

CHEMICAL THINNING ON DELICIOUS APPLES IN THE STANTHORPE DISTRICT, QUEENSLAND

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SUMMARY

Thinning trials with the Delicious variety of apple at Stanthorpe were conducted from 1960 to 1963, using naphthalene acetic acid (NAA), naphthalene acetamide (NAD) and 1 naphthyl N methyl carbamate (carbaryl). NAA gave variable results and sometimes severely overthinned the trees. NAD proved a more consistent thinner but treated trees retained an excessively large number of small, non-commercial fruit. Carbaryl was the best of the three materials under trial. It partially corrected the biennial bearing habit of the trees and increased yields over a two-year period.

I. INTRODUCTION

The variety Delicious constitutes 35 per cent. of the apple crop in the Stanthorpe district. It has a tendency to exhibit a biennial bearing habit, producing a large crop of small fruit in the "on" year followed by a light crop of large fruit in the "off" year. This characteristic is undesirable; an average to good crop every year is the practical ideal.

In the "on" year, Delicious trees may be hand-thinned, but because of work commitments in earlier maturing varieties, thinning is normally delayed until December. Apart from the cost, hand-thinning at that time is not wholly effective. Floral differentiation for the next year's crop is then in progress and hand-thinning has little effect on blossoming in the following spring.

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Chemical thinners applied at or near full bloom are of considerable experimental interest. They remove excess fruit sufficiently early to promote increased size in the remainder of the crop and influence floral differentiation for the next season. In practice, however, results may be somewhat variable and range from underthinning to severe overthinning.

Previous thinning trials at Stanthorpe have been reported by T. J. Bowen and J. B. Watkins (unpublished reports, Queensland Department of Primary Industries, 1956–1958), who investigated the effects of caustic and hormone sprays. Caustic sprays showed some phytotoxicity but hormones such as NAA (naphthalene acetic acid) thinned the crop reasonably well with some increase in fruit size. Since then, other materials and new experimental techniques have become available and a new series of Delicious thinning trials was therefore laid down in 1960. These measured the effect of treatment both in the season the sprays were applied and in the following year, which is referred to later as the “return bloom year”.

II. MATERIALS AND METHODS

Materials used in these trials were:—

- (1) Naphthalene acetic acid (NAA) applied at 10 p.p.m. from 5 to 9 days after full bloom.
- (2) Naphthalene acetamide (NAD) applied at 25 p.p.m. and 50 p.p.m. from 5 to 9 days after full bloom.
- (3) Naphthyl N methyl carbamate (carbaryl) applied at 1000 p.p.m. from 5 to 22 days after full bloom in either one or two applications.

Healthy Delicious trees were selected for treatment at blossoming in the “on” year. Blocks with single-tree plots were used in all trials. Sprays were applied through mobile power sprays at 250 lb/sq. in. at a rate of 1–1½ gal per tree as a complete cover. Weather conditions at the time of spraying were noted, yield data were taken in both the sprayed and return bloom year, and girth measurements were recorded.

In the first series of trials, shed fruit was counted at regular intervals from the time of spray application to harvest. In the second series of trials, blossom cluster and fruit-set counts from typical leaders were also made in both the sprayed and the return bloom year.

At harvest, fruit weights from individual trees were taken for all trials. In the first series of trials, fruit from trees receiving the same treatment was bulked and graded for size.

III. RESULTS

(a) Trial 1-2a

The trees used were 27-year-old Delicious on Northern Spy rootstock. The seven treatments, which were replicated five times, were:—

- (A) NAA (10 p.p.m.) at calyx—8 days after full bloom.
- (B) NAD (25 p.p.m.) at calyx—8 days after full bloom.
- (C) NAD (50 p.p.m.) at calyx—8 days after full bloom.
- (D) Carbaryl (1000 p.p.m.) at calyx.
- (E) Carbaryl (1000 p.p.m.) at calyx and again at first cover (22 days from full bloom).
- (F) Carbaryl (1000 p.p.m.) 15 days from full bloom.
- (G) Control.

Treatments D and E simulated the time when carbaryl can be applied as an insecticidal spray. Treatment F was applied at the time when carbaryl would be expected to have its maximum thinning effect.

Full bloom occurred on October 5, 1960. Sprays were applied on October 13 (calyx), October 20 (15 days from full bloom) and October 27 (first cover). On the first two spray dates, the weather was warm and cloudy with a light breeze; October 27 was hot and clear with a light variable breeze.

No follow-up hand-thinning was attempted. This trial was characterized by heavy fruit-shedding but yields were still good (Table 1).

