Thermotherapy's effects on fruit drop, yield and quality

By Megan Dewdney, Evan Johnson, Naweena Thapa and Michelle Danyluk

In 2015, we started a large-scale project to determine if thermotherapy would be an effective huanglongbing (HLB) treatment for field trees. Some of the objectives were to determine effective temperature-time combinations for thermotherapy, which season gave optimal results for thermotherapy, and the effect on yield in subsequent years.

TRIAL DETAILS

Comprehensive trials were established at two sites of Valencia trees on Swingle rootstock. Each trial had an untreated control (UTC) and five treatments: 131°F for 0 seconds, 131°F for 30 seconds, 131°F for 90 seconds, 131°F for 120 seconds, and finally, the extreme treatment which was 140°F for 30 seconds.

Treatments were done in the spring, summer, fall and winter to see if there was a seasonal effect of when the trees were treated. Thirty trees per treatment were evaluated in the first trial, and 21 trees per treatment were evaluated in the second trial.

To date, yield and fruit quality were evaluated for three years following treatment of the first trial, and one year following the second trial. Because there is only one year of data from the second trial and the results were confused by the effects of Hurricane Irma, which caused significant fruit drop, we are only presenting the first trial.

FRUIT DROP

As expected, the thermotherapy treatments caused post-treatment fruit drop within the first few months after treatment (Figure 1, page 14). When treatments were applied in the summer, post-treatment fruit drop (45 to 60 fruit per tree) increased with treatment severity until 131°F for 90 seconds, and then the effect was not significantly different.

A comparable trend is seen for the winter, except that the effects (40 to 45 fruit per tree) were similar among treatments 131°F for 60 seconds to 120 seconds. However, there was increased drop (60 fruit/tree) for the most severe treatment at 140°F for 30 seconds.

Surprisingly, in the fall, treatments had a very limited effect, and there was no significant difference among the treatments and the UTC. It is thought that there was so much pre-harvest fruit drop occurring already that treatment did not increase this effect.

We were unable to accurately measure post-treatment fruit drop for the spring treatments as the fruitlets were difficult to count, and there was natural physiological drop at the same time. These post-treatment fruit drop results are reflected in the first year post-treatment yield responses.

One of the first mature fruit measurements we took at the Fort Meade area (first trial) was pre-harvest fruit drop. At this site, the summer treatment was in July 2015, fall in October 2015, winter in February 2016 and spring in May 2016. The data were collected between October 2016 and January 2018.

In general, fruit drop per tree was low, 15 to 25 fruit on average in October 2016. Fruit drop rose in January and February 2017 to 25 to 30 fruit within the same harvest season, as was expected.

In the 2017–18 harvest season, the October fruit drop was the highest recorded in our measurements (40 fruit), which is likely to be in part the effect of Irma.

The one treatment where the yield did not follow the expected pattern was 131°F for 60 seconds; yield was lower than other treatments.

The numbers were lower (20 fruit) in January 2018 compared to the previous year, suggesting that Irma dropped some of the fruit that would have dropped in January. When examining the specific effects of time and temperature, overall there was no statistical difference between the UTC and 131°F for 0 to 90 seconds, with approximately 30 fruit dropped (Figure 2, page 14).

The fruit drop response of the two most severe treatments was generally lower, but varied by season of treatment. However, where a reduction in fruit drop was observed, there was also a reduction in yield. The reduced fruit drop may have resulted from poor fruit set as the tree recovered from the damage and stress of the extreme heat treatments. Direct comparison of fruit drop in the spring treatments to other treatments is limited because it was treated in the 2016–17 season.

YIELD

The trees were harvested in March of each harvest season (Figure 3, page 14). The results for the UTCs give an idea of how much natural change in yield there was across the three years presented, but also among the trees randomly assigned to seasons for treatment. It is clear that UTC yields were reduced in 2017 compared to 2016 and 2018, but the cause of this yield reduction is unexplained. One possibility is that post-bloom fruit drop in 2016 reduced the overall fruit set as the disease was frequently observed in this grove, although not measured. The yield results for the 2016 spring treatment also demonstrate the natural variability among treatments as the fruit were harvested pre-treatment but unfortunately, the pre-harvest variability could not be collected for the other seasons.

