Breaking the Biennial Bearing Cycle in Apple with Arrange™ PGR

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A major apple problem in commercial apple production worldwide is biennial or alternate bearing. Many of our commercial apple varieties are prone to biennial bearing, but some are worse than others. Fuji is one of the worst, and Honeycrisp can be as well. Control of biennial bearing can be very challenging and certainly is one of the most difficult tasks apple growers face every year. Growers must use a number of management techniques to regulate fruiting and flowering to increase flower bud formation. Pruning, chemical thinning with PGR's, rootstock selection, and summer return bloom programs (Cowgill, Autio, 2016) with PGR's all can be used. We have gotten better at these practices with our precision thinning programs (Francescatto and Robinson, 2016) and (Schwallier, 2015). There is another approach, however, that has been studied for over 50 years that will provide a complementary addition to the other programs for varieties that that are very biennial. That is the ability of gibberellins to inhibit flowering in pome fruit (Green, 2000). In 1981, Marino and Greene (1981) detailed the involvement of gibberellins in the biennial bearing of Early McIntosh apples. Schmidt (2006) did multiple experiments looking at cropload and flower manipulation with gibberellins and other PGR's on apple. Suppression of apple bloom with gibberellin sprays was shown by Unrath and Whitworth (1991).

There are many different commercially available gibberellins labeled for apples that result in better fruit quality (reduced russeting) and enhanced fruit set after a freeze at bloom. The historical work has shown that some gibberellins applied in the off year can reduce bloom in the on year, thereby reducing the biennial bearing cycle. Green (1992) found both GA_4 and GA_7 inhibited return bloom on Redspur Delicious, although GA_7 inhibited flowering more severely. Four sprays of GA_3 or three of GA_{4+7} at 250 mg·L–1 essentially eliminated flowering in Gala, whereas it was not quite enough on Pink Lady. Davis (2002) observed that GA_{4+7} more effectively suppressed flowering than GA_3 on Ramey York in Blacksburg, Virginia.

There are many different formulations of GA with different concentrations of the active ingredients. Personal communication with Jim Scrugss, Fine Americas, Inc., indicates that most commercial formulations of gibberellins for apple contain various concentrations

Figure 1. Treatments applied to single trees with a Solo 451 sprayer.

of GA_4 and GA_7. What varies is the ratio of these two gibberellins in the commercial product. For instance, GA_4 has a minimal effect on return bloom while GA_7 is significantly more active according to Scruggs.

Arrange™ Trial New Jersey

Arrange™, plant growth regulator for use on apple was labeled in 2020 by Fine Americas, Inc. "to mitigate the biennial bearing cycle in apple varieties prone to producing crops in a biennial cycle". When applied to trees in the "off" bearing year, when fruit load is low, Arrange can be used to reduce the return bloom of the apple trees in the following "on" bearing year when fruit set/load would normally be heavier.

In 2020 and 2021 multiple trials in New York and New Jersey were conducted to confirm the efficacy of Arrange to modify biennial bearing on apple in commercial blocks. This article includes brief results from the 2020 trial at Wightman Farms, Morristown, NJ. Two varieties were selected, Crispen and Fuji planted to a tall spindle system, on full dwarfing rootstock. Trees were 7-years old and approximately 11 feet tall for Crispen and 9 feet tall for Fuji. The study was set up as a completely randomized trial with 10 single-tree replications with no buffer tree on each side of the treatment tree.

Treatments were applied June 13, 2020 at 100 gallons per acre tree row volume with a backpack Solo 451 air powered sprayer (Figure 1). Only one application was applied. The label allows for multiple applications, but 100ppm total. Both Arrange treatments were applied with Regulaid surfactant at 1 quart/100 gallons. Treatments were as follows:

1) Untreated control
2) 100 ppm - label rate (1 gallon/100gallons)
3) 200 ppm - 2x Label rate (2 gallons/100 gallons)

In May of 2021, bloom was evaluated for each tree. The total number of flowering spurs was counted, and total number of resting spurs was counted. The binomial data set was analyzed using JMP software ver. 14.0 from SAS, Fit Y by X Platform, Analysis of Means of Proportions procedure, alpha = 0.05.

For Fuji, both treatments significantly reduced flowering (Table 1). One hundred ppm and 200 ppm reduced return bloom to 60% and 47% of spurs, respectively. For Crispen, both treatments also significantly reduced flowering, but the 100 ppm and 200 ppm were not significantly different from each other (Table 1).

Table 1. The effects of Arrange application in 2020 on bloom in 2021 (percent of spurs flowering).

Application rate (ppm)	Fuji	Mutsu
0	75	74
100	60	55
200	47	47

Reductions were 55% and 47% for 100 ppm and 200 ppm, respectively.

These reductions in bloom should help break the biennial bearing cycle in these trees.

Future and Ongoing Research

For the past three years we have been looking at GA_7 as Arrange for reducing flower bud formation on apple in the nursery and in first-year established apple orchards. While this is not a labeled use yet, the data are indicating that this may be an efficacious way that nursery apples can be treated to reduce or eliminate bloom so there is not a fireblight issue on the subsequent blooming of this newly planted trees. This has been a significant issue on newly planted high density apple orchards.

More on this line of research will be forthcoming as data is collected.

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