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Chemical Thinning 'Gala' Apple in the Midwest

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Abstract

'Gala' trees were treated with various chemical thinners in eight trials conducted over four years. NAA (naphthalene acetic acid) at 10 ppm applied at 10-12 mm fruit diameter caused reduction in fruit set, but was not consistent in causing a fruit size increase. Carbaryl (1-naphthyl N-methylcarbamate) at 2.5 ml/L applied at 10-12 mm fruit diameter consistently reduced fruit set, increased fruit size and improved return bloom compared to the untreated controls. At petal fall, application of carbaryl failed to thin 'Gala.' Accel (1.8% N-(phenylmethyl)-1H-purine-6 amino and 0.18% gibberellic acid) at 50 ppm did not thin 'Gala' in three of these trials. Endothal (heptani-2,3-dicarboxylate), an experimental bloom thinner, reduced fruit set with an increasing effect with increasing rates. Of the materials currently available carbaryl, applied at 10-12 mm fruit diameter was the most consistent thinning chemical for 'Gala'.

Introduction

'Gala' was named and introduced in New Zealand by Dr. Don McKenzie in 1962 (10). Since that time, it has been widely planted in most apple producing regions of the world. In a recent presentation on the many positive features, as well as shortcomings of 'Gala,' Hirst (6) stated that "the most serious drawback with this variety is its tendency for small fruit size." Chemical thinning is usually carried out to encourage return bloom and to improve fruit size. Since 'Gala' tends to bear regularly, the emphasis on thinning is to achieve good size. Although it is difficult to counter the genetic influence of fruit size, chemical thinning is the most influential cultural practice growers can use to insure small fruited cultivars achieve their maximum potential size (6, 11, 12).

McArtney et al. (8) demonstrated that the earlier 'Gala' was thinned, the greater the harvest fruit size. Byers (1) tested several bloom thinning chemicals on 'Gala' and found that endothal and Wilthin caused fruit thinning. Fruit growers would prefer to delay thinning as long as possible after bloom because of the potential of spring frosts to further reduce crop.

Because of the increasing commercial importance of 'Gala,' a series of chemical thinning trials was conducted evaluating the effect of various chemicals, rates and times of application with the goal of improving fruit size.

Materials and Methods

A series of eight chemical thinning studies over four years was conducted on 'Gala' by spraying individual trees with a high pressure hand-gun sprayer to thoroughly wet the foliage. Experiments in commercial orchards had the crop load rated by two independent observers using a scale of 1 = no crop, 5 = full crop and 10 = excessive crop. Return bloom was rated using a scale of 1 = no bloom to 10 = a snowball bloom. Fruit set in all studies was determined by counting flower clusters on one or more limbs per tree so that more than 200 flower clusters were counted and subsequently fruit was counted on the same limbs. Fruit size was determined by taking a random sample of 25 fruit per tree.

In 1993 a sequence of thinning trials was established in a large replicated block of 'Gala,' 'Imperial Gala,' and 'Royal Gala' on M.7 rootstock located at the Overlook Branch of the Ohio Agricultural Research and Development Center located near Carroll, Ohio. The trees were six-years-old

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and had produced two previous crops. The first study was designed to determine if 'Gala' strains differed in their response to NAA at 10 ppm. The treatments were arranged as a factorial (NAA x strain) with six single-tree replications.

'Gala' trees in this block were sprayed with the following thinning sprays at 10 mm fruit size of the largest fruit: unsprayed control, NAA (10 ppm), carbaryl at 1.25 ml/L, 2.5 ml/L, or 5.0 ml/L, and a combination of NAA (10 ppm) and carbaryl at 2.5 ml/L. The treatments were arranged in a randomized complete block with six single-tree replications.

'Imperial Gala' trees in this block were treated at 10 mm fruit size as follows: unsprayed control, NAA (10 ppm), BA, 50 ppm alone, BA 50 ppm, plus either 0.8 ml or 1.6 ml Regulaid per liter. Treatments were arranged in a randomized complete block with six single-tree replications.

'Royal Gala' trees in the above orchard were treated at 10 mm fruit size as follows: unsprayed control, NAA (10 ppm), BA (50 ppm), BA (50 ppm) plus carbaryl (2.5 ml/L), BA (50 ppm) plus NAA (5 ppm), and BA (50 ppm) plus NAA (10 ppm). All BA sprays included Regulaid at .8 ml/L. Treatments were arranged in a randomized complete block with six single-tree replications.

