Optimization of Gibberellin and Cytokinin-based programs for control of flowering and crop load in 'Honeycrisp'

Steve van Nocker‡, Chris Gottschalk†, M. John Bukovac‡, and Phil Schwallier*

‡ Department of Horticulture, Michigan State University, East Lansing, MI 48824
† Graduate Research Assistant, Plant Breeding, Genetics, and Biotechnology, Michigan State University, East Lansing, MI 48824
*MSU Extension, Michigan State University, East Lansing, MI 48824

Project Summary

The plant hormone gibberellin (GA) and cytokinin (CK) influences the flowering process in many plants. In apple, GA both promotes vegetative growth and represses flowering while cytokinin is believed to promote flowering. We evaluated the potential use of exogenous CK (Maxcel) and GA inhibitors (Piccolo and Apogee) 'summer sprays' for promotive effects on flowering in the following year (return bloom) in 'Honeycrisp'. We found that both the GA inhibitors and CK were ineffective at promoting a return bloom. We also evaluated the potential to use exogenous GA to repress flowering the following year (return bloom) in 'Honeycrisp'. In 2018, we applied a commercial formulation of GA_3 (ProGibb) as a foliar spray at 4, 6, or 8 weeks after full bloom (WAFB) to lightly bearing 'Honeycrisp' trees in a high-density planting at the MSU Clarksville Research Center. These treatments significantly reduced return bloom in 2019, resulting in increased fruit size, red coloration, firmness, and sugar concentration, without reducing yield per tree. GA summer sprays may be an effective alternative or complement to spring flower/fruit thinning for reducing crop load and increasing fruit quality.

Figure 4. Fruit collected from the treated trees (white arrow) vs control trees (red arrow) by the field crew at CRC.

Figure 6. The Compac Spectrim System at the Michigan State University's Ridge Apple Quality Lab. Photo: Amy Irish-Brown

GA Experiment Methods

2016 Season

We utilized a block of high-density and uniform sized 'Honeycrisp' trees at the Clarksville Research Station (CRC) in Clarksville, MI. The 'Honeycrisp' trees were more than five years old and grown on 'Bud9' in a row of 82 contiguous trees. Treatment blocks were organized in sets of ten replicate trees with a single buffer tree between treatments. All trees were completely thinned of blossoms or fruit within two weeks of full bloom to promote return bloom. We then applied GA_3 (ProGibb, Valent BioSciences, Libertyville, IL) + 0.1% surfactant (Regulaid, KALO, Overland Park, KS) at a concentration of 200 ppm at one-week intervals beginning at 5 WAFB and continuing thru 8 WAFB. Control trees received an application of 0.1% Regulaid surfactant only at 5 WAFB. Applications were performed using a commercially available backpack sprayer until foliar runoff was observed. Return bloom was calculated in the spring of 2017 by selecting three random branches and counting the number of flowering spurs and nonflowering spurs.

2018 Season

We utilized a new orchard block of high-density and uniform sized 'Honeycrisp' trees at the CRC. The 'Honeycrisp' trees used in this season were in their third leaf grown on 'Bud9' in a slender spindle system organized in paired rows of 84 trees. The paired rows of 'Honeycrisp' alternated with paired rows of 'Gala', which facilitated the use of replicate treatment blocks that were isolated from one another. In the spring of 2018, all trees were completely thinned of blossoms or fruit within two weeks of full bloom to promote return bloom. We then applied GA_3 at a concentration of 400 ppm + 0.1% Regulaid as single applications on a two-week interval beginning at 4 WAFB through 12 WAFB. Each application of GA_3 was made to three replicate sets of five trees each positioned in the separate rows. Each row also contained a set of five trees to serve as controls that received an application of 0.1% Regulaid surfactant only at 4 WAFB. Applications were again performed using a commercially available backpack sprayer until foliar runoff was observed. Return bloom was calculated in the spring of 2019 by selecting three random branches and counting the number of flowering spurs and nonflowering spurs per each replicate tree. Tree yield was determined by collecting all the fruit that remained on three representative trees per treatment replicate at the time of commercial 'Honeycrisp' harvest (September 17th, 2019). Fruit size and coloration measurements were obtained by processing five random fruit collected from each tree using a commercial sorting machine (Compac Spectrim System; Auckland, NZ) at the Michigan State University's Ridge Apple Quality Lab (Fig. 6). Fruit firmness was calculated using a standard fruit pressure tester (QA Supplies, Norfolk, VA). Brix was calculated using a digital Brix refractometer (Atago, Bellevue, WA) using juice collected during the firmness test.

