CHEMICAL THINNING *for shipping peaches, nectarines and plums*

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CHEMICAL SPRAY THINNING has proved to be a promising way to reduce the costs and labor needed for thinning stone fruits. Dinitro materials like Elgetol sprays and D.O.C. dusts have been used more than 25 years for thinning out heavy fruit sets in plums and peaches. To be most effective, dinitro materials must be applied during a one- to two-day period before full bloom (at 60 to 90 per cent of full bloom) when set is unknown and frost and rain are still crop hazards. The erratic quality of the thinning with dinitros plus the necessity for early season application has limited the use of these chemicals to extra heavy setting fruit varieties.

In 1968, two promising chemicals were used in spray thinning tests on important varieties of freestone peaches, nectarines, and plums in Tulare, Fresno, and Merced counties. NPA ("Nip-A-Thin 6 0 2," 30 per cent sodium salt of N-1 Naphthylphthalmic acid) was applied one to five days after full bloom at rates of 100, 200, and 300 ppm. Fruitone 3-CPA (7.9 per cent 2-[3-chlorophenoxy]-proprionamide) was applied 25 to 42 days after full bloom and one to four weeks before normal hand thinning. Fruitone 3-CPA was applied at 300 ppm and sometimes at 150 ppm when ovule (seed) length was 4 to 5 mm, 7 to 8 mm, and 9 to 11 mm. Amchem 3-CP (8.33 per cent 2-[3-chlorophenoxy]-proprionic acid) was applied to plums only at 50, 100, and 150 ppm when ovule lengths were 4 to 10 mm.

TABLE 1. THINNING RESPONSES OF FREESTONE PEACHES 1968

Treatment	Red Haven	Early Elberta	Sun-crest	Fay Elberta
	Thinning response rating*			
Check (Crop load)	Heavy	Heavy	Mod. to Heavy	Heavy
Elgetol 1.5 pints/100	...	1–2	0–3	0–1
NPA 100 ppm FB + 4†	1	...	2	1
NPA 200 ppm FB + 4	1	1–2	1–2	0–1
NPA 300 ppm FB + 4	2	0–1	0–1	...
3-CPA 300 ppm ovule 4–5 mm	3	2	2–3	3
3-CPA 300 ppm ovule 7–8 mm	2–3	0–1	1	3
3-CPA 300 ppm ovule 10–11 mm	...	3	1–3	3

* 0 = overthinned moderately; 1 = excellent—requires some thinning of clusters; 2 = good—reduces hand thinning time; 3 = slight or no thinning.
† FB + 4 = 4 days after full bloom.

The results of these spray thinning tests were evaluated on the basis of the amount of crop removed and size of fruit remaining on treated trees at hand thinning time as compared with unsprayed trees. Additional observations were made of phytotoxicity, fruit growth, size, and color at harvest.

Some test plots contained four to eight single tree replications in random block design, and other plots consisted of groups of two to six trees per variety, each with a separate treatment. Evaluation of data on spray thinning for each of the three tree fruit crops is presented in separate sections of this article. These are progress reports of research and are not to be considered as recommendations.

FREESTONE PEACHES

M. Gerdts

The varieties of peaches treated with chemical thinners in Fresno, Tulare, or Merced County included Springtime, Cardinal, Gold Dust, Dixired, Coronet, Red Haven, Regina, Redtop, Babcock, Early Elberta, Redglobe, Suncrest, Elberta, Forty Niner, Fay Elberta, Angelus, Pacifica, Rio Oso Gem, Merricle 120, Fiesta, and Jody Gay. Table 1 shows the range of thinning response ratings of four peach varieties in Fresno, Tulare, and Merced counties.

Good to excellent thinning was obtained with 3-CPA on Angelus, Early Elberta, Pacifica and Suncrest, and with NPA on Fay Elberta, Forty Niner, Red Haven, and Suncrest. Other varieties tested did not thin well in 1968 with either NPA or Fruitone 3-CPA.

