Effects of Chemical Thinners on Fruit Set, Yield, Fruit Size, and Fruit Quality of Honeycrisp Apple

J. R. Schupp

Dept. of Horticultural Sciences, Hudson Valley Lab, Cornell University, Highland, NY

Since Honeycrisp is a new variety, optimal thinning chemistries and rates are unknown. Based on this research, Honeycrisp is relatively easy to thin chemically at the traditional 10-12 mm growth stage. Best results were with NAA at 5 ppm, or the combination of 2.5 NAA plus 1 pint Sevin XLR/ 100 gal. Honeycrisp appears to be very sensitive to benzyladenine (Accel), and is easily over-thinned with this chemical.

Honeycrisp is being extensively planted as growers seek profitable new cultivars to diversify their variety mix. Because it is new, Honeycrisp has not been well studied and there is little information available to make recommendations about specific horticultural practices. Chemical thinning is important for managing crop load, fruit size and quality, and for increasing return bloom of apple. The optimal thinning chemistries and rates are variety specific. This study was initiated to evaluate the effect of chemical thinners on fruit set, yield, fruit size, and fruit quality of Honeycrisp.

Materials and Methods

These studies were conducted in a commercial orchard in Milton, NY, in 1999, 2000, and 2001 on fifth, sixth, and seventh leaf Honeycrisp/M.26 trees, respectively. To avoid complications due to differences in bloom density, different trees were used in each year. The trees were planted at 8 X 16 ft. spacing with trickle irrigation, and trained to the vertical axe system.

Chemical thinners were applied to drip with an air-blast sprayer when the largest fruit were 10-12 mm in diameter. The flower clusters on one or two scaffold limbs per tree were counted at bloom and the number of fruits remaining after June drop were counted on the same limbs. Fruit set was calculated as the ratio of fruits per 100 flower clusters. The fruit were harvested in three or four pickings each season and weighed. The total yield per tree was the sum of all harvests. A sample of 20 fruits per tree was evaluated for mean fruit weight, diameter, percent blush, incidence of bitter pit, and firmness.

Experiments 1 and 2: Experiments to evaluate a range of napthaleneacetic acid (NAA) concentrations, with and without carbaryl, as well as carbaryl alone, and Accel plus carbaryl were conducted in 1999 and 2000. The treatments were: 1) untreated control; 2) carbaryl, 600 ppm (Sevin XLR Plus, 1 pint/100 gallons); 3) NAA, 2.5 ppm (Fruitone N, 1 oz./100 gal.); 4) NAA, 5 ppm (Fruitone N, 2 oz./ 100 gal.); 5) NAA, 7.5 ppm (Fruitone N, 3 oz./100 gal.); 6) NAA, 2.5 ppm plus Sevin; 7) NAA, 5 ppm plus Sevin; and 8) benzyladenine, 75 ppm, plus carbaryl (Accel, 53 fl. oz/100 gal plus Sevin).

Experiment 3: This experiment was conducted in 2001 to evaluate two rates of Accel, with and without carbaryl, compared to NAA plus carbaryl and an untreated control. The treatments were: 1) untreated control; 2) NAA, 2.5 ppm plus Sevin; 3) benzyladenine, 50 ppm, (Accel, 35.3 fl. oz/100 gal); 4) benzyladenine, 75 ppm, (Accel, 53 fl. oz/ 100 gal); 5) benzyladenine, 50 ppm, plus carbaryl (Accel, 35.3 fl. oz/100 gal plus Sevin); and 6) benzyladenine, 75 ppm, plus carbaryl (Accel, 53 fl. oz/100 gal plus Sevin).

Results and Discussion

Experiments 1 and 2: NAA at 5 ppm or greater concentrations, as well as 2.5 ppm NAA plus carbaryl provided thinning activity on Honeycrisp (Table 1). NAA alone at 2.5 ppm and carbaryl alone appeared to provide some mild thinning, but the effect on fruit set was not significant. NAA at 7.5 ppm did not remove more fruit than NAA at 5 ppm. The tank mix sprays of 5 ppm NAA plus Sevin, and Accel plus Sevin both over-thinned Honeycrisp severely. The fruit set results followed similar trends in 2000, although there was greater variability within the experiment, and few statistical differences as a result. Accel plus Sevin over-thinned Honeycrisp again.

