

Developing Field Strategies to Correct Alternate Bearing (II)

Carol Lovatt
UC Riverside

Cooperators: Darren Haver, Joanne Watkins and Christopher Martinez – South Coast Research and Extension Center

When 'Hass' avocado trees produce an on-bloom and set an on-crop, the apical (and axillary) buds on the spring shoots, which would normally produce vegetative shoots during the summer and fall, are inhibited by the young developing fruit. Inhibition of summer shoot growth reduces the number of nodes that can bear floral shoots the next spring. It is important to note that summer shoots contribute > 60% of the spring bloom. The objectives of the research were to adapt prior trunk-injected and foliar-applied PGR treatments that showed promise in overcoming correlative inhibition (auxin > cytokinin) of summer vegetative shoot growth and inhibition of spring bud break (endodormancy, ABA > cytokinin) during the on-crop year as foliar- and irrigation-applied PGR treatments for use on 'Hass' avocado. The research was conducted at the South Coast Research and Education Center (SCREC). A commercial (synthetic) cytokinin (6-benzyladenine, 6-BA) plus auxin-transport inhibitor (triiodobenzoic acid, TIBA) treatment was compared with a proprietary (naturally plant product) cytokinin (PCK) plus auxin-transport inhibitor (NATI) treatment. The PGR combinations were applied in July 2012 and again in January 2013 as foliar-sprays (100 mg/L each). In this experiment, a second set of on-crop trees was treated again during the putative of-crop year. This experiment also included inflorescence pruning, in which 3 out of 10 major floral branches were removed (J. Dixon) and S-abscisic acid (S-ABA, a growth inhibitor) sprayed in spring 2012 at 500 and 2000 mg/L in an 18"-wide strip on two sides of the tree parallel to the row. Both treatments were designed to reduce fruit set by the on-bloom sufficiently early to increase the yield of large size fruit in the on-crop year and total yield the following year. In a second experiment, 6-BA and TIBA were applied through the irrigation system (4 g each/tree). To test the concept, 6-BA plus TIBA were sprayed directly onto the soil under the canopy of each tree (4 g each/tree) and mulch under each tree was removed before the soil spray and replaced immediately after application; the mulch was left in place for the irrigation application.

Results

Experiment 1 - Year 1 (2012-2013). On-crop control trees and on-crop trees treated with the proprietary natural product cytokinin (PCK) plus natural auxin-transport inhibitor (NATI) applied in July and again in January had significantly greater yields as lb ($P = 0.0016$) and number of fruit ($P = 0.0003$) per acre than off-crop control trees and on-crop trees that underwent inflorescence pruning, which reduced total yield to that of the off-crop control trees. Both S-ABA concentrations and 6-BA plus TIBA applied in July and January reduced total yield as lb and number of fruit per acre to values intermediate to and not significantly different from the off- and on-crop control trees and on-crop trees treated with PCK plus NATI. There were no significant treatment effects on the yield of commercially valuable size fruit (packing carton sizes 60+48+40) as lb per acre. On-crop control trees produced a significantly greater number of commercially valuable size fruit per acre compared to off-crop control trees and on-crop trees that underwent inflorescence pruning in Year 1 ($P = 0.0768$). All PGR-treated trees had yields of commercially valuable size fruit as number of fruit per acre that were intermediate to and not significantly different from the on- and off-crop control trees. Both cytokinin plus auxin-transport inhibitor treatments increased the time it took for fruit to ripen to "eating soft" compared to the off-crop control trees and trees that underwent inflorescence pruning in Year 1 ($P = 0.0128$). A significantly greater proportion of the fruit harvested from on-crop control trees and on-crop trees treated with the low S-ABA concentration or 6-BA plus TIBA had peels that turned black relative to fruit from the off-crop control trees and trees that underwent inflorescence pruning in Year 1 ($P = 0.0482$). There were no other treatment effects on fruit quality.

Year 2 (2013-2014). All on-crop trees in Year 1 had significantly lower yields in Year 2. There were no significant treatment effects on total yield, fruit size or fruit quality in Year 2. It should be noted that reducing

the on-crop yield to the level of the off-crop control trees by inflorescence pruning in Year 1 did not significantly increase yield in Year 2. Applying 6-BA plus TIBA or PCK plus NATI in both the on- and off-crop years provided no benefit over treating only in the on-crop year.

