

CRDF Research Management Committee
Workshop on Post-bloom Fruit Drop, June 29, 2016
Summary of Discussion and Opportunities

A CRDF Research Management Committee workshop was held on June 29, 2016 at the UF, IFAS CREC to engage growers and research scientists in discussion of post-bloom fruit drop (PFD). Targets for management and intervention were discussed, as were potential research questions that need to be answered. The following is a synopsis of the discussion and potential next steps.

1. Targeting Management of Citrus Bloom Phenology:

The contribution of flush phenology to epidemics of PFD has been recognized for some time, as have the factors that influence the timing and synchrony of citrus bloom. The convergence of el Nino weather patterns, cool winter temperatures, and rainfall in winter contribute to asynchronous flush. These factors lead to periods of vulnerability to PFD infection due to an extended period of petal presence during rain events allowing sequential cycling of *Colletotrichum* as bloom progresses.

Another factor that appears to be contributing to asynchronous flush is the drought stress from chronic infection and decline of citrus roots and trees infected with CLAs. HLB has disrupted normal plant phenology, and off-cycle blooming is happening increasingly as trees advance in HLB decline. This has led to increased amounts of winter bloom (late December to early February), occurring prior to normal cold-induced bloom in February/March. The early bloom serves as the starting point for *Colletotrichum* inoculum buildup.

Interventions to reduce PFD that focus on synchrony (or asynchrony) of bloom include:

- Keeping trees well-watered to reduce HLB related drought induction of flowering. This must be balanced against normal winter drought induction of spring flowers.
- Indications are that declining root health plays a role in synchronization of flush and consequently bloom. Dr. Graham cited observation that field trials with bicarbonate adjustment of irrigation water appeared to have more synchronous flush, and perhaps had less PFD. No data were available and there were no untreated trees at this location for comparison.

It was suggested that forensic information might be gathered from the 2016 bloom by revisiting research field sites where irrigation pH and bicarbonates are being manipulated. Drs. Graham, Johnson and Morgan should be encouraged ASAP to consider which, if any of their field experiments could provide a backward look at PFD incidence and impact among plots that have bicarbonate adjustment versus untreated plots. Collection of data on number of new buttons as well as fruit counts might provide useful information to evaluate Dr. Graham's hypothesis.

- Application to citrus of the plant growth regulator, gibberellic acid (GA) in late Fall has been studied for various reasons, and Dr. Albrigo proposed that low dose applications of GA at appropriate times could differentially reverse flower induction of the winter bloom without affecting induction of the desired later normal bloom. Research opportunities in this area were discussed, and there was a range of opinions on how effective this might be, as it was stated that drought stress and cool temperature drivers of flower induction would likely

trump exogenous plant hormones. Nonetheless, the opportunity exists to field test the ability of GA to limit the induction of bloom that precedes normal seasonal bloom.

There may be an opportunity to take a backward look at ongoing and previous field trials where GA was applied prior to November. Dr. Albrigo and others involved (crop consultants, registrants of PGRs) should be encouraged to review their trials to determine where trial protocols include fall GA applications, if PFD and fruit set evaluation could shed light on any effect of the GA applications on PFD. This would require collection of data on buttons and fruit count on plots that were treated in fall/winter 2015/16. Dr. Syvertsen will follow up to determine if there is an opportunity with ongoing work.

Drs. Vashisth and Dewdney reported that they plan to conduct fall applications of GA in a single field trial site in Fall 2016 to further evaluate this treatment's impact on PFD and fruit set. This work should be coordinated with other plans and consideration given to broaden the field trial to more than one site.

- Another approach that was discussed focused on methods to reduce or eliminate early bloom (December – February) on which *Colletotrichum* begins its seasonal increase. Properly timed application of light doses of chemicals on moderately declined trees might burn and therefore shorten the duration of petals on early emerging flowers, effectively preventing inoculum buildup. Some felt that this could be a more beneficial approach than preventing induction of early bloom as discussed above.

Dr. Albrigo agreed to follow up on retrieving information on chemicals that he was aware of that might have the potential to burn back winter bloom as a starting point to consider.

- Dr. Timmer offered that the recommendation to remove non-productive trees from groves has been in place as a PFD management element since early on, and should be followed. Declining trees (before HLB and more so now) contribute to the asynchronous winter bloom and are an early inoculum source, and thus should be eliminated. There was discussion about how to determine which of the declining trees should be removed in an environment where widespread HLB decline is observed and winter bloom is present throughout the grove.

2. Targeting Pre-bloom *Colletotrichum* Inoculum Reduction

Growers raised the question of what can be done off-season (prior to bloom) to reduce resident *Colletotrichum* inoculum and thereby reduce disease pressure once bloom begins. The discussion established that quiescent *Colletotrichum* survives between bloom periods on plant surfaces imbedded in cells, and is stimulated to sporulate by flower exudates. Therefore, off-cycle, the fungus is not susceptible to fungicidal treatment. Experimentally, it has been demonstrated that sugar can stimulate *C. acutatum* sporulation.

There was discussion of how the fungus might be triggered pre-bloom to become active and then through treatment, be reduced. Dr. Peres reminded the group that fungicides are not perfect, and stimulating pre-bloom fungal sporulation and then treating might lead to increased inoculum at bloom. It appeared that those familiar with the disease biology are skeptical of this approach.