Yield per tree followed the same trends as fruit set (Table 2). Five ppm NAA tank mixed with Sevin greatly reduced yield in 1999. Accel plus Sevin greatly reduced yield in both years.

In 1999, Accel plus Sevin and 5 ppm NAA plus Sevin increased mean fruit weight relative to unthinned trees, with the other thinning treatments resulting in intermediate values (Table 3). Mean fruit weights were more variable in 2000, and only the severely thinned Accel plus Sevin trees produced larger fruit than the controls. Mean fruit diameter exceeded 3 inches for all thinning treatments in both years (data not presented). Fruit from excessively thinned trees was especially large and had more bitter pit at harvest than fruit from moderately thinned trees (data not presented). Honeycrisp is susceptible to bitter pit in part due to the large size of its fruit (Schupp et al., 2001a). Thus thinning

lightly to produce optimal crop load is important not only for obtaining good productivity, but to prevent excessive loss of marketable fruit due to bitter pit.

Chemical thinners had no effect on red fruit color, and all thinning treatments increased soluble solids slightly, compared to the unthinned control (data not presented). Fruit from Accel-treated trees were firmer than other treatments, despite the very large size (data not presented).

Honeycrisp leaves often develop a zonal chlorosis that resembles potato leafhopper damage (Rosenberger et al., 2001). Studies at Cornell's Hudson Valley Lab have shown that the damage is caused independently of the presence of potato leafhopper (Schupp, et al., 2001b). Differences in the severity of zonal chlorosis between trees in the 1999 experiment were observed and visually rated on a 1-5 scale, where 1= no chlorosis and 5=100 percent chlorotic. The chemical thinners tested provided a range of crop loads on the trees, and the severity of the chlorosis was inversely related to crop load. Leaf rating ranged from 1.8 on the untreated controls with the heaviest yield, to 4.5 on the Accel + carbaryl treated trees, which had the lightest crop (Table 4).

Based upon preliminary research, the zonal chlorosis of Honeycrisp leaves appears to have a physiological cause, and may be triggered by the buildup of starch grains in the chloroplasts. Schupp, et al (1992) reported that deblossoming Golden Delicious apple trees led to development of numerous large starch granules in the chloroplasts, which disrupted the membranes, leading to chlorosis. Similarly, Schaffer et al. (1986) reported chlorosis and chloroplast disruption due to starch buildup in leaves of de-fruited, girdled citrus trees. It may be that anatomical differences in Honeycrisp leaves may impair phloem loading, causing the leaves to be more susceptible to this injury. We have cooperative research underway with Drs. Lailiang Cheng, Dept. of Horticulture, Cornell, and Teresa Snyder-Lieby, Dept. of Biology, SUNY New Paltz, to determine if this hypothesis is valid.

Experiment 3: Fruit set was low in this experiment, even in the untreated trees (Table 5). Accel severely over-thinned Honeycrisp, even when applied alone at two-thirds the standard rate. Benzyladenine (Accel) at 50 ppm reduced yield by 74 percent. Increasing the benzyladenine concentration to 75 ppm or adding carbaryl reduced yield by 86 to 93 percent. Fruit size was excessively large for all Accel-treated trees. The combination of 2.5 ppm NAA plus carbaryl had no effect on fruit set, yield, or mean fruit weight, which was a desirable outcome in this season's lightly cropped trees.

Return bloom in all three experiments was low for all but the over-thinned trees (data not presented). Honeycrisp is a large fruited variety, and thinning it severely enough to assure return bloom not only reduced yield, but also caused the remaining fruit to be excessively large and more susceptible to bitter pit. It is unlikely that alternate bearing in Honeycrisp will be managed by thinning at the 10-12 mm fruit growth stage alone.