Ongoing Research

In 2019, we conducted a new trial of applying GA_3 at 400 ppm as a double spray separated by a two-week interval at 4 and 6 WAFB, respectively. We selected a 4 + 6 WAFB application scheme as these time points exhibited the strongest repression response as a single spray when trialed in 2018. Here, our field design is set up to include three replicate treatment blocks of 18 trees each. We anticipate this application approach will elicit a strong repression of flowering in 2020. Other questions concerning the use of GA/CK that we still want to address include:

How does GA-mediated flower repression compare to chemical and/or fruit thinning regarding tree yield and fruit quality?

Does the GA approach offer any economic adavantages over traditional thinning methods?

What flowering responses do combination sprays (e.g. GA + CK) elicit in 'Honeycrisp'?

Are muiltiple applications of GA, CK, or GA+CK more effective than a single application?

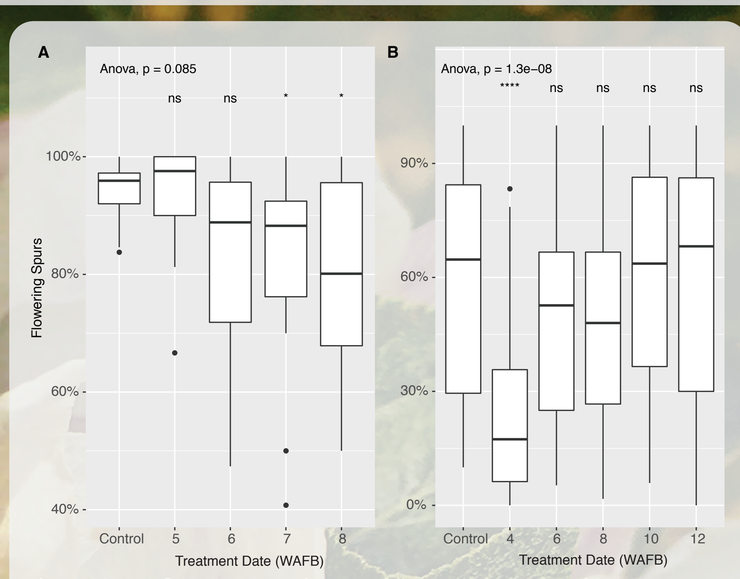

Figure 1. Percent flowering spurs in the season following the application of GA_3 in 'Honeycrisp'. A) Percent flowering spurs during the 2017 growing seasons following GA_3 application at 200 ppm during the 2016 growing season. Signification repression of flowering was observed when GA_3 was applied at 7 and 8 WAFB. B) Percent flowering spurs during the 2019 growing seasons following GA_3 application at 400 ppm during the 2018 growing season. Signification repression of flowering was observed when GA_3 was applied at 4 WAFB. Repression of flowering was also observed at 6 and 8 WAFB, although not to a significant threshold. WAFB - Weeks after full bloom; Student's T-test - * P<= 0.05, **** P<= 0.0001.

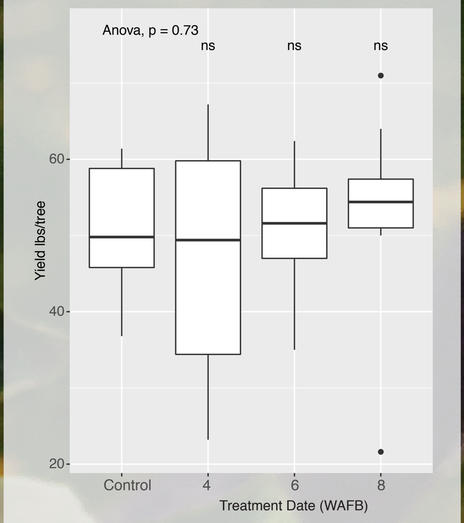

Figure 2. Yield per tree in the 2019 season following GA_3 application during the 2018 season. WAFB - Weeks after full bloom; Student's T-test - ns = not significant.

