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Chemical Thinning of Peach Fruits with CGA 15281 and CGA 17856[1]

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Abstract. **Beta-chloroethyl-methyl-bis-benzyloxy-silane (CGA 15281) was applied to 6 Eastern U.S. grown peach (*Prunus persica* (L.) Batsch) cultivars. Thinning response varied considerably with cultivar, timing, concentration and year. Unpredictable and commercially unacceptable leaf abscission occurred with most cultivars during the three-year period. Adequate thinning was achieved without excessive leaf abscission (10% or less) with only one treatment on 3 cultivars ('Redhaven', 'Loring', and 'Sunhigh') during the 3-year period. Reproducibility between years was not good. Unpruned trees or long 2-year-old limbs lost a greater portion of fruit at the base of shoots and on the interior of the trees than trees pruned to a uniform shoot length. The thinning response to CGA 17856 (an analogue of CGA 15281) was compared to the same rate of CGA 15281 on 5 cultivars. A tendency to greater leaf abscission was observed with CGA 17856.**

The search for an effective chemical peach thinning agent has not resulted in a commercially acceptable method of fruit removal. Numerous materials have been tried (2, 3, 4, 7, 8, 10, 11) and most have been discarded due to inconsistent results, leaf abscission, fruit deformation, or unacceptable timing in relation to bloom and the frost period. The timing of N-1-naphthylphthalamic acid (NPA) near bloom (1) and naphthaleneacetic acid (NAA) and 3-chlorophenoxy-α-propionamide (3-CPA) during cytokinesis (5, 6, 8) has been more critical than for ethylene-releasing compounds such as ethephon (9). Since CGA 15281 and CGA 17856 are known to release ethylene when applied to plants, the applications were timed when weather conditions were 20-27°C and ovule length was 8-16 mm and not necessarily according to the time of cytokinesis.

Materials and Methods

All treatments within an experiment were applied to 4 single tree replicates in a randomized complete block design. Percentage fruit remaining and fruit size were determined on 4 pre-selected limbs (each with 75 fruit or more) per tree. Ten fruit per limb were sized at 2 dates prior to harvest with a band-type hand sizer. The controls for each experiment were unthinned; however, to prevent tree breakage the controls and underthinned treatments were hand thinned about 14 days after treatment, except for the tagged limbs on each tree.

In 1974 and 1975, treatments were applied with a high-pressure gun-type sprayer at about 35 kg/cm^2 (500 psi). In 1976 a commercial 3-point hitch airblast sprayer was used at 27 kg/cm^2 (380 psi) and nozzled to deliver approx 2, 620 liters/ha (280 gal/acre) at about 2.4 km/hr (1.5 mph). Temp were higher and wind calmer in 1974 and 1975 than in 1976. Ovule length of 50 randomly selected fruits from at least 10 border row trees was measured on each spray date with a hand caliper.

Commercial peach orchards in the vicinity of Winchester, Virginia used for these experiments were: in 1974, 15-year-old 'Redhaven' and 18-year-old 'Elberta'; in 1975, 9-year-old 'Redhaven', 'Loring', and 'Sunhigh' and 15-year-old 'Madison'; in 1976, 10-year-old 'Redhaven', 'Loring', and 'Sunhigh' and 18-year-old 'Madison', 'Redhaven', and 'Jefferson'.

Results and Discussion

The desired percentage fruit remaining after the thinner applications ranged from 25 to 35% in most of these experiments; however, this figure was dependent on original crop load. Fruit-size measurements reflected effective thinning; however, if serious foliage injury had occurred fruit size could have been adversely affected. In addition, since these compounds release ethylene, the fruit growth rates and/or maturity may also affect fruit size measurements. The thinners did not appear to affect maturity when applied at this stage of fruit development.

'Redhaven'. In 1974, CGA 15281 slightly over-thinned at 500 ppm and caused some leaf abscission (about 10% removal) when applied at an ovule length of 8.6 mm (Table 1A). The 1000 ppm treatment caused excessive fruit and leaf abscission

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Table 1. Effect of chemical thinning agents on 'Redhaven' peach fruit thinning and fruit size in 1974, 1975, and 1976.