In 1994, seven-year-old 'Gala' trees on M.7 rootstock at Peace Valley Orchard near Rogers, OH, were treated as follows either at petal fall (PF) May 16 or 10 mm fruit diameter on May 27: unsprayed control, Accel (PF), Accel (10 mm), Accel (PF and 10 mm), Carbaryl (PF), Carbaryl (10 mm), Accel (PF) plus Carbaryl (10 mm), Carbaryl (PF + Accel (10 mm). All Accel sprays were at the 50 ppm rate and carbaryl at 2.5 ml/L. Treatments were arranged as a randomized complete block with six single-tree replications.

In 1994, seven-year-old 'Regal Gala' trees on M.7 rootstock at Lynd Orchard near Pataskala, OH were treated as follows either at PF (May 9) or 10 mm fruit diameter (May 19): unsprayed control, Accel 50 ppm PF, Accel 100 ppm PF, Accel 50 ppm PF plus Accel 5 ppm 10 mm, Accel 50 ppm PF plus carbaryl 10 mm, carbaryl 10 mm, Accel 50 ppm 10mm, Accel 100 ppm PF plus carbaryl 10 mm. Carbaryl XLR was applied at 2.5 ml/L. Treatments were arranged as a randomized complete block with eight single-tree replications.

In 1995, eight-year-old 'Regal Gala' trees on M.7 at Lynd Orchard near Pataskala, OH, were sprayed at 10 mm fruit diameter as follows: unsprayed control, Accel 75 ppm, Carbaryl, Accel 75 ppm plus Carbaryl, NAA, Accel 50 ppm, Accel 50 ppm plus Carbaryl, Accel 50 ppm plus NAA. Carbaryl was applied at 2.5 ml/L and NAA at 10 ppm. Treatments were arranged as a randomized complete block with seven replications.

In 1996 treatments were applied in the same block but on the different trees at the Lynd Farm as follows: unsprayed control, Carbaryl (PF), Carbaryl (10 mm), Accel (PF), Promalin (King open) plus Carbaryl (10 mm), Promalin (King open) plus Carbaryl (PF), Promalin (King open) plus Accel (PF). Date for King open was May 6, PF, May 14 and 10-12 mm May 17. Rates were as follows: Promalin 1.87 ml/L, Carbaryl 2.5 ml/L and Accel 50 ppm. Treatments were arranged as a randomized complete block with eight single-tree replications.

In 1996 lower scaffold limbs on 'Regal Gala' trees adjacent to those above were treated at 80% open bloom as follows: unsprayed control or Endothal at one of the following rates per L: .93 ml, 1.25 ml, 1.87 ml, 2.50 ml. Treatments were arranged as a randomized complete block with seven individual limbs treated per treatment.

Results

There were no differences among the three 'Gala' strains ('Gala,' 'Imperial Gala,' and 'Royal Gala') in fruit set, size or yield. NAA at 10 ppm resulted in a significant 29% reduction in fruit set, but at harvest there was no difference in average fruit weight or yield. There was no interaction between thinning with NAA and 'Gala' strain (Data not presented).

No differences were found among the various rates of carbaryl XLR in fruit set,

Table 1. Influence of foliar sprays of Accel or carbaryl on 'Regal Gala' at petal fall (PF) or when fruit were 10 mm in diameter at Lynd Farm, Pataskala, OH[z] in 1994.

Treatment	Set %	Yield[y] rating	Avg. fruit size (g)	Return[x] bloom–1995
Control	53.6a[w]	6.1a	154b	7.3b
Accel 50 ppm PF	51.0a	6.1a	155b	7.5b
Accel 100 ppm PF	42.8abc	6.3a	158ab	8.1ab
Accel 50 ppm PF + 50 ppm 10 mm	55.2a	5.2ab	170a	7.6ab
Accel 50 ppm PF + carbaryl 10 mm	32.1c	5.5a	166ab	8.1ab
Carbaryl 2.5 ml/L 10mm	34.0c	5.7a	164ab	8.6a
Accel 50 ppm 10 mm	48.5ab	6.1a	168ab	8.1ab
Accel 100 ppm PF + carbaryl 10 mm	35.8bc	4.3b	172a	8.2ab

[z]Sprays applied with hand-gun to drip on May 9 petal fall or when fruit were 10 mm, with replicate trees for each treatment. Carbaryl was XLR formulation at a rate of 2.5 ml/l.
[y]Yield rating: 1 = no crop to 10 = excessive crop.
[x]Return bloom rating: 1 = no bloom to 10 = snowball bloom.
[w]Mean separation by Duncan's multiple range P = .05.

fruit number per tree or yield. Average fruit size from the 2.5 ml/L was larger than on the unthinned control, but it did not differ from higher or lower rates of carbaryl (data not presented).