For summer treatments, the greatest in-season damage occurred in the most severe treatments. However, the

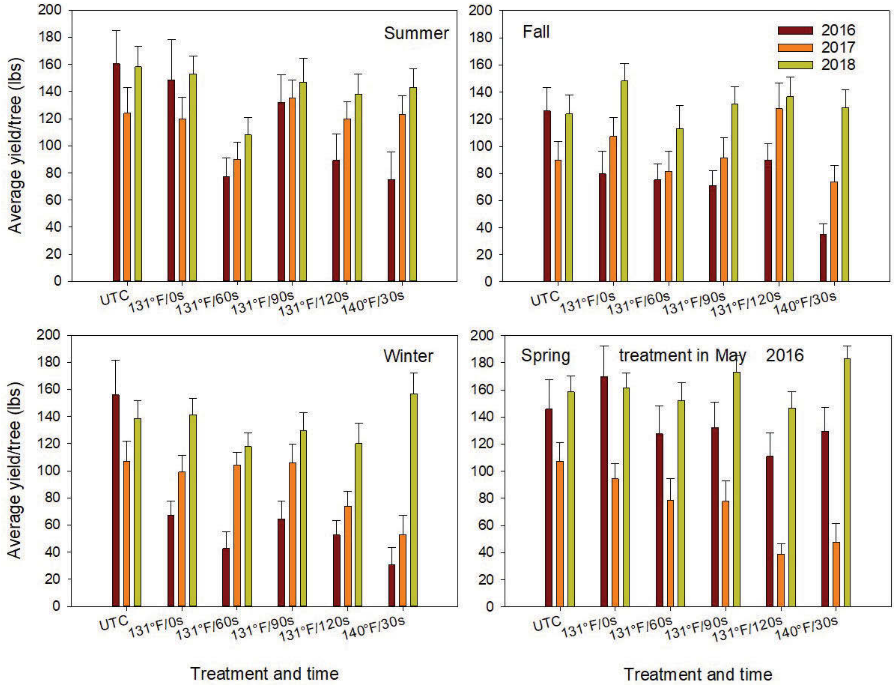

Figure 1. Post-treatment fruit drop by temperature and time (s = seconds) treatments, presented by season of treatment.

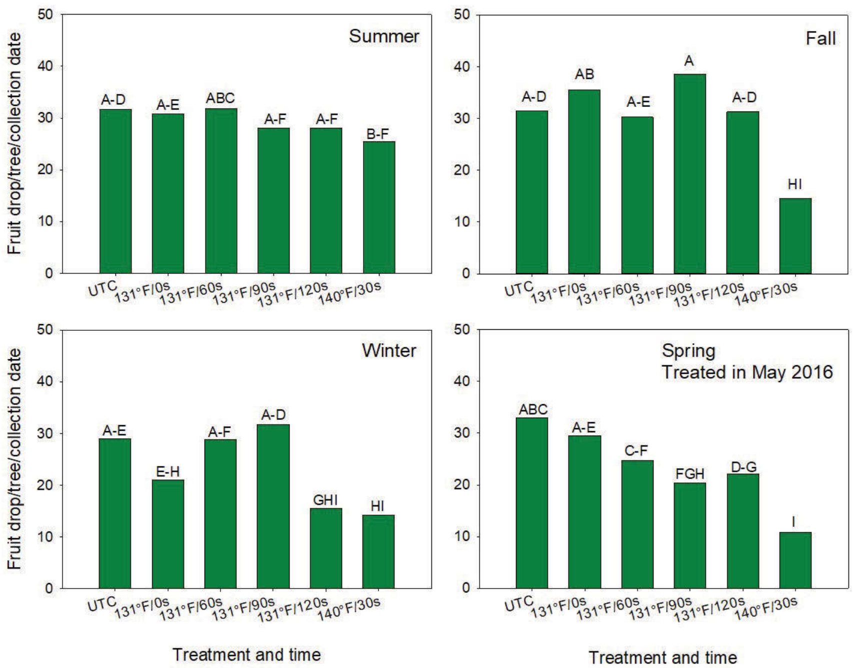

Figure 2. Pre-harvest fruit drop by season of treatment and the temperature and time (s = seconds) of treatments. The columns in all four panels with the same letter are not statistically different (P < 0.05).

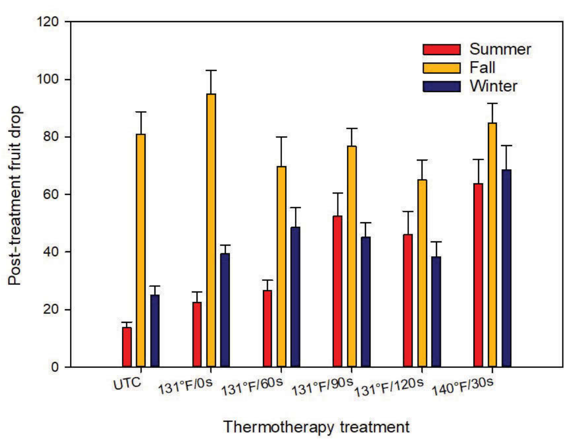

Figure 3. Yield by season of treatment and the temperature and time treatments for harvest in 2016, 2017 and 2018.

yield recovered by 2017 and was stable in 2018. The one treatment where the yield did not follow the expected pattern was 131°F for 60 seconds; yield was lower than other treatments for all three years but it is unknown why.