Treatment	Concn (ppm)	Date applied	Ovule length (mm)[z]	% fruit remaining	Fruit diam (cm)	
			A. 1974, 15 yr old, full bloom: April 16			
				June 14	*June 14*	*July 8*
Control				47 a[y]	3.6 a	4.7 a
Ethephon	50	May 16	8.6 ± 0.8	44 a	3.7 a	5.2 b
CGA 15281	500	May 16		26 b	4.0 b	6.0 c
CGA 15281	1000	May 16		19 b	4.0 b	6.4 c
			B. 1975, 9 yr old, full bloom: April 22			
				June 23	*June 23*	*July 21*
Control				56 a	3.4 a	4.6 a
CGA 15281	100	May 22	8.7 ± 0.2	49 a	3.4 a	4.8 a
CGA 15281	175	May 22		57 a	3.3 a	4.7 a
CGA 15281	250	May 22		49 a	3.4 a	4.7 a
CGA 15281	400	May 22		37 b	3.7 b	5.4 b
CGA 15281	250	June 4	16.1 ± 0.3	27 b	3.8 b	5.9 c
			C. 1976, 10 yr old, full bloom: March 29			
				June 14	*June 14*	*July 9*
Control				60 a	3.9 a	5.8 b
CGA 15281	400	May 10	9.7 ± 0.3	44 a	3.7 a	5.3 a
CGA 17856	400	May 10		38 a	3.6 a	5.5 ab
			D. 1976, 18 yr old, full bloom: March 29			
				June 14	*June 14*	*July 15*
Control				55 a	3.3 a	4.6 a
CGA 15281	450	May 10	8.8 ± 0.2	59 a	3.4 ab	5.0 b
CGA 17856	450	May 10		59 a	3.6 b	5.1 b

[z]Ovule length of 50 randomly selected fruit from an adjacent row for each spray date.
[y]Mean separation in columns within experiment by Duncan's multiple range test, 5% level.

Table 2. Effect of CGA 15281 on 'Elberta' peach fruit thinning and fruit size in 1974.

Treatment[z]	Concn (ppm)	Date applied	Ovule length (mm)[y]	% fruit remaining June 13	Fruit diam (cm) June 13	Fruit diam (cm) August 2
Control				35 a[x]	3.5 a	5.0 a
Ethephon	50	May 16	8.9 ± 0.8	30 a	3.6 a	5.5 b
CGA 15281	500	May 16		20 b	3.9 b	6.4 c
CGA 15281	1000	May 16		11 c	3.9 b	6.7 c
CGA 15281	200	May 23	15.2 ± 1.0	14 bc	3.9 b	6.3 c

[z]Full bloom: April 16.
[y]Ovule length of 50 randomly selected fruit from an adjacent row for each spray date.
[x]Mean separation in columns by Duncan's multiple range test, 5% level.

(about 25% removal). Ethephon caused a significant increase in fruit size on July 8, which indicated that some thinning may have occurred with this treatment; however, this may have been the result of ethylene-induced size increase.

In 1975, 'Redhaven' peach trees were not thinned by 100, 175, or 250 ppm CGA 15281 applied at an ovule length of 8.7 mm (Table 1B). The 400 ppm treatment slightly under thinned and would have required some additional hand thinning. However, only about 2% of the leaves abscised. An application of 250 ppm applied two weeks later at an ovule length of 16 mm caused over thinning and more leaf drop (about 15%) than desirable. The greatest no. of fruit and leaves were retained at the end of long branches on more vigorous limbs in the tops and sides of the trees.

In 1976, 'Redhaven' trees treated with CGA 15281 and CGA 17856 at an ovule length of 9.7 mm were not adequately thinned by either material (Table 1C). However, most of the small 1st and 2nd basal leaves turned yellow and dropped, and about 20% of mature fully expanded leaves abscised. The CGA 17856 caused slightly more leaf and fruit abscission than CGA 15281. The degree of leaf abscission caused by both materials would be commercially unacceptable.

Applications of 450 ppm CGA 15281 or CGA 17856 made to 18-year-old 'Redhaven' trees at an ovule length of 8.8 mm caused abscission of 30% of the leaves, but no fruit abscission.

Rates of CGA 15281 between 400 ppm and 500 ppm at similar ovule lengths (8.7–9.7 mm) caused adequate thinning of 'Redhaven' in 1974 and 1975 and no thinning in 1976. Leaf abscission was not serious in 1974, did not occur in 1975 and was serious in 1976.

