Comparison of NAA and Carbaryl Petal-fall Sprays on Fruit Set of Apples

Max W. Williams¹

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Summary. Biennial bearing of apple trees can be overcome either by the use of a blossom chemical thinner or by early application of a postbloom thinner. Carbaryl (Sevin) is a post-bloom fruit-thinning chemical with an effective thinning period of 4 to 5 weeks after bloom. Sevin was compared in 1992 and 1993 with NAA as an early petal-fall spray. Sevin treatments reduced fruit set to one fruit per cluster with no adverse side effects on the foliage. NAA inconsistently reduced fruit set and the remaining fruit were in clusters. The NAA-treated foliage was adversely affected; having small curled leaves. NAA at 10 ppm under-thinned in 1992 and seriously over-thinned in 1993, whereas Sevin treatments were consistent for fruit thinning in both years. Sevin applied at petal-fall or at petal-fall + 7 days effectively reduced fruit set and reduced fruit competition.

Postbloom sprays of NAA and carbaryl (Sevin) are used for reducing fruit set of apples (*Malus domestica* Borkh.) The usual time of chemical application is when the largest fruit are 10 to 15 mm in diameter (Williams and Edgerton, 1981). Ap-

plication of sprays at the 10- to 15-mm fruit diameter stage takes advantage of warm weather conditions after spraying, thus increasing stress and reducing fruit set with a minimum effect on the seed number in the persisting fruit (Williams, 1989).

Elgetol, a blossom-thinning agent, was used previously in Washington and other western states before postbloom application NAA and Sevin, and there was no need for earlier timing of the NAA and Sevin sprays. In 1989, Elgetol was removed from the market by the manufacturer because of the high cost of re-registration. Without a blossom thinner or an early petal-fall spray there is no guarantee for a return bloom on severely biennial-bearing cultivars, even when adequate fruit thinning occurs with the later postbloom thinning sprays. Both NAA and Sevin are effective fruit thinners over a period of 4 to 5 weeks after full bloom (Batjer and Hoffman, 1968; Donoho, 1988; Washington State University, 1993; Williams and Batjer, 1964; Williams and Edgerton, 1981).

Early applications of NAA or Sevin at the petal-fall stage have not been evaluated thoroughly. This report compares the efficacy of the postbloom thinners NAA and Sevin as early petal fall sprays for reducing fruit set.

Methods

In 1992, two different thinning trials were conducted on 'Delicious', one at Wenatchee, Wash., and one in a commercial orchard at Quincy, Wash. The XLR Plus flowable 50% a.i. Sevin and the K salt of naphthalene acetic acid (NAA) were used in all trials. Regulaid, a non-ionic surfactant, was used with NAA at a rate of 0.125% (v/v). The chemical rates used on 'Delicious' are shown in Tables 1 and 2. Sulfcarbamide (D-88), 79% a.i., was included as a full-bloom spray in the Quincy trial. The chemical rate used on 'Fuji' apples are shown in Table 3.

In the Wenatchee trials, three uniform full-bloom trees of 14-year-old 'Oregon Spur Delicious' on M7 rootstock were selected. The number of blossom clusters on each of three limbs per tree were counted and recorded. In the Quincy trial, two limbs were counted on each of 10 trees of 'Oregon Spur Delicious' per treatment. The Wenatchee treatments were applied at full-bloom or at early petal-fall

as full-volume sprays with a high-pressure hand gun, and the Quincy treatments were applied at early petal-fall with a commercial air-blast sprayer. After fruit abscission, » 6 weeks after bloom, the number of fruit remaining on the previously counted limbs were counted and recorded. Data were subjected to analysis of variance, and means within treatments were compared using Waller-Duncan K ratio *t* test at $\alpha = 0.05$ (SAS Institute, 1987). Fruit set is expressed in the tables as the number of fruit per 100 blossom clusters and as percentage fruit set relative to the control. Seed number per fruit and average number of fruit per cluster were determined after natural fruit drop was complete.

The 1993 trials were conducted to confirm the 1992 results using the same methods as in 1992 Wenatchee trials. The cultivars Fuji, Granny Smith, and Delicious were included in the 1993 trials. Sprays were applied at petal-fall and 1 week later when king fruit were 5 mm in diameter.

Results

NAA at 5 ppm + Regulaid slightly increased fruit drop, but at the 10-ppm rate, NAA significantly increased thinning (Table 1). Sevin caused significant fruit drop on 'Delicious' and 'Fuji' (Tables 1-3). The petal-fall time application of Sevin was more effective than the full-bloom rime of application. A particularly noteworthy observation was the Sevin petal-fall treat-

Table 1. Effect of early sprays of NAA or Sevin on fruit set of 'Delicious' apples, Wenatchee, Wash., 1992.