No significant chemical differences between treatments were recorded in the 1961 harvest; that is, thinners did not reduce the crop. In 1962, plots receiving carbaryl applied at calyx and first cover (Treatment E) produced twice the crop in the control plots. Yield for the 2-year period 1961 and 1962 was 50 per cent. higher. The differences were highly significant. This treatment proved significantly better than NAA at 10 p.p.m. (Treatment A) and NAD at 50 p.p.m. (Treatment C). NAD at 25 p.p.m. (Treatment B) and carbaryl applied 15 days from full bloom (Treatment F) significantly outyielded the control plots in 1962 but not the combined 1961 + 1962 yields.

The fruit size data (Table 2) for treatments indicate a relation between fruit size and fruit numbers; decrease in fruit numbers was linked with increased fruit size.

TABLE 1
YIELD DATA, TRIALS 1-2a AND 1-2b—MEAN WEIGHT (LB)

Treatment	Trial 1-2a				Trial 1-2b				
	Girth (cm)	1961	1962	1961+1962	Girth (cm)	1961	1962	1961+1962	Adjusted for Girth
A. NAA 10 p.p.m. at calyx	52.3	325.2	346.2	671.4	42.8	56.8	73.8	130.7	130.0
B. NAD 25 p.p.m. at calyx	53.5	336.4	417.6	754.0	43.6	113.3	95.7	209.0	204.8
C. NAD 50 p.p.m. at calyx	51.9	360.4	295.4	655.8	42.2	108.0	142.2	250.2	252.7
D. Carbaryl at calyx ..	55.1	390.0	371.2	761.2	44.3	73.5	180.0	253.5	245.7
E. Carbaryl at calyx and first cover	54.4	368.2	518.0	886.2	41.1	86.5	171.2	257.7	265.2
F. Carbaryl 14-15 days from full bloom ..	54.5	326.8	402.2	729.0	43.7	114.7	211.3	326.0	321.3
G. Control	50.6	329.6	251.0	580.6	41.2	130.0	76.7	206.7	213.9
Necessary differences for significance {		74.1	149.0	190.7		35.2	46.7	70.8	67.1
		100.4	202.0	258.5		47.4	62.9	95.3	90.4
	N.S.D.	N.S.D.	E ≥ C, G E > A B, F > G	E ≥ G E > A, C	N.S.D.	B, F, C, G ≥ A G ≥ D B, F > D G > E	C, D, E, F ≥ A, G D, E, F ≥ B F ≥ C > B	C, D, E, F ≥ A F ≥ B, G > A F > C, D	C, D, E, F ≥ A F ≥ B, G > A F > C, D

Notes on Trial 1-2a—

A co-variance analysis for Girth Measurement and Total Weight (1961+1962) gave a non-significant error regression. Calyx was 8 days, first cover 22 days from full bloom.

Notes on Trial 1-2b—

Error regression in co-variance analysis of Girth Measurement and Total Weight (1961+1962) was significant at the 5% level. Adjusted yield differences are slight and significances remain the same.

Calyx was 7 days, first cover 21 days from full bloom.

TABLE 2
FRUIT SIZE PERCENTAGES, TRIALS 1-2a AND 1-2b

	Trial 1-2a				Trial 1-2b			
	1961		1962		1961		1962	
	Under 2 $\frac{5}{8}$ "	2 $\frac{5}{8}$ " and over	Under 2 $\frac{5}{8}$ "	2 $\frac{5}{8}$ " and over	Under 2 $\frac{5}{8}$ "	2 $\frac{5}{8}$ " and over	Under 2 $\frac{5}{8}$ "	2 $\frac{5}{8}$ " and over
A. NAA 10 p.p.m. at calyx	80.2	19.8	19.9	80.1	7.8	92.2	3.1	96.9
B. NAD 25 p.p.m. at calyx	89.1	10.9	34.6	65.4	33.7	66.3	6.2	93.8
C. NAD 50 p.p.m. at calyx	91.8	8.2	16.6	83.4	22.7	77.3	7.9	92.1
D. Carbaryl at calyx	89.3	10.7	22.8	77.2	13.4	86.6	11.8	88.2
E. Carbaryl at calyx and first cover	83.2	16.8	36.8	63.2	15.6	84.4	4.7	95.3
F. Carbaryl 14-15 days from full bloom	82.0	18.0	28.2	71.8	14.9	85.1	8.0	92.0
G. Control	93.2	6.8	31.4	68.6	22.5	77.5	5.9	94.1

The shedding percentage data (Table 3) suggest that early shedding is characteristic of the carbaryl treatments.