'Elberta'. In 1974, CGA 15281 applied at 500 or 1000 ppm at an ovule length of 8.9 mm caused about 50 and 70% leaf

Table 3. Effect of chemical thinning agents on 'Loring' peach fruit thinning and fruit size in 1975 and 1976.

Treatment	Concn (ppm)	Date applied	Ovule length (mm)[z]	% Fruit remaining	Fruit diam (cm)	
				A. 1975, 9 yr old, full bloom: April 30		
				June 23	*June 23*	*August 4*
Control				53 bc[y]	3.6 a	5.8 a
CGA 15281	100	May 22	10.5 ± 0.3	59 ab	3.6 a	5.8 a
CGA 15281	175	May 22		61 a	3.7 ab	5.9 ab
CGA 15281	250	May 22		49 c	3.8 bc	6.3 ab
CGA 15281	400	May 22		38 d	4.0 d	6.4 b
				B. 1976, 10 yr old, full bloom: March 29		
				June 14	*June 14*	*July 28*
Control				42 a	3.6 a	6.1 a
CGA 15281	400	May 10	10.2 ± 0.3	42 a	3.5 a	6.1 a
CGA 17856	400	May 10		48 a	3.5 a	6.3 a

[z]Ovule length of 50 randomly selected fruit with an adjacent row for each spray date.

[y]Mean separation in columns within years by Duncan's multiple range test, 5% level.

Table 4. Effect of chemical thinning agents on 'Sunhigh' peach fruit thinning and fruit size in 1975 and 1976.

Treatment	Concn (ppm)	Date applied	Ovule length (mm)[z]	% fruit remaining	Fruit diam (cm)	
				A. 1975, 10 yr old, full bloom: April 21		
				June 23	*June 23*	*August 4*
Control				62 a[y]	3.5 a	5.8 a
CGA 15281	250	May 22	10.6 ± 0.3	37 b	3.6 a	6.1 a
				B. 1976, 10 yr old, full bloom: March 30		
				June 14	*June 14*	*July 28*
Control				49 a	3.5 a	5.7 a
CGA 15281	300	May 6	9.0 ± 0.4	37 b	3.6 a	6.1 a
CGA 15281	300	May 10	11.0 ± 0.3	36 b	3.7 a	6.5 a
CGA 17856	300	May 6	9.0 ± 0.4	45 ab	3.5 a	6.0 a
CGA 17856	300	May 10	11.0 ± 0.3	40 b	3.5 a	6.1 a

[z]Ovule length of 50 randomly selected fruit with an adjacent row for each spray date.

[y]Mean separation in columns within years by Duncan's multiple range test, 5% level.

abscission, respectively. Also, both caused excessive fruit abscission (Table 2). The 200 ppm treatment at an ovule length of 15.2 mm also caused excessive fruit and leaf abscission (about 50%) and was similar to the earlier 500 ppm treatment. These trees had not been pruned the previous winter. Leaves and fruit on the interior of the trees were severely affected and the most fruit and leaves were retained at the end of long branches in the tops and sides of the trees. Fruit size increase in the ethephon treatment may have been the result of thinning.

'Loring'. In 1975, trees sprayed with 100 and 175 ppm CGA 15281 applied at an ovule length of 10.5 mm were not thinned (Table 3A). The 250 ppm treatment caused some commercially important thinning without any phytotoxicity to leaves but was considered inadequate. The 400 ppm treatment slightly over thinned and caused abscission of a few older leaves, but this leaf drop was not considered important.

In 1976, the application of 400 ppm CGA 15281 or CGA 17856 at an ovule length of 10.2 mm caused commercially unacceptable leaf abscission (15% removal). More leaves abscised from the CGA 17856 treatment. The fruit were underthinned and a considerable difference in fruit removal existed between trees and among limbs within a tree (Table 3B). The timing of the 1975 and 1976 CGA 15281 treatments was very similar as determined by ovule length; however, much more leaf abscission occurred in 1976. The 1976 applications were made with an airblast sprayer and I anticipated a lesser effect than with the 1975 hand gun application due to spray application technique.

'Sunhigh'. In 1975, trees sprayed with 250 ppm CGA 15281 at an ovule length of 10.6 mm were thinned with no phytotoxicity symptoms (Table 4A). Since the crop load prior to thinning was not heavy, fruit size differences were not great even though the percentage fruit remaining was greatly reduced.

