Leafminer galleries are very susceptible to invasion by the canker bacterium. Extensive infection of leafminer galleries by canker bacteria greatly increases inoculum, making the disease explosive, particularly on flush from July to the end of the season. Leafminer control on the summer flushes is difficult because the duration of flush susceptibility exceeds the residual activity of most foliar-applied insecticides. On younger trees, loss of leafminer control on summer flushes occurs when the flush production is ongoing and the neonicotinoids drop below a protection-providing level in the leaf. Loss of insect control is accentuated by erratic and continuous flushing activity, making the timing of foliar insecticide sprays problematic. Effective control of leafminer is made even more difficult by the intensive insecticide sprays required for psyllid control that have reduced the populations of biological control agents in the grove.

The mating disruption technique with the natural pheromone of leafminer is proving to be an effective possible tool for reducing the incidence of leaf damage in continuing field trials. This technique inhibits moths from reproducing by saturating the air in the grove with the actual chemical that the moths use to find each other for mating. In other words, the males which depend on the female's pheromone to find her are confused because it becomes analogous to trying to find a "smoke signal in a dense fog." Importantly, mating is prevented before the moths can reproduce and therefore lay eggs. However, the technique is specific to leafminer and does not affect other pests, such as the psyllid. A commercial product for mating disruption of leafminer is available from ISCA Technologies (http://www.iscatech.com).

SYSTEMIC ACQUIRED RESISTANCE (SAR) FOR CANKER CONTROL ON YOUNG FRUITING TREES

In 2013, we demonstrated reduction in foliar infection and incidence

of canker on fruit of grapefruit trees up to 8 feet in height with the combination of soil applications of Admire Pro® (imidacloprid), Platinum® (thiamethoxam) and Belay® (clothianidin), or with the commercial SAR elicitor, Actigard® (acibenzolar-S-methyl). Four drenches with Actigard® at a 45-day interval was as effective as 21-day interval sprays of Kocide 3000® for season-long suppression of foliar canker and fruit disease (Figure 3). Our findings are consistent with the current recommendation for comprehensive seasonal application of neonicotinoid insecticides for psyllid management on trees up to 8 feet tall. For best management, the timing for the application of neonicotinoids should be determined by the potential for insecticide movement in the soil by rainfall.

In 2013 Actigard®, which is not currently registered, was evaluated in conjunction with grower standard copper spray programs in two commercial operations under an EPA-approved experimental use program. In each grapefruit grove, four drenches of Actigard® at 60-day intervals between April and October produced better control of foliar and fruit disease than the copper program alone. This evaluation will be repeated in 2014 and efficacy data will be used to support a citrus registration of Actigard® for integrated canker management with copper sprays, which may permit reduction in the rate of copper for optimal control.

For additional information regarding management recommendations discussed, consult the Florida Citrus Pest Management Guide (http://www.crec.ifas.ufl.edu/extension/pest/).

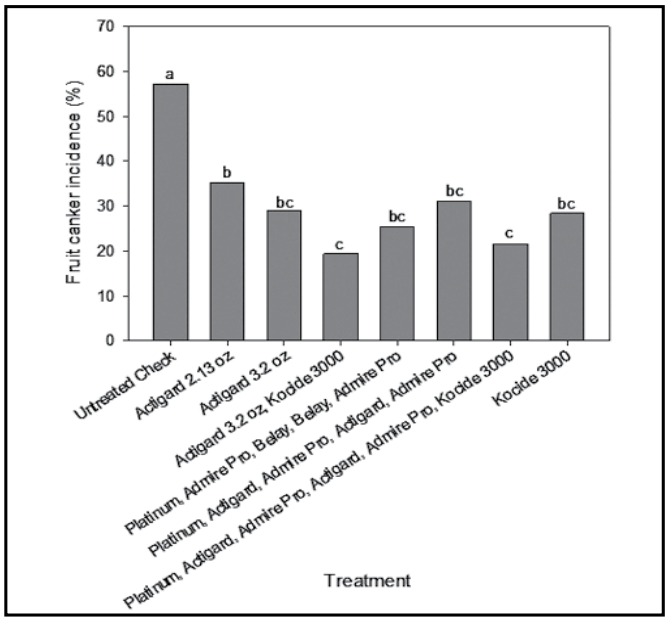

Figure 3. Soil applications of systemic acquired resistance inducers at 45-day intervals on 5-year-old Ray Ruby grapefruit. Applications of Actigard® with or without 21-day interval Kocide 3000® sprays, and with or without integrated programs of Admire Pro®, Platinum compared with 21-day interval sprays of Kocide 3000® alone. Bars with different letters are significantly different according to Student-Newman-Keuls multiple range test.

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