On 'Imperial Gala' BA at 50 ppm had no effect on fruit set, size or yield alone or when combined with Regulaid which was tested at two rates (data not presented). Chemical thinners applied to 'Royal Gala' in 1993, did not affect fruit set or number of fruit per tree (control, NAA 10 ppm, BA 50 ppm, BA 50 ppm + carbaryl 2.5 ml/L; BA 50 ppm + NAA 5 ppm; BA 50 ppm + NAA 10 ppm). Trees sprayed with 50 ppm BA had a higher yield per tree than 50 ppm BA plus carbaryl (data not presented).

In 1994, Accel (50 ppm) or carbaryl applied at PF or at 10 mm fruit diameter or in various combinations of the two materials and timings had no effect on set, crop load or average fruit weight in a commercial orchard near Rogers, Ohio (data not presented). Similarly, in a commercial orchard near Pataskala, Ohio, Accel alone at either 50 or 100 ppm had no effect, however carbaryl applied at 10 mm fruit diameter did reduce fruit set of 'Regal Gala' (Table 1). The combination of 100 ppm of Accel at petal fall, plus carbaryl at 10 mm fruit diameter reduced crop load and increased average fruit weight. Accel at 50 ppm applied at PF plus a second application of 10 mm fruit diameter increased fruit weight compared to the untreated control or Accel 50 ppm applied at PF. Although not always significant, return bloom was generally enhanced by most treatments, particularly those combined with carbaryl.

In 1995, all chemical thinning treatments caused a significant reduction in fruit set (Table 2). Carbaryl caused greater

Table 2. Influence of chemical thinning treatments applied at 10 mm fruit diameter on 'Regal Gala' apples in 1995 (Pataskala, OH).

Treatment	Rate	Fruit set %	Yield[z] rating	Avg. fruit wt. (g)	Return[y] bloom–1996
Check		41.5a[x]	5.7a	129d	3.7d
Accel	50 ppm	31.4b	4.6b	135cd	4.3cd
Accel	75 ppm	27.1b	5.4ab	139bc	4.3cd
Accel + Carbaryl	50 ppm + 2.5 ml/L	9.3de	3.0d	152a	7.1a
Accel + Carbaryl	75 ppm + 2.5 ml/L	6.2e	2.4d	151a	6.5ab
Accel + NAA	50 ppm + 10 ppm	17.2cd	3.4cd	152a	5.7a
Carbaryl	2.5 ml/L	17.4cd	3.0d	145ab	6.1ab
NAA	10 ppm	22.9bc	4.4bc	151a	5.5bc

[z]Yield rating: 1 = no crop, 5 = full crop, 10 = excessive crop
[y]Return bloom rating: 1 = no bloom to 10 = snowball bloom.
[x]Mean separation by Duncan's multiple range P = .05.

Table 3. Influence of thinning treatments on fruit set, crop and fruit size of 'Regal Gala' in 1996 at Pataskala, OH.

Treatment[z]	Time of[y] application	Set %	Yield[x] rating	Avg. fruit wt.	Return[w] bloom–1997
Control	——	46.5a[v]	6.7a	116b	3.8b
Promalin + Carbaryl	B + 10-12 mm	17.9d	4.1c	126a	6.2a
Carbaryl PF	PF	41.6ab	5.6ab	120ab	5.7a
Accel PF	PF	20.1cd	4.7bc	129a	6.2a
Promalin + Carbaryl	B + PF	29.3bcd	4.7bc	126a	6.2a
Promalin + Accel PF	B + PF	24.8cd	4.7bc	122ab	6.5a
Carbaryl	10-12 mm	32.7bc	4.7bc	127a	6.8a

[z]Promalin 1.87 ml/L Kings open (May 6); PF May 14; Carbaryl XLR 2.5 ml/L; Accel 50 ppm 10-\tab 12 mm May 17.
[y]B = Kings open in bloom, PF = petal fall, 10-12 mm = fruit diameter\super.
[x]Yield rating: 1 = no crop; 5 = full crop; 10 = excessive crop.
[w]Return bloom rating: 1 = no bloom to 10 = snowball. Rated after severe frost in April that reduced bloom.
[v]Mean separation by Duncan's multiple range P = .05.

thinning than Accel at either 50 or 75 ppm, which were similar. The combination of carbaryl plus Accel tended to over thin. All treatments except 50 ppm Accel caused an increase in fruit weight compared to the untreated control. NAA alone caused a large increase (15%) in fruit size while not causing the reduction in yield or fruit set that the combination of Accel and carbaryl to achieve equivalent fruit size. All treatments except Accel alone at 50 or 75 ppm caused an increase in return bloom.