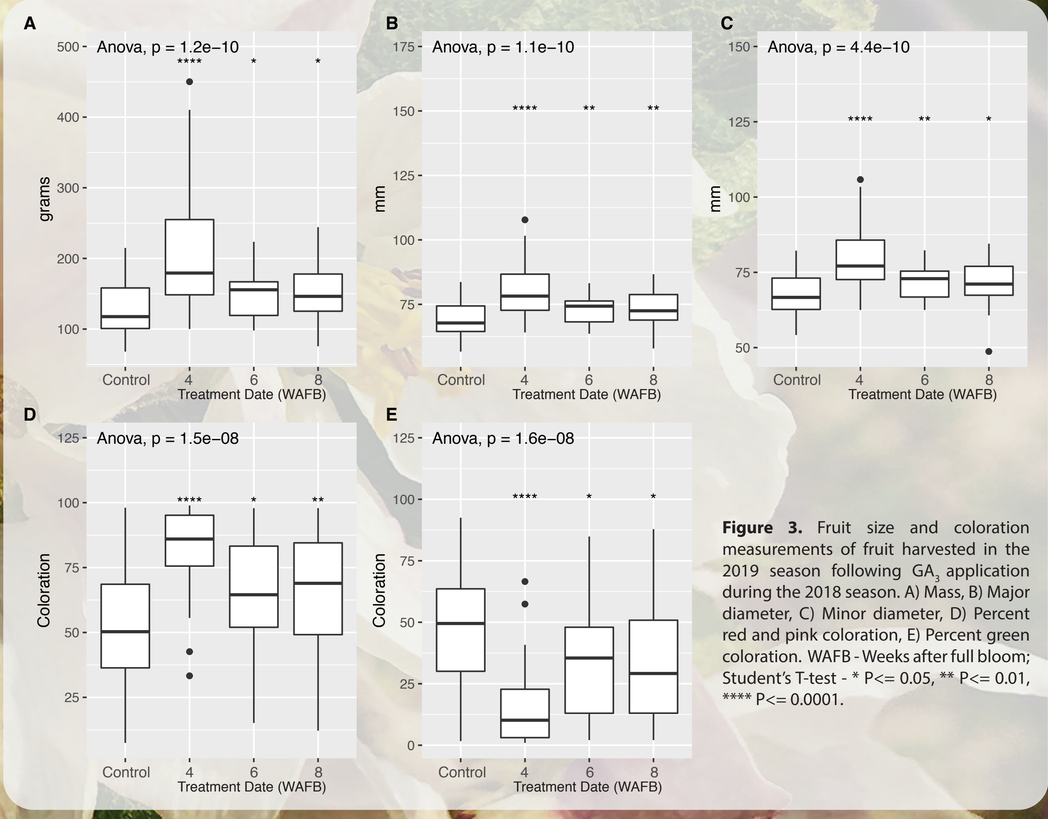

Figure 3. Fruit size and coloration measurements of fruit harvested in the 2019 season following GA_3 application during the 2018 season. A) Mass, B) Major diameter, C) Minor diameter, D) Percent red and pink coloration, E) Percent green coloration. WAFB - Weeks after full bloom; Student's T-test - * P<= 0.05, ** P<= 0.01, **** P<= 0.0001.

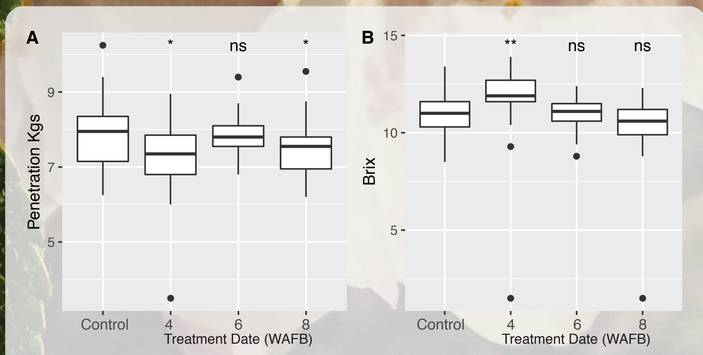

Figure 5. Firmness and Brix measurements of fruit harvested in the 2019 season following GA_3 application during the 2018 season. A) Fruit firmness, B) Soluable sugar content. WAFB - Weeks after full bloom; Student's T-test - ns = not significant, * P<= 0.05, ** P<= 0.01.