Manipulating flowering for better grove management

By Tripti Vashisth, Garima Singh and Megan Dewdney

Citrus trees grown in the field undergo various types and levels of stress continuously. The stressors can be several things, including heat, cold, drought, soil pH, chemicals, pests and diseases. The constant presence of huanglongbing (HLB) and psyllid infestation adds stress to the trees, which compromises the plant response and makes the trees susceptible to number of other diseases.

Off-season and prolonged flowering is a common response of trees when undergoing various stress conditions. For example, Navel and Valencia are well known to have prolonged flowering periods with sporadic flowering during the fall. Generally, off-season and prolonged flowering is not a great concern, but when combined with heavy rainfall and warm weather, this can increase the threat of postbloom fruit drop (PFD).

POSTBLOOM FRUIT DROP

PFD is caused by a fungal pathogen, *Colletotrichum acutatum.* This pathogen is usually present on the tree (twigs, leaves, etc.) in a dormant stage and rapidly grows on flowers. Upon rainfall, the fungus can quickly disperse throughout the tree in a couple of days. Upon PFD infection, the flower and young (newly set) fruitlet drops. If severe, this infection can cause a complete yield loss. Therefore, the ability to synchronize and suppress off-season flowering can be beneficial for the following reasons:

1) Compressed and synchronized flowering period can be efficiently targeted with fungicides.
2) With a shorter flowering period, fungicide use can be reduced.
3) Reduced inoculum build-up in the tree during off-season
4) Profuse flowering of citrus provides plenty of opportunity for the fungus to flourish; fewer flowers could reduce potential locations for fungal growth.

A further consideration about the profuse citrus flowering is that only approximately 2 percent of flowers are harvested as fruit. Thus, many tree resources are invested in flowering and fruit set which eventually end up on the ground. The ability to conserve these resources to harvestable fruit may be highly beneficial for HLB-affected trees.

The plant hormone gibberellic acid (GA) is known to influence flowering in citrus plants. GA is also involved in many different aspects of citrus growth and development, such as fruit growth, peel senescence, flowering, etc. GA applied externally can suppress flowering as well as reduce the number of buds in healthy trees. Therefore, GA

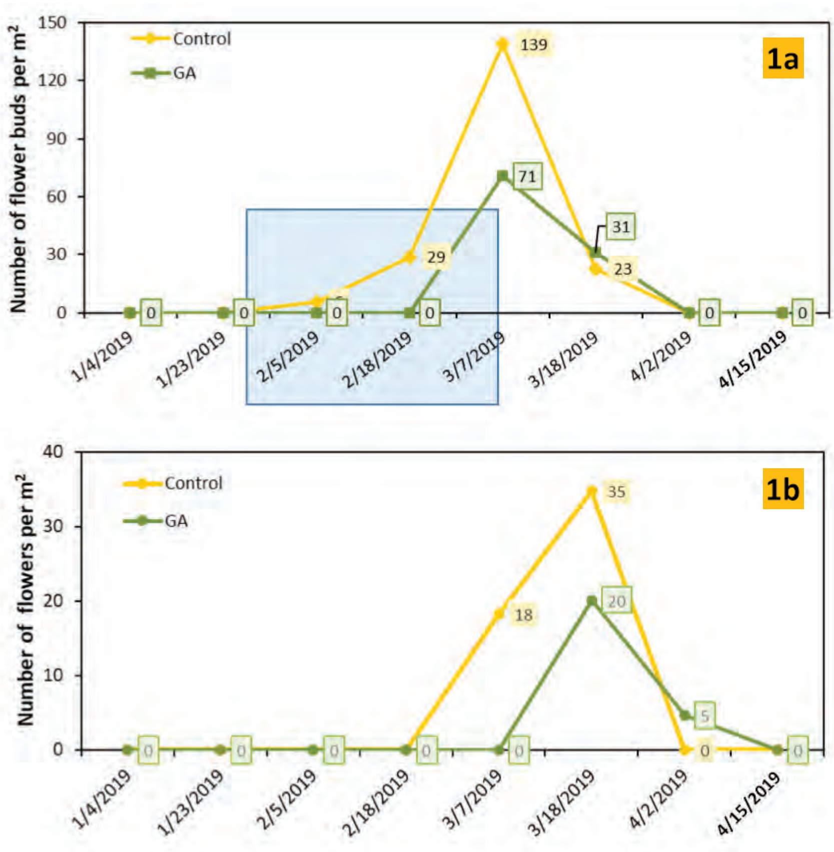

Figure 1. Average number of buds (1a) and flowers (1b) per m² per tree in gibberellic acid (GA)-treated (September–January) and untreated Valencia trees in Fort Meade, Florida, from January–April. The blue highlighted box in 1a shows the two-week flowering period where a significant difference in bud activity between untreated and GA-treated trees was observed.

applications can be potentially useful for manipulating flowering for better PFD management.