In 1976, 300 ppm CGA 15281 or CGA 17856 applied at an ovule length of 9.0 mm thinned slightly with no phytotoxicity (Table 4B). Applications made 4 days later at an ovule length of 11.0 mm caused yellow leaves (about 5%) to develop at the same concn and under very similar temp and weather conditions as the earlier application. CGA 15281 appeared to cause less phytotoxicity to leaves than CGA 17856.

'Madison'. In 1975, 100, 175, 250 and 400 ppm CGA 15281 applied at an ovule length of 8.6 mm did not cause fruit or leaf abscission (Table 5A). However, an application of 250 ppm at an ovule length of 15.9 mm caused excessive leaf abscission (about 25% removal) and slightly over thinned the fruit.

Applying 450 or 550 ppm of either CGA 15281 or CGA 17856 at an ovule length of 10.1 mm caused about 50 and 70%

Table 5. Effect of chemical thinning agents on 'Madison' peach fruit thinning and fruit size in 1975 and 1976.

Treatment	Concn (ppm)	Date applied	Ovule length (mm)[z]	% fruit remaining	Fruit diam (cm)	
			A. 1975, 15 yr old, full bloom: April 22			
				June 25	*June 25*	*August 15*
Control				45 ab[y]	3.4 b	5.2 ab
CGA 15281	100	May 23	8.6 ± 0.2	36 b	3.3 ab	5.3 b
CGA 15281	175	May 23		42 ab	3.3 ab	5.3 b
CGA 15281	250	May 23		39 ab	3.2 a	4.9 a
CGA 15281	400	May 23		51 a	3.4 b	5.3 b
CGA 15281	250	June 4	15.9 ± 0.3	23 c	3.6 c	6.2 c
			B. 1976, 18 yr old, full bloom: April 1			
				June 16	*June 16*	*August 4*
Control				72 a	3.6 a	5.9 a
CGA 15281	450	May 13	10.1 ± 0.3	30 bc	3.8 b	6.7 cd
CGA 17856	450	May 13		25 bc	3.9 b	6.7 cd
CGA 15281	550	May 13		23 bc	3.8 b	6.5 bcd
CGA 17856	550	May 13		17 c	3.9 c	6.8 d
CGA 15281	150	May 17	12.9 ± 0.3	33 b	3.8 b	6.3 b
CGA 17856	150	May 17		35 b	3.9 b	6.4 bc
Hand thinned		May 26		36 b	4.0 c	6.6 bcd

[z]Ovule length of 50 randomly selected fruit with an adjacent row for each spray date.

[y]Mean separation in columns within years by Duncan's multiple range test, 5% level.

Table 6. Effect of CGA 15281 and CGA 17856 on 'Jefferson' peach fruit thinning and fruit size in 1976.

Treatment[z]	Concn (ppm)	Date applied	Ovule length (mm)[y]	% fruit remaining June 15	Fruit diam (cm)	
					June 15	August 6
Control				85 a[x]	3.7 a	5.6 a
CGA 15281	400	May 14	10.6 ± 0.2	65 b	3.7 a	5.9 b
CGA 17856	400	May 14		52 c	3.6 a	6.2 b

[z]Full bloom: March 30.

[y]Ovule length of 50 randomly selected fruit with an adjacent row for each spray date.

[x]Mean separation in columns by Duncan's multiple range test, 5% level.

of the leaves to abscise, respectively, and over thinned the fruit (Table 5B). An application at 150 ppm at an ovule length of 12.9 mm caused 5 to 10% leaf drop and adequately thinned the trees. A hand-thinned treatment in this experiment was included in the original experimental design and thus provided a good reference point for the desired thinning response.

Since the 400 ppm treatment of CGA 15281 at 8.6 mm ovule length in 1975 did not give thinning or leaf abscission and, in 1976, the 450 ppm at 10.1 mm ovule length gave serious leaf and fruit abscission, I think that this material will be extremely difficult for growers to use safely.

'Jefferson'. The application of 400 ppm CGA 15281 at an ovule length of 10.6 mm in 1976 caused less leaf abscission and more fruit abscission than CGA 17856 (Table 6). Since trees were not heavily loaded, fruit size differences were small. About 10 to 15% of the leaves abscised with the CGA 15281 and I feel this could be tolerated on a commercial scale.