In 1996 all treatments except carbaryl at PF caused reductions in fruit set and yield (Table 3). Promalin applied at bloom followed by carbaryl at 10-12 mm fruit diameter caused a greater reduction in set than carbaryl alone. However, Promalin did not enhance the thinning effect of Accel at PF. Average fruit weight was increased by all treatments except carbaryl at PF and Promalin plus Accel at PF. Return bloom was enhanced similarly by all treatments compared to the untreated control.

Limb treatments with the experimental bloom thinner endothal caused a linear reduction in fruit set as rate increased up to 1.87 ml/L (Table 4). The effects of endothal on fruit weight, russet, scarf skin or stem end cracking were negligible (Table 4).

Discussion

NAA at 10 ppm caused a reduction in fruit set in the 1993 and 1995 trial, but fruit size was only increased in 1995. Previous studies on a range of apple cultivars demonstrate that although NAA can reduce set, this is not always followed by an increase in fruit size (3). Tiscornia and Iuchi (9) reported that NAA and ethephon were not as consistent in thinning 'Gala' as carbaryl. Jones et al. (7) found that ethephon at bloom thinned 'Gala' with greater thinning with increased concentration. However, the increase in fruit size achieved with ethephon treatments was not adequate for the Australian market.

Table 4. Influence of various rates of endothal applied at bloom on fruit set, size and quality of 'Regal Gala' in 1996, Pataskala, OH.

Treatment	Rate ml/L	Set (%)	Fruit wt. (g)	Russet[z]	Scarf[y] skin	Stem[x] cracking
Control		45.7a[w]	117ab	2.1ab	3.8	.13ab
Endothal	.93	14.2b	122a	2.4ab	3.1	.24a
Endothal	1.25	6.7c	112ab	2.1b	3.6	.02b
Endothal	1.87	5.4c	101b	2.2ab	3.9	.07ab
Endothal	2.50	7.8bc	118ab	2.7a	3.9	.12ab

[z]Rating for russet: 1 = no russet to 5 = complete russet
[y]Rating for scarf skin: 1 = no scarf skin to 5 = complete scarf skin
[x]Rating for stem cracking: 0 = no cracks, 1 = cracks
[w]Mean separation by Duncan's multiple range P = .05.

Carbaryl applied at the 10-12 mm fruit size was the most consistent thinner for 'Gala' in these trials. 'Gala' appeared insensitive to increasing rates of carbaryl as has been reported with other cultivars (12). Carbaryl thinning consistently increased fruit size as well as return bloom of 'Gala.' A petal fall application of carbaryl was not successful in thinning 'Gala' but did result in a reduction in fruit set and an increase in fruit size when followed by a Promalin application applied at bloom. The only time when over-thinning occurred was with a combination of carbaryl plus Accel in 1995, a year when most chemical thinners worked well on many cultivars (4).

Accel at 50 ppm did not thin 'Gala' in three of these trials. A combination of sprays of Accel at petal fall followed by a second spray at 10-12 mm fruit diameter did not reduce fruit set or yield, but did increase fruit size. It was hoped that Accel could induce an increase in fruit size of 'Gala' beyond that related to the reduction in crop load as reported for 'McIntosh' and 'Empire' (2, 5). Unfortunately, we did not find this response with the rates or times of application tried in these studies.

Endothal applied at bloom as limb treatments caused increased thinning as rates were increased. Byers (1) also found endothal effective in reducing set of 'Gala.' Since the work of McArtney et al (8) demonstrated that early thinning resulted in maximum fruit size increase, further work with bloom thinners is warranted, as these materials approach registration for commercial use.

In summary, carbaryl applied at 10-12 mm fruit diameter provided adequate thinning for 'Gala' in the midwest for most years. The reduction in fruit set was consistently followed by an increase in fruit size and return bloom.

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Relationship of Tree N Status and N Uptake

Leaf N of almond was related positively with amino acids (asparagine and gultamine) in phloem and xylem saps. Trees receiving low soil N previously took up N from a N pulse but previous high N trees did not. Authors suggest that high amino acid conc. in phloem and xylem saps are indicative of a larger pool of amino N cycling throughout the vasculature of high N status trees. Data indicate an inverse relationship between N status, amino acid in xylem and phloem saps and capacity for soil N uptake in trees. From Yousseffi et al. 2000. J. Hort. Sci. & Biotech. 75(1):62-68.