GIBBERELLIC ACID TRIAL

In 2016, a 3-year trial was initiated to evaluate the effect of GA to synchronize and compress the flowering period. A major aspect of this study was to evaluate the effect of GA on yield. Because GA could potentially reduce flowering intensity, the yield may therefore be reduced. This study was conducted on two PFD-prone cultivars, Valencia and Navel, at two sites known to have PFD history in Fort Meade and Haines City in Central Florida.

In order to synchronize flowering and suppress off-season flowering, the GA treatments were initiated in early September and continued until early January. The GA was applied at 20 grams active ingredient per acre per application with a surfactant (Induce® 0.125 percent), for a total of five GA applications. These GA applications were compared with an untreated control, where only water and surfactant were sprayed on the trees. Flowering intensity was monitored from December to April. At the time of harvest, yield was measured per tree to assess the effect of potentially suppressed flowering. Altogether, there were two cultivars and two sites, treated and monitored for three years.

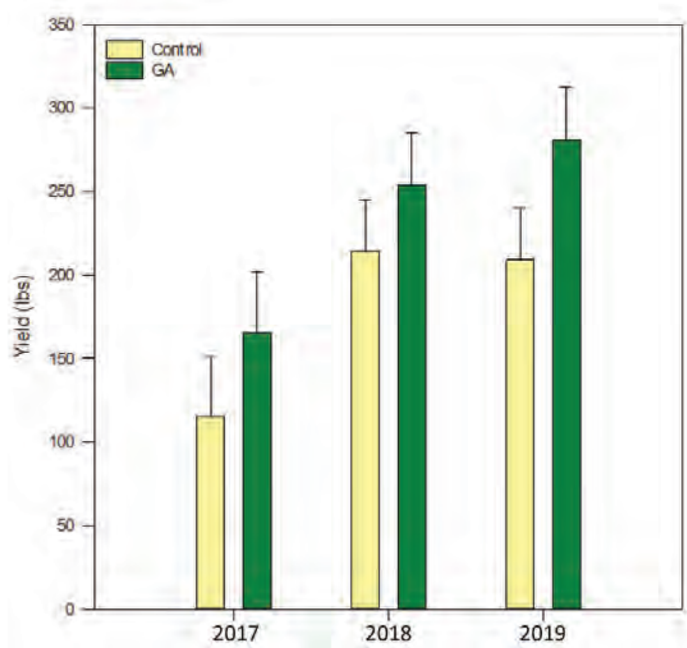

Figure 2. Average yield (lbs) per tree with standard deviation of Valencia trees treated with gibberellic acid (GA) from September to January and untreated trees grown in Fort Meade, Florida, in 2017, 2018 and 2019.

LESS FLOWERING, MORE YIELD

Trees of both sites and cultivars had similar responses to GA treatment. Flowering intensity decreased by approximately 50 percent in addition to suppression of flowering in February/early March. A shift in peak