Cumulative Yield. Two-year cumulative total yields for the off- and on-crop control trees were not significantly different as lb/110 trees/acre. Trees treated with PCK plus NATI applied in July plus January only during the on-crop year produced 2-year cumulative total yields (lbs/acre) that were significantly greater than on-crop trees treated with 6-BA plus TIBA in July plus January in Year 1, trees that underwent inflorescence pruning in Year 1, and the off-crop control trees, but not significantly different from the on-crop control trees or trees treated with some of the other PGRs ($P = 0.0031$). There were no significant treatment effects on yield of commercially valuable size fruit as lb/acre. Trees treated with PCK plus NATI applied in July plus January (Year 1) produced 2-year cumulative total yields as number of fruit/acre that were significantly greater than the off-crop control trees, trees that underwent inflorescence pruning (Year 1), trees treated with S-ABA (2,000 mg/L) (Year 1), and trees treated with 6-BA plus TIBA in July plus January (Year 1), but not significantly different from the on-crop control trees or other PGR-treated trees ($P = 0.0005$). Trees treated with PCK plus NATI applied in July plus January (Year 1) produced 2-year cumulative yields of commercially valuable size fruit as number of fruit/acre that were significantly greater, but only at the 10% level, than trees that were inflorescence pruned (Year 1) and trees treated with 6-BA plus TIBA in July plus January (Year 1), but not significantly different from trees in all other treatments, including the on- and off-crop control trees. Trees treated with PCK plus NATI applied in July plus January (Year 1) produced the greatest 2-year cumulative crop value per acre but it was not significantly different from any other treatment.

Experiment 2 - Year 1 (2012-2103). Trees treated with 6-BA plus TIBA applied through the irrigation produced the greatest total yields as lb and number of fruit per tree, but not significantly greater than the on-crop control trees. Trees with the 6-BA plus TIBA sprayed directly onto the soil to test the concept produced intermediate yields not significantly different from the on-crop control trees or on-crop trees receiving 6-BA plus TIBA via the irrigation. However, 6-BA plus TIBA applied through the irrigation significantly increased the yield of fruit of packing carton size 48 and the combined pool of fruit of packing carton sizes 60+48+40 as lb ($P = 0.0327$) and number of fruit per tree ($P = 0.0395$) compared to the on-crop control trees. Trees with the 6-BA plus TIBA sprayed directly onto the soil produced intermediate yields of commercially valuable size fruit not significantly different from the on-crop control trees or on-crop trees receiving the 6-BA plus TIBA via the irrigation. There were no significant treatment effects on any fruit quality parameter.

Year 2 (2013-2014). Trees treated with 6-BA plus TIBA applied through the irrigation or sprayed onto the soil produced total yields and yields of commercially valuable size fruit, as both lb and number of fruit per acre that were not significantly different from the on-crop control trees. For trees treated with 6-BA plus TIBA sprayed directly onto the soil, yield was substantially lower. Fruit from trees treated with 6-BA plus TIBA sprayed onto the soil in July plus January (Year 1) were significantly longer ($P = 0.036$) and wider ($P = 0.0101$) than fruit from the on-crop control trees (Table 21). There were no treatment effects on any other fruit quality parameters.

Cumulative Yield. There were no significant treatment effects on 2-year cumulative total yield as lb or number of fruit per tree. Due to increases in the yield of commercially valuable size fruit achieved in Year 1, trees treated with 6-BA plus TIBA (4 g each/tree) through the irrigation in July plus January (Year 1) produced a greater 2-year cumulative yield of commercially valuable size fruit as lb ($P = 0.0655$) and number of fruit per acre ($P = 0.0717$) than the on-crop control trees. As a result, trees treated with 6-BA plus TIBA through the irrigation in July plus January (Year 1) produced a 2-year cumulative crop value that was significantly greater (US\$ 6,829) than the on-crop control trees ($P = 0.0440$) (Table 24). The results demonstrate a potential benefit from providing 6-benzyladenine plus triiodobenzoic acid through the irrigation on 'Hass' avocado fruit size and grower income, but clearly further research beyond one experiment is required.

Take Home Message

Foliar application of a cytokinin plus an auxin transport inhibitor to on-crop trees did not produce the positive effects on yield and fruit size that we obtained in our previous preliminary experiments using trunk injection and foliar-application of these PGRs. Trees treated with PCK plus NATI applied in Year 1 produced only a marginally greater 2-year cumulative crop value per acre that was not significantly different from any other treatment. Whether this was due to the much higher on-crop yields in this current experiment compared to our previous experiments or PGR rates were too high or too low relative to previous rates will require further research. The irrigation application of the synthetic cytokinin plus auxin transport inhibitor significantly increased the yield of commercially valuable size fruit in the on-crop year and as 2-year cumulative yield, resulting in a significant increase in income. The treatments show promise but further research would be required. In each experiment, only one concentration of each PGR, with the exception of S-ABA, was tested. Optimizing the concentrations of the foliar-, irrigation- and soil-applied PGRs by testing different concentrations was not an option due to a lack of available trees. Further research would clearly be required to develop the use of a foliar- or irrigation-applied cytokinin plus auxin-transport inhibitor treatment, inflorescence pruning or fruit thinning with S-ABA into a reliable commercial practice to mitigate alternate bearing and increase yield of commercially valuable size fruit and grower income.

Benefits to the Industry

A side benefit of this research was the demonstration that trees can be managed to obtain good yields despite the use of reclaimed irrigation water.

Acknowledgement.

The author thanks Darren Haver, Director of the SCREC, for use of the station's facilities, staff and services during the period of this research. We especially thank Joanne Watkins and Chris Martinez, for implementing our tree fertilization, irrigation and *phytophthora* management programs.