To further evaluate thinning responses, random samples of 40 peaches were taken at hand thinning time from each treated tree and weighed. Weights from all trees from similar treatments were averaged. The results for Fresno County tests are shown in table 2; similar results were obtained in Tulare and Merced counties.

NPA was active on several varieties ripening after Coronet. In Tulare County applications made one to two days after full bloom were more effective on Red Haven and Suncrest peaches than applications of similar rates made four days after full bloom. Weak trees were thinned more than vigorous trees. Vigorous shoots were sometimes stripped leaving voids in parts of trees and fruit clusters in other areas on the same tree. When NPA applications were made one to five days after full bloom, a slight twisting and some reddening of leaves occurred. When applications were made seven to 12 days after full bloom in 1966, serious leaf twisting and reduced fruit growth resulted. Many freestone varieties were thinned with applications of 200 to 300 ppm two to five days after full bloom. However, Fay El-

TABLE 2. AVERAGE INDIVIDUAL FRUIT WEIGHTS AT THINNING TIME
Freestone Peaches, Fresno County—1968

Treatment	Variety			
	Red Haven	Early Elberta	Sun-crest	Fay Elberta
	gms	gms	gms	gms
Check	277	552	698	684
Elgetol 1.5 pt.	...	718†	...	885†
NPA 200 ppm	353†	730†	...	777*
NPA 300 ppm	342†	739†	...	807
CPA 4–5 mm	...	593	...	706
CPA 7–8 mm	...	659†	734*	751
CPA 10–11 mm	...	597	...	734

* Significant at 5% probability level.
† Significant at 1% probability level.

TABLE 3. NECTARINE THINNING SUMMARY
Tulare and Fresno Counties, 1968

Treatment	Time	Red June	Early Sun Grand	Sun Grand	Red Grand	Le Grand	Late Le Grand	Gold King	Sept. Grand
		Thinning response rating*							
NPA 100 ppm	FB + 2–3	1	2	1–2	...	3	3	...	...
NPA 200 ppm	FB + 2–3	0	...	2	...	3	3	...	...
NPA 100 ppm	FB + 4–6	4	2	3	4	4	4	1	...
NPA 200 ppm	FB + 4–6	1–2	...	2	4	3	1–3	0–1	...
NPA 300 ppm	FB + 4–6	...	...	1	...	...	1	0	...
3-CPA 300 ppm	3–4 mm ovule	3	3	3	3	4	3	4	...
3-CPA 300 ppm	7–8 mm ovule	...	...	2–3	...	2–3	2	3	2
3-CPA 300 ppm	8–10 mm ovule	3	3	3	3	3	2	3	...
3-CPA 150 ppm	8–10 mm ovule	4	4	4	4	4	3	4	3
Check (crop load)		mod.	light to mod.	heavy	heavy	mod.	mod. to heavy	mod.	mod. to heavy

* 0 = overthinned; 1 = Excellent thinning, little or no hand thinning needed; 2 = Good thinning, heavy limbs need some hand thinning; 3 = Slight thinning, little value in reducing hand thinning time; 4 = No thinning.

berta thinned well with applications of 100 ppm and was overthinned at higher rates.

Fruitone 3-CPA thinned such freestone peach varieties as Suncrest, Early Elberta, Angelus, and Pacifica at 300 ppm, but not others. More thinning was obtained when sprays were applied at ovule lengths of 7 to 8 mm (mid-April in 1968) than at 4 to 5 mm or 10 to 11 mm. Less vigorous trees were thinned more than vigorous trees of the same variety. Fruit drop was too late on varieties maturing before July 1 for satisfactory sizing of the remaining crop. No serious phytotoxic effects were observed in peaches. Slight temporary wilt was evident one to two days after spraying and some tip burn and yellowing occurred on a few leaves which dropped a week later.

NPA at 200 ppm seems promising for many early and heavy setting varieties. However, since it must be applied before the crop set is known, its use will be limited to heavy setting varieties. More information is needed on its year-to-year performance, the proper spray timing, and different varietal responses before NPA can be used commercially on freestone peaches.