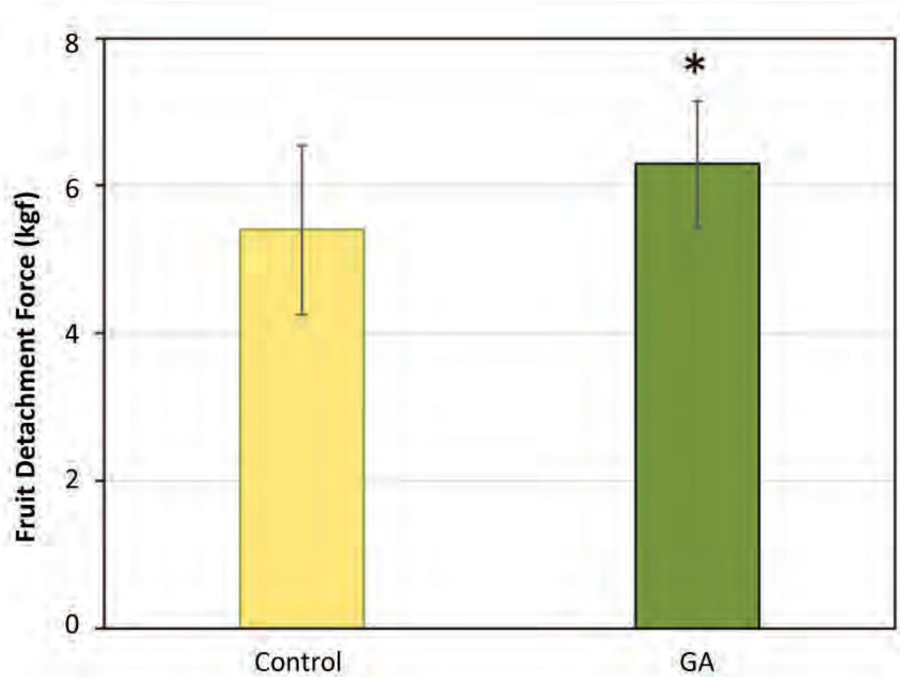

Figure 3. Average fruit detachment force (FDF) in kilogram-force (kgf) with standard deviation for gibberellic acid (GA)-treated and untreated Valencia orange trees at time of full maturity in 2019, grown in Fort Meade, Florida. The asterisk indicates the significantly higher FDF in GA-treated trees.

of flowering intensity was observed for Navel; peak flowering was delayed by at least a week. In this article, the trial on Valencia in Fort Meade is mainly discussed. The number of elongated flower buds (buds with elongated petals) formed and subsequent flowers on GA-treated trees decreased by almost half compared to control trees (Figures 1a and 1b, page 16). As expected, the peak of flowering was two weeks later than the peak of bud activity. Bud growth extended from late January to early April (more than eight weeks) on the untreated control, whereas bud activity was compressed to less than six weeks for the GA treatment.

The flowering (open flowers) was more synchronized in the GA treatment; open flowers were observed for approximately three weeks. Control trees had a flowering period extending for four weeks. This data is consistent with previous years' observations, suggesting that flowering can be suppressed and synchronized with GA on HLB-affected trees, which leads to better PFD management.

Since there is no bud activity in GA-treated trees until early March (see the blue highlighted box in Figure 1a, page 16), a fungicide application will not be needed. However, untreated control trees have a significant number of buds warranting an early fungicide spray, if weather is conducive for PFD.

Researchers also counted the number of persistent calyces (PFD buttons) on the tree before and after a flowering period. No significant differences were observed in PFD button number among GA-treated and untreated control trees. This may be partially due to the fact there was no major PFD event in 2017 and 2018. The button counts have been generally low in the GA-treated and untreated trees.

Since GA reduced flowering significantly (by 50 percent), a major concern was if the use of GA reduced fruit yield. Fruit yields were collected on a per tree basis. Interestingly, we found that the use of GA increased the yield compared to the control, when considering the multiple-year data (Figure 2, page 17).

When annual yield was considered separately, there was no difference in yield for 2017 and 2018 in GA-treated and control trees. However, in 2019, GA-treated trees had significantly higher yield than control trees.

It was demonstrated that GA application reduced flowering without reducing yield and may have increased it. In GA-treated trees, the yield consistently increased from 2017 to 2019, going from 165 pounds per tree to 282 pounds per tree with the repeated application of GA. No such increase was observed for untreated control trees.

HIGHER FDF FOUND

As no negative effects of GA on yield were observed, even though the flowering was reduced by 50 percent, researchers tried to find potential reasons for such observations. In 2019, the potential of GA treatments to reduce fruit drop and thereby improve fruit yield was evaluated. The fruit detachment force (FDF) was measured on the GA-treated and untreated control trees. FDF is the force required to remove the fruit from the peduncle of the twig. The idea is that a fruit that is likely to drop will have lower FDF, and fruit that is hanging tight onto a tree will have higher FDF.

GA-treated trees were found to have significantly higher FDF than untreated trees (Figure 3, page 18), indicating that GA-treated fruit were less likely to drop. Numerically, the average FDF between GA-treated and untreated trees differed only by one unit. However, that difference was meaningful. According to existing literature on healthy citrus, fruit below 6 kilogram-force (kgf) is considered loose. Fruit above 6 kgf is considered well retained on the tree, suggesting that GA application from September to January improved fruit retention in Valencia, thereby potentially improving yield.

In summary, this three-year study suggests that GA can be effectively used for synchronizing and suppressing profuse flowering without affecting yield in Valencia. In addition, GA treatment has potential to improve yield and reduce fruit drop. This relationship will be explored further to be confirmed and validated.

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