TABLE 3

TIME OF SHED AND PERCENTAGE OF TOTAL FRUIT SHED, TRIALS 1-2a AND 1-2b

Treatment	Trial 1-2a			Trial 1-2b		
	16.xi.60	24.xi.60	28.xi.60	16.xi.60	24.xi.60	29.xi.60
A. NAA 10 p.p.m. at calyx	71	75	96	80	86	94
B. NAD 25 p.p.m. at calyx	74	89	95	74	80	90
C. NAD 50 p.p.m. at calyx	71	85	93	56	68	80
D. Carbaryl at calyx	88	92	98	96	99	100
E. Carbaryl at calyx and first cover ..	84	89	97	88	95	99
F. Carbaryl 14-15 days from full bloom	92	95	98	96	98	99
G. Control	77	89	96	81	91	97

Calyx, 13.x.60; first cover, 27.x.60.

(b) Trial 1-2b

The trees used were 13-year-old Delicious apple trees on Northern Spy rootstock and treatments were the same as in Trial 1-2a. The number of replications was increased to six. Full bloom occurred on October 6, 1960. Spray dates and weather conditions were as for Trial 1-2a.

The trial was laid down in a block of trees containing fewer pollinators than usual and yields were correspondingly low. Dieback occurred on odd leaders in the spring of 1961. No follow-up hand-thinning took place.

The 1961 cropping data (Table 1) indicate that NAA (Treatment A), carbaryl at calyx (Treatment D), and carbaryl at calyx and first cover (Treatment E) significantly reduced yields. Production from trees receiving carbaryl at 14 days from full bloom (Treatment F), NAD at 25 p.p.m. (Treatment B) and NAD at 50 p.p.m. (Treatment C) was similar to that recorded in control plots and all were significantly better than NAA (Treatment A).

In the 1962 crop, all carbaryl schedules (Treatments D, E and F) significantly outyielded control, NAA and NAD (25 p.p.m.) treated trees. Carbaryl at 14 days from full bloom (Treatment F) also significantly outyielded NAD at 50 p.p.m. (Treatment C).

For the combined 2-year period 1961-1962, carbaryl applied at 14 days after full bloom was the most effective spray, with a yield 50 per cent. greater than in control plots and 150 per cent. greater than in NAA plots. All other treatments, including control plots, produced significantly better yields than NAA.

As in Trial 1-2a, decrease in fruit numbers was correlated with increased fruit size (Table 2) and the greatest proportion of early shedding occurred in carbaryl treatments (Table 3).

(c) Trial 2-3a

This trial was placed in a block of 31-year-old Delicious apples on Northern Spy rootstock. The following treatments were replicated 10 times:—

- (A) NAA (10 p.p.m.) at calyx—5 days from full bloom.
- (B) Carbaryl (1000 p.p.m.) at calyx.
- (C) Carbaryl (1000 p.p.m.) at calyx and again at first cover (19 days from full bloom).
- (D) Control.

Full bloom occurred on October 13, 1960. After a rapid petal fall, the calyx spray was applied on October 18 and the first cover spray on November 1. The weather at the time of spraying was warm and humid with patchy cloud and a light easterly wind. No follow-up hand-thinning took place.

Data for fruit set in 1961, return bloom blossom clusters in 1962, and fruit set in 1962 are summarized in Table 4. NAA (Treatment A) and carbaryl at calyx and first cover (Treatment C) reduced fruit set in 1961 but carbaryl at calyx alone (Treatment B) had no such effect. In the return bloom year (1962), blossom clusters and fruit set were substantially greater in plots where thinning had been recorded in the previous year. The differences were again highly significant.

Similar significant differences were recorded for yield (Table 5), blossom cluster counts and fruit set in both 1962 and 1963 but not for the combined 2-year period. The biennial bearing habit shown by trees which were not effectively thinned was modified in those receiving NAA (Treatment A) and carbaryl applied at calyx and first cover (Treatment C).

(d) Trial 2-3b

The trees used in this trial were 40-year-old Delicious apple trees on Northern Spy rootstock. Treatments, blossoming dates, spraying dates and weather conditions were as for Trial 2-3a. Some follow-up hand-thinning took place.

Blossom cluster and fruit-set counts (Table 4) followed the same pattern as in Trial 2-3a, with minor differences in fruit set during the return bloom year (1963). Yield data (Table 5) for 1963 gave significant differences of the same order. Differences in fruit set for the return bloom year show a similar trend.

TABLE 4
EFFECT OF THINNING TREATMENTS ON NUMBER OF BLOSSOM CLUSTERS AND FRUIT SET
Number per 100 blossom clusters in 1961