In some years the rate of CGA 15281 required for thinning resulted in serious leaf abscission; however, in other years good fruit abscission was obtained without leaf abscission. These experiments indicate that much understanding and control over the action of CGA 15281 will be required to make it an effective and safe compound for peach thinning.

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Yield and Secondary Root Growth of Carrots as Influenced by Tillage System, Cultivation, and Irrigation[1]

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Abstract. **There were no significant yield differences among tillage systems of carrots (*Daucus carota* L. cv. Danvers 126) planted into a rye mulch, soybean stubble, and conventionally tilled plots. Secondary root growth of carrot was greater in soybean than either rye or conventionally-tilled carrot plots. Irrigation decreased secondary root growth in conventional tilled and rye mulch plots, but not in the soybean stubble.**

Carrot production in Delaware is beset with numerous problems. One of the most important concerns to most growers is poor stand establishment brought about by lack of moisture in the seedbed and blowing sand. Sometimes carrots must be replanted 2 or 3 times in the spring. Low yields, abnormal root growth, and a non-uniform crop at harvest are common in many Delaware carrot fields. Excessive "hairy root" development on carrots has also been a severe problem for some growers (4).

Recent studies of minimum and no-till vegetables, with acceptable weed control, (2, 5, 6) have demonstrated that comparable yields can be obtained from no-till snapbeans, tomatoes, and cucumbers. The no-till system leads to an increase in soil moisture retention and reduces sand and wind damage to tender seedlings. Minimum and no-tillage systems reduce labor and erosion hazards as well as the need for primary tillage before planting.

This study was conducted to determine the feasibility of growing carrots in a no-till system and to evaluate the effect of irrigation and cultivation on yield and secondary root development.

Materials and Methods

The experimental design used for this study was a split-split plot with 3 replications. The main treatment was the cover crop–rye, soybean, and conventional (no cover crop–control). The sub-treatment was irrigation vs. no irrigation and the sub-sub-treatment was cultivation vs. no cultivation.

Paraquat at 1.1 kg/ha was applied to the rye and soybean plots on April 13, 1976 to destroy these cover crops and reduce the existing weed population. A no-till corn planter with fertilizer attachment was then used to apply 889 kg/ha of 15N–3.4P-9.9K banded in 76 cm rows prior to planting. Pelleted seed of 'Danvers 126' was planted in loamy sand soil (pH 6.0) at the Univ. of Delaware Substation, Georgetown, with a Stan-Hay precision seeder on April 30, 1976. The seeder was equipped with a rubber belt punched to drop 12 seeds/30 cm and followed the press wheel impression of the no-till planter. Postemergence application of nitrofen at 2.2 kg/ha was made on May 4, May 13, and June 8, 1976 to control grasses and broadleaf weed species. Moisture blocks were placed on one half of all main treatments to monitor available soil moisture during the growing season. Irrigated plots received the following amounts of additional water, with monthly precipitation in parenthesis: May 3.2 cm (6.6 cm), June 12.7 cm (3.2 cm), July 3.2 cm (6.3 cm) and August 3.2 cm (16.0 cm). One half of the sub-treatments were cultivated 6 times during the growing season beginning July 6, 1976. The carrots were harvested from 4.5 m rows on Oct. 11, 1976, weighed, and indexed for secondary root growth (4).

Results and Discussion

There was no significant difference in the yield of carrots among the cover crops (main plots) regardless of cultivation practices (Table 1). However, yield of carrots was significantly lower from the soybean plot than either of the 2 cover crop plots when cultivation practices were considered.

Irrigation did not significantly increase the yield of carrots from cover crops, but the rye mulch plots did show a response of higher yields to additional water (Table 2). Lowest carrot yield was obtained from the soybean plots. There was a significant increase in carrot yield from irrigated and cultivated as compared to non-irrigated and non-cultivated plots.

Table 1. Influence of cultivation on yield of carrots from conventionally tilled, no-till soybean and no-till rye plots.

	Yield (MT/ha)			
Treatment	Soybean cover crop[z]	Rye cover crop	No cover crop	Mean[y]
Cultivation	31.6 bc	48.3 a	58.5 a	46.1
No-cultivation	30.1 c	44.8 ab	53.2 a	42.7
Mean[y]	30.9	46.6	55.9	

[z]Mean separation by Duncan's multiple range test, 5% level.
[y]No significant differences among means.

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