Timing of 3-CPA sprays can be made after crop set is known which makes it an ideal material to use on mid- and late-season varieties that are not thinned early. A rate of 300 ppm applied at 7 to 8 mm ovule length seems ideal for varieties like Suncrest and Early Elberta. More tests are needed in other varieties. Touch-up hand thinning should be done cautiously after chemical thinning with either NPA or 3-CPA to avoid overthinning. The total amount of fruit left on the tree after chemical thinning should be the same as that left when hand thinning only is used; but fruit spacing will be more variable. Although progress is being made on chemical thinning of freestone peaches, it is not recommended for commercial use at this time.

NECTARINES

J. LaRue

Eight varieties, representive of commercial nectarines grown in California, tested with chemicals for spray thinning possibilities included: Red June, Early Sun Grand, Sun Grand, Red Grand, Le Grand, Late Le Grand, Gold King, and September Grand. Test results, summarized in table 3, show that NPA and 3-CPA can effectively aid thinning in nectarines.

NPA applied at 100 and 200 ppm two to three days after full bloom thinned some varieties well. There was less thinning when NPA was applied at these rates four to six days after full bloom. Except for slight leaf burn and foliage yellowing, no phytotoxic effects were noted in any variety sprayed in 1968. NPA-treated trees had more vegetative growth and, in some early varieties (Red June and Red Grand), fruit color was less intense.

At 300 ppm 3-CPA sprays thinned most effectively when applied at 7 to 8 mm ovule (seed) length (early to mid-April in 1968) with only slight thinning noted in either larger or smaller fruit. Mild leaf burn and drop occurred in all varieties. CPA hastened the drop of dummy or off-type fruit. Fruit also lost its external luster or shine for extended periods after treatment.

Nectarine summary

Both the 100 and 200 ppm NPA treatments applied two to three days after full bloom appear promising as chemical thinning aids for nectarines. Evidence from previous trials shows that Early Sun Grand and Gold King were more subject to phytotoxicity and overthinning in some years than in others. Increased vegetative growth, with accompanying poor fruit color development in early varieties must be further investigated.

The thinning action of 3-CPA at 7 to 8 mm ovule length in mid- to late maturing nectarine varieties is promising. Activity of this chemical probably would be too late for the Early Sun Grand and other early maturing varieties. Higher application rates will be tested in future experiments at the 3 to 4 mm ovule length size. Although slight leaf fall and burn appeared after applications of the chemical, effects were not serious enough to change yields or fruit size. Further study is needed to evaluate the loss of external luster observed on some varieties after 3-CPA applications.

Both NPA and 3-CPA are still experimental materials and further tests are needed to establish optimum rates and timing for both materials in important varieties—and to determine whether results can be duplicated year after year.

JAPANESE PLUMS

J. LaRue

Plum varieties studied in the spray thinning tests included Beauty, Burmosa, Santa Rosa, El Dorado, Nubiana, Laroda, Kelsey, Queen Ann, Red Roy, Simka, and Casselman. Most of these varieties are shipped in large volume and are considered representative of plums grown in California. The potential uses of chemical thinners on Japanese plums based upon these 1968 trial results are summarized in table 4.

NPA applications resulted in some thinning on each variety tested, and rates of 200 ppm were generally more effective than rates of 100 ppm. Thinning was satisfactory when NPA was applied from full bloom to three or four days after full bloom. When NPA was applied five to six days after full bloom less thinning occurred at the same rates than with earlier treatments. NPA applications on the Queen Ann variety caused phytotoxic effects and also resulted in overthinning at each rate and date of application. No phytotoxic effects were noted in other varieties.

Fruitone 3-CPA sprays resulted in some thinning in most plum varieties. The

TABLE 4. JAPANESE PLUM THINNING SUMMARY FOR 1968

Variety	NPA	3-CPA	3-CP
	Thinning response rating*		
Beauty	2	0	0
Burmosa	1	0	0
Santa Rosa	1	2	2
El Dorado	2	0	.
Red Roy	1	2	2
Nubiana	1	1	1
Laroda	2	2	2
Kelsey	2	2	.
Queen Ann	2	2	2
Simka	2	2	.
Casselman	2	2	.

* 0 = no potential; 1 = good potential; 2 = some potential, but more rate and time testing needed.

effects of CPA emerged slowly (three weeks after application), so any judgment of the degree of thinning was made after the time when normal hand thinning should have been completed for the fruit to gain maximum size at maturity. In early varieties such as Beauty and Burmosa the thinning effect did not show until long after normal hand thinning time. At 300 ppm 3-CPA applied at 8 to 10 mm ovule length killed many shoot tips on Laroda and Queen Ann. El Dorado and Nubiana reacted with heavy leaf roll and shot holing, but the reaction of other varieties appeared to be negligible.

At 50 ppm 3-CP was ineffective when applied two to three weeks post bloom at 6 to 10 mm ovule length on the varieties tested. It was an effective thinner, however, when applied at 100 and 150 ppm when ovules were 6 to 7 mm long. Slight to moderate leaf shot holing was evident at both rates. El Dorado and Nubiana were the most sensitive varieties.

Plum summary

NPA looks promising as a chemical thinner for a number of plum varieties. Its potential is greatest in early maturing varieties and in those varieties (both early and late) that set heavily every year. Since NPA must be applied immediately post bloom to be effective, the potential crop is not yet known at application time. There is a hazard of overthinning trees that set lightly.

Although effective, 3-CPA activity is too late for use on early varieties such as Beauty and Burmosa. In general, it looks good as a chemical thinner for later maturing varieties. Where the time of hand thinning is not critical, 3-CPA has much potential since it can be applied after crop set is known. At 50 ppm 3-CP was not an effective thinner, at 100 to 150 ppm it appears to have more potential but leaf phytotoxic effects may be a disadvantage.

Additional tests are being made to establish satisfactory rates, timing of sprays, varietal behavior, climatic effects, year to year performance, and phytotoxicity. Results of these tests are limited in scope and are reported to show potential, but none of these materials are presently recommended for use on plums.

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The method proposed here for soil moisture and salt control in irrigation utilizes solar energy and clear plastic to recycle water from irrigated furrows to adjacent seed or plant beds. The use of clear plastic canopies over the irrigated furrows prevents evaporation and maintains a moist seedbed for long periods of time. Harmful concentrations of soluble salts can also be redistributed within the bed by recycling water from the wetted furrow. Installation of the hydrologic minicycle system can be beneficial in seed germination and establishment of many of our high value crops. It can also be useful in areas of insufficient rainfall and high temperatures, especially where water is costly or of poor quality. Adaptation to nursery and greenhouse culture could greatly reduce the labor required by the frequent watering of plants. Warmer soil temperatures found in the plant beds beneath the edge of plastic canopies could facilitate early spring seed germination when solar energy is available but outside air temperatures are still too low for a normal seeding date.

HYDROLOGIC MINI

for soil moisture and

THE PROBLEM of obtaining sufficient water for irrigated agriculture grows more and more acute as the world's population continues to increase at an alarming rate. It has been estimated that in only 30 years the world will double its present population. The impact of the estimated population increase becomes even more critical since it will occur during a period of an expected decrease in fresh water supply. Another consideration is the fact that land suitable for crop food production, although presently adequate in some areas, will someday become limiting. The demand for more food to feed the millions of new people every year confronts agriculture experts the world over. However, while great pressure for more food will be exerted on agriculture, increased demands for water for industrial and domestic use will literally put the squeeze on irrigated agriculture. Roughly 50 per cent of the water used in the United States today is used by agriculture for irrigation. The present distribution ratio of water among agricultural, industrial, and domestic users can be expected to undergo considerable change in the future. It is apparent that if agriculture is to