Treatment	Trial 2-3a					Trial 2-3b				
	Fruit Set 1961	Blossom Clusters 1962		Fruit Set 1962		Fruit Set 1961	Blossom Clusters 1962		Fruit Set 1962	
	Mean	Transformed Mean*	Mean	Transformed Mean*	Mean	Mean	Transformed Mean*	Mean	Transformed Mean*	Mean
A. NAA 10 p.p.m. at calyx	29.8	7.51	55.9	6.68	44.1	36.4	5.32	27.8	5.94	34.8
B. Carbaryl 1000 p.p.m. at calyx	47.5	3.90	14.7	3.48	11.6	43.6	3.62	12.6	4.77	22.2
C. Carbaryl 1000 p.p.m. at calyx and first cover	33.7	7.37	53.8	6.80	45.7	34.4	4.67	21.3	5.26	27.2
D. Control	52.3	2.76	7.1	2.51	5.8	61.7	2.82	7.5	3.78	13.8
Necessary differences for significance .. $\left\{ \begin{array}{l} 5\% \\ 1\% \end{array} \right.$	13.3 18.0	1.93 2.61		1.80 2.44		16.3 22.0	1.61 2.17		N.S.D.	
	B, D \gg A, C	A, C \gg B, D		A, C \gg B, D		D \gg A, C B > A, C	A \gg D A > B C > D			

* Mean transformed as $\sqrt{x + \frac{1}{2}}$

Calyx was 5 days from full bloom, first cover 19 days from full bloom.

TABLE 5
YIELD DATA
Mean Weight (lb)

Treatment	Trial 2-3a					Trial 2-3b				
	Girth (cm)	1962	1963	1962+1963	Adjusted for Girth	Girth (cm)	1962	1963	1962+1963	Adjusted for Girth
A. NAA 10 p.p.m. at calyx	47.4	195.8	197.5	393.3	399.3	46.8	163.9	120.4	284.3	295.3
B. Carbaryl 1000 p.p.m. at calyx ..	46.7	265.9	114.8	380.7	400.6	47.4	224.2	79.7	303.9	305.9
C. Carbaryl 1000 p.p.m. at calyx and first cover	48.6	233.3	198.7	432.0	412.9	47.7	186.0	121.5	307.5	304.2
D. Control	48.0	305.3	84.6	389.9	383.1	48.1	216.9	36.1	253.0	243.3
Necessary differences for significance $\left\{ \begin{array}{l} 5\% \\ 1\% \end{array} \right.$		49.9 67.4 D \geq A, C B > A	67.5 91.2 A, C \geq D A, C > B	N.S.D.	N.S.D.		45.9 62.0 B, D > A	41.8 56.4 A, C \geq D C > B B > D	N.S.D.	51.5 69.6 A, B, C > D

No significant differences were obtained from an analysis of variance for yield data in the 1962-1963 period. However, a co-variance analysis for tree girth and the 1962 + 1963 crops gave a highly significant error regression. After yield adjustment, all thinning treatments significantly outyielded the controls. In addition, the data indicate more uniformity in cropping from year to year than in the control plots.

IV. DISCUSSION

The variety Delicious is highly variable in yield performance at Stanthorpe (Bengston 1964). Because of this, blossom cluster and fruit-set counts give a more reliable indication of thinning efficiency than yield data. Nevertheless, in these trials significant differences in yield were recorded, so indicating the large effect exerted by chemical thinners on cropping.

NAD was used in the first series of trials only. Treated trees tend to hold considerable numbers of small fruit containing aborted seed. This type of fruit sometimes amounted to 50 per cent. of the crop and caused complications at harvesting. The commercial use of NAD as a chemical thinner in the variety Delicious is therefore impracticable. The phenomenon has been recorded elsewhere with Delicious, but not with other varieties (Cripps and Halse 1962).

Results with NAA have been variable. In one trial, severe overthinning in the sprayed year was not followed by above-normal yields in the following year. In no trial did yields for the 2-year period reach those of the carbaryl-treated trees, and in two trials yields from carbaryl-treated trees were significantly greater than in trees receiving NAA. NAA may cause minor damage to the foliage, ranging from wilting to a scorch within a few days of application. The variable results recorded with NAA are largely due to climatic factors such as temperature and humidity, which affect absorption (Westwood and Batjer 1960).

When applied as a calyx spray, carbaryl gave variable results and the earlier the calyx spray the less the thinning effect. This material exerted its maximum thinning effect when applied some 14-22 days from full bloom. In all trials, it modified the biennial bearing habit of Delicious and increased yields. In three of the four trials the increases were significant. Because of the mild thinning action of carbaryl, the trees may carry too much fruit if stress conditions occur after spraying. Even so, it should be used in preference to NAA. Carbaryl has never reduced the crop in the spray year to subeconomic levels as has NAA.

Shedding percentage data (Table 3) show that carbaryl-treated trees shed their surplus fruit earlier than either control trees or trees receiving other chemical thinners. This is an advantage, as the remainder of the crop fills better and supplementary hand-thinning can take place earlier in the season.

It is concluded that carbaryl at a concentration of 1000 p.p.m. applied 14–22 days after full bloom on Delicious apple trees is an effective chemical thinning agent. The use of this material in the “on” year reduced the seasonal variability in yield which is typical of this biennial bearing variety and increased yield for the 2-year period.

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