Discussion also covered the role of PFD-induced buttons as *Colletotrichum* reservoirs. It was noted that tests by Dr. Futch where buttons were removed showed no reduction in PDF in subsequent bloom. It was also pointed out that research in the 1980s established that only about 6 fruit are lost from production for every 100 buttons that appear in the field. Caution should be exercised in directly translating the presence of buttons to crop loss, since there is excess bloom that thins through the production season.

There were no questions posed for consideration of follow-up research in this topical area.

3. Disease Model and Predicting Critical Infection

A detailed discussion of the value of more accurate ability to predict timing of infection processes and therefore treatment timing was held, and Dr. Natalia Peres updated the group on her work with *C. acutatum* in Florida strawberries. The model that has emerged from her work uses phenology and relies on temperature and leaf wetness in addition to rain, to predict disease infection periods. In addition, the application sends an alert to strawberry growers when conditions requiring treatment are met. This model is being tested in Brazil citrus as an improvement over the current PFD citrus model that is used in both Brazil and Florida.

Further discussion among the plant pathologists and growers covered the critical period around *Colletotrichum* infection when chemical treatment has greatest effect. In general, the period 2 days prior to and 2-3 days following a rain event (infection period) is the most effective window for fungicide application to prevent infection. Once infection appears (4 + days after a rain event), sporulation has occurred and it is too late to stop infection.

- There was consensus that the *Colletotrichum* predictive model should be evaluated and validated in Florida citrus, which will require at least one-two years of follow-up research. There was discussion about the availability of leaf wetness data and how best to acquire local leaf-wetness information. Dr. Peres and Dr. Dewdney will develop a plan for validating this new model and application in Florida citrus, with the need expressed to begin planning now so that logistics are in place by spring bloom 2017. RMC will request a pre-proposal on this project for consideration at next meeting.

4. Application of Fungicides During Vulnerable Bloom Period

A number of chemical trials were conducted in Florida citrus covering the 2016 bloom period, and data are still forthcoming. Button counts have occurred, but fruit counts have not been concluded in most trials. It was stated that a summary of all ongoing field tests should be evaluated to ensure adequate coverage of materials and application methods (aerial, low volume, etc.) are included in the trials. In addition, the opportunity exists to coordinate with field trials in Brazil (Geraldo Silva) which are planned for August.

- Assembly of general information on ongoing field trials of PFD treatments should be accomplished as soon as possible to determine if additional test materials and applications

are necessary in spring 2017. The presumption is that current trials will be continued into the next season.

There was discussion of active ingredients used against PFD. An update on the status of Topsin was provided, as well as discussion of the BCS Luna series fungicide materials and what has been learned with field use of Luna Sensation during this past season. Further discussion of the experiences in 2016 with PFD infection centered on the confluence of environmental factors (fall, winter and spring rains) with considerable winter bloom, and specifics of failure and success in protecting bloom from PFD was discussed. The primary determinant seemed to be timing of the major flush period with rain episodes that occurred throughout the state. Those whose bloom was earlier or had less rain reported less disease.

- Further discussion and planning for 2016 (Brazil) and 2017 (Florida) field trials is in order to ensure that all options are covered. The group was reminded that field trials are only successful when appropriate conditions occur to produce *Colletotrichum* infection, so there are no guarantees that a test can be conducted in future seasons.
- It was suggested that forensics should be conducted on 2016 bloom and PFD management, engaging 25 or 30 growers and collecting information on their treatment programs, weather conditions, and resulting success in managing PFD. Field counts of buttons and fruit set could be obtained to learn as much as possible from the season just passed. Dr. Dewdney indicated that cooperation and logistics support would be necessary to make this successful. RMC will request a pre-proposal on this topic for consideration at next RMC meeting.

5. Summary

Dr. Timmer summarized his view of the best practices for managing PDF in the current situation:

- a) Pull non-productive trees, eliminating potential for winter bloom and inoculum buildup
 - b) Focus on the major bloom period that must be protected.
 - c) Monitoring and treatment should begin early, especially when the main bloom is progressing, beginning applications when first major bloom is coming on.
 - d) Prioritize blocks (Citrovita example) for their bloom progression and PFD pressure to schedule most timely applications to those higher-risk blocks.
- There was consensus that all growers need to be updated on PFD, and much of what was discussed in this workshop would be beneficial to communicate more widely. A summary should cover the details of explicit timing and effectiveness of treatments to prevent *Colletotrichum* infection, the discussion of lower volume/higher sprayer speed to allow more acreage covered under infection conditions, and other details of how growers can monitor and respond to PFD periods of infection.

It was suggested that the UF, IFAS 2017 Pest Management Guide Revision that occurs this summer would be a great vehicle to update growers. While some felt most of this PFD detail already is present in the guide, the group encouraged that review of the PFD section

should be done with an eye to update the broader issues of flush phenology, scouting, timing of applications, and other details that were discussed at the workshop.

It also may be valuable to disseminate a summary of the workshop more immediately to those who are evaluating the spring 2016 bloom and PFD experience.