For treatments applied in the fall, there was less severe initial damage, except at 140°F for 30 seconds. The 2017 yield did not recover as it had for the summer treatments, but yield was low that year overall, so it is difficult to demonstrate that the treatments were the only cause of the low yield. Recovery continued into 2018. One possible explanation for the particularly low yield in the fall treatments is that the roots were more damaged by the fall treatments than other seasons because of the timing of the fall root flush.

The winter treatments had the worst initial crop damage, which was uniform across all treatments. This was likely because the treatments were approximately one month prior to harvest. In 2017, the recovery was nearly complete, except in the most severe treatments. For the 2018 harvest, all treatments had yields equivalent to the UTC.

When the treatments were done in the spring of 2016, the initial damage was relatively light, possibly because the trees were still balancing their fruit loads by drop and could compensate for the loss of fruit. Full yield recovery occurred in the first year after treatment, but we have not collected two years post-treatment yet to see if this trend is stable.

Based on the two years of yield data post-treatment, spring seems to have the best response, but we did not see a statistically significant effect of season. The effect of the treatments was not consistent for each season over time. We plan to collect one final harvest to see if the trend remains stable. While the trees were able in some cases to recover to pre-treatment yields, it was disappointing not to see an improvement in yield that would correspond to an improvement in tree health.

QUALITY

A subset of the harvested fruit was brought to the Citrus Research and Education Center (CREC) pilot plant to assess the fruit quality and determine if there was a change in fruit size. We looked at total soluble solids (TSS), brix, acid, the brix/acid ratio and color. There were no significant differences among any of the treatments for any measurement. The one observed trend was that TSS in 2016 was lower than 2017 and 2018, but this difference was not attributable to our treatments. Similarly, there was no change in fruit size, which in other experiments has been an early indication of improved tree health.

When we look at the levels of HLB bacteria (*Candidatus* Liberibacter asiaticus) in the canopy and roots, we see movement between the two types of tissue in the three months post-treatment. Most commonly, a decrease of bacteria in the roots is detected. Whether the bacteria in the canopy decreases depends on season of treatment. The seasons that caused the greatest decrease in bacteria are spring and winter, but in no season do the bacteria disappear from the canopy as we originally hoped. The decreased root bacterial titer is likely because of the mobilization of root resources to produce new canopy.

CONCLUSION

Overall, thermotherapy does not improve yield enough to compensate for the damage caused to the canopy. If thermotherapy was to be part of a management plan, time of year for the treatments is very important. Based on only two years of data, spring appears to be the best time of year for treatment.

Only the most severe temperature and time combinations had a reduction in pre-harvest fruit drop, but they also caused the most post-treatment fruit drop. Quality was unaffected by thermotherapy treatments, indicating that tree health did not improve. From a preliminary economic analysis, it does not appear that the yield recovery in the years post-treatment pays for the fruit lost during thermotherapy.

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Updating the CRDF Business Plan

By Rick Dantzler

In 2009, the business plan for the Citrus Research and Development Foundation (CRDF) was adopted by the board of directors. Since then, the industry has evolved in the face of HLB, and so must CRDF. Lessons have been learned, and our knowledge of greening has greatly expanded. Our challenge is to now convert this knowledge to practical use for growers.

It is against this backdrop that the current board of directors of CRDF is updating the organization's business plan. The draft which the board is considering places greater emphasis on applied research — research aimed at providing immediate, practical help to growers who are trying to squeeze additional yield from greening-infected trees. To be sure, there are still basic research questions to be answered, but helping growers stay in business until long-term solutions can be found must be our highest priority.

The document lays out in clear terms the role of CRDF, as well as how it shall manage the research it funds. Of special note to growers is the document does not prohibit CRDF from going wherever it must to find the answers the industry needs.

Regarding the process for making research decisions, the draft maintains review of proposals by unbiased, third-party advisors for assurance that proposals have scientific merit and a reasonable opportunity for practical benefit to growers. Likewise, it gives CRDF the ability to move quickly so it can take advantage of research ideas or opportunities that manifest themselves at any point during the year.

It clearly states that assisting in field evaluations and data collection and distribution is an allowable CRDF activity. Whether to do this is still being considered by the board, but if there is a role for CRDF to play and the board agrees, the document would allow it.

Finally, it stays true to the initial intent of the founders of keeping CRDF lean administratively. In fact, CRDF has reduced its office personnel by 25 percent in the last two months.

The next board meeting is Dec. 11. At this meeting, the board will again consider the draft business plan. If you have suggestions for what it should or should not include, please let us know. After all, the Florida citrus industry is the ultimate intended beneficiary of CRDF's work, so it is completely appropriate for you to have input, and we welcome it.

You may email your ideas to support@citrusrdf.org or call us at 863-956-8817.

Rick Dantzler is chief operating officer of the Citrus Research and Development Foundation.

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