Treatment ^a	Fruit set/100 blossom clusters	Control (%)
Control	65 a ^c	100
NAA 5 ppm + Reg. PF	54 a-c	83
NAA 10 ppm + Reg. PF	50 c-f	77
Sevin 0.125% (v/v) FB	52 b-d	80
Sevin 0.188% (v/v) FB	43 c-f	66
Sevin 0.125% (v/v) PF	38 e ^c	59
Sevin 0.188% (v/v) PF	35 f	54

^aFB=full bloom, PF=petal-fall, Reg.=Regulaid, a non-ionic surfactant, at 0.125% (v/v).

^cTreatments with common letters are not different by Waller-Duncan K ratio *t* test.

U.S. Department of Agriculture, Agricultural Research Service, Tree Fruit Research Laboratory, 1104 N. Westcm Avenue, Wenatchee, WA 98801.

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¹Plant Physiologist.

Table 2. Comparison of petal-fall sprays of Sevin, NAA, and D-88 on 'Delicious' apples, Quincy, Wash., 1992.

Treatment ^a	Fruit set/100 blossom clusters	Control (%)
Control	73 a ^y	100
NAA 5 ppm		
PF	56 b	77
Sevin 0.188% (v/v) PF	52 bc	71
D-88 0.375% (v/v) FB	40 c	55

^aFB = full bloom, PF = petal-fall.

^yTreatments with common letters are not different by Waller-Duncan K ratio t test.

Table 3. Effect of petal-fall sprays of Sevin on 'Fuji' apples, 1992.

Treatment ^a	Fruit set/100 blossom clusters	Control (%)
Control	74 a ^y	100
Sevin 0.188% (v/v) PF	45 c	61

^aPF = petal-fall.

^yTreatments with common letters are not different by Waller-Duncan K ratio t test.

ments reduced fruit number to one per cluster, compared with two to three fruit per cluster for NAA (Table 4).

Table 4. Seed number per fruit after NAA or Sevin petal-fall sprays on 'Delicious' apples, Wenatchee, Wash., 1992.

Treatment ^a	No. seed/fruit	Avg. no. fruit/cluster
Control	5.5 c ^y	3.5 cd ^x
NAA 5 ppm + Reg. PF	2.3 d	3.0 c
NAA 10 ppm + Reg. PF	3.5 c	2.8 bc
Sevin 0.188% (v/v) FB	7.5 a	1.5 b
Sevin 0.188% (v/v) PF	6.8 b	1.0 a
D-88 0.375% (v/v) FB	6.7 b	2.0 bc

^aFB = full bloom, PF = petal-fall.

^yAverage for 100 fruit per treatment.

^xAverage number of fruit after "June drop." Treatments with common letters are not different by the Waller-Duncan K ratio t test.

Table 5. Effect of early sprays of Sevin on fruit set of apples, 1993.

Cultivar and rate	Fruit set/100 blossom clusters		
	Petal-fall	Petal-fall + 7 days	Control
Delicious, 0.188% (v/v)	44 b ^z	54 b	86 a
Granny Smith, 0.188% (v/v)	62 b	48 c	84 a
Fuji, 0.188% (v/v)	51 b	66 b	98 a

^zTreatments with common letters are not different by the Waller-Duncan K ratio t test.

The seed number per fruit was not reduced with Sevin, whereas with NAA both the 5- and 10-ppm rates reduced seed numbers (Table 4). The king-bloom fruit remained, and the side-bloom fruit were removed by the Sevin sprays. In contrast to Sevin, which reduced fruit to one per cluster, NAA removed fruit indiscriminately and the fruit remained in clusters. The foliage of the Sevin-treated trees was not affected, whereas the NAA treatments tended to curl the leaves inward and reduced leaf size. Return bloom on all 1992 sprayed plots was adequate (50% to 65%) for a crop in 1993.

Fruit-thinning of the apple cultivars treated in 1993 was significant (Table 5). The early post-bloom sprays were effective for a period of 7 to 10 days after bloom (Table 5). In 1993, NAA at 10 ppm caused over-thinning and had a more-pronounced effect on leaf size and leaf curling than in 1992. The persisting fruit on the NAA trees were small, with pinched calyx ends. The 1993 Sevin treatments on 'Delicious' reduced fruit set to one per cluster and did not adversely affect the foliage. Fruit set on 'Granny Smith' and 'Fuji' after Sevin treatment was one, two, or three fruit per cluster, depending on spur vigor. The daytime temperatures following the treatments in 1993 were from 30 to 37C and some weak spurs and limbs on 'Delicious' were overthinned by the Sevin applications.

Conclusions

Both Sevin and NAA applied at petal-fall reduced fruit set. Undesirable side effects such as low seed num-

ber, small fruit size, poor fruit shape, and foliage curling were observed in NAA treatments. None of the above effects were noted with Sevin, and the reduction of set to one fruit per cluster was desirable. Sevin applied later than petal-fall may cause seed abortion unless the temperature is high enough to cause fruit with aborted seeds to abscise (Washington State Univ., 1993; Williams, 1989; Williams and Edgerton, 1981).

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