Alternative strategies to promote return bloom in alternate bearing varieties include reducing the crop load earlier, (i.e. at bloom or at petal fall), and spraying with ethephon or NAA five to six weeks after petal fall (Agnello et al., 2003). Investigations to determine the critical time period for crop load adjustment and to evaluate the efficacy of plant growth regulators to stimulate flower formation are underway, but the results are not definitive at the time of writing.

Summary

Based on this research, Honeycrisp is a large-fruited cultivar that is relatively easy to thin chemically at the traditional 10-12 mm growth stage. For a starting point, I suggest NAA at 5 ppm, or the combination of 2.5 ppm NAA plus 1 pint Sevin XLR / 100 gal. If initial set is very heavy and a stronger thinning response is needed, try the combination of 5 ppm NAA plus 1 pint Sevin XLR / 100 gal. Honeycrisp is very sensitive to benzyladenine, and is easily over-thinned with this chemistry. I recommend that growers not use this material to thin Honeycrisp, unless they are trying to de-fruit young trees to encourage more vegetative growth.

TABLE 1

Effect of thinning treatments on Honeycrisp fruit set (%).

Treatment	1999	2000
Control	66 a	81 a
Sevin XLR	55 ab	71 a
NAA 2.5 ppm	51 ab	71 a
NAA 5 ppm	38 b	64 ab
NAA 7.5 ppm	43 b	62 ab
NAA 2.5ppm + Sevin	39 b	61 ab
NAA 5 ppm + Sevin	19 c	56 ab
Accel + Sevin	2 d	41 b

TABLE 2

Effect of thinning treatments on Honeycrisp yield (kg).

Treatment	1999	2000
Control	49 a	116 a
Sevin XLR	37 ab	102 ab
NAA 2.5 ppm	41 ab	110 a
NAA 5 ppm	41 ab	102 ab
NAA 7.5 ppm	33 ab	99 ab
NAA 2.5ppm + Sevin	36 ab	98 ab
NAA 5 ppm + Sevin	24 b	82 ab
Accel + Sevin	5 c	59 b

TABLE 3

Effect of thinning treatments on Honeycrisp fruit weight (g).

Treatment	1999	2000
Control	153 b	175 b
Sevin XLR	196 ab	203 ab
NAA 2.5 ppm	184 ab	194 b
NAA 5 ppm	208 ab	197 ab
NAA 7.5 ppm	190 ab	193 b
NAA 2.5ppm + Sevin	203 ab	198 ab
NAA 5 ppm + Sevin	249 a	207 ab
Accel + Sevin	225 a	238 a

TABLE 4

Effect of thinning treatments on Honeycrisp leaf chlorosis, 1999 (Scale of 1=none to 5=100% chlorotic).

Treatment	Yield (lb)	Chlorosis Rating
Control	107	1.8
Sevin XLR	81	2.5
NAA 2.5 ppm	90	2.3
NAA 5 ppm	90	2.8
NAA 7.5 ppm	73	3.0
NAA 2.5ppm + Sevin	80	2.3
NAA 5 ppm + Sevin	54	3.3
Accel + Sevin	12	4.5

TABLE 5

Effect of Accel, with or without Sevin on Honeycrisp set, yield, and fruit weight, 2001.

Treatment	Fruit Set (%)	Yield (kg)	Fruit Wt. (g)
Control	28 a	58 a	220 b
NAA, 2.5 ppm + Sevin	24 a	56 a	223 b
Accel 50 ppm	4 b	15 b	293 a
Accel 75 ppm	3 b	6 b	313 a
Accel 50 + Sevin	2 b	8 b	306 a
Accel 75 + Sevin	1 b	4 b	295 a

Rather than fruit size or quality, the challenge in thinning Honeycrisp is achieving adequate return bloom. It seems unlikely that chemical thinning at the traditional timing of 10-12 mm fruit diameter growth stage will result in adequate return bloom. Although our knowledge is not complete on how well these techniques will work on Honeycrisp, growers may want to conduct small-scale on-farm trials with blossom thinning or thinning at petal fall to see if earlier thinning results in increased return bloom.

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Jim Schupp is a research and extension professor at Cornell's Hudson Valley Lab. He specializes in the use of plant growth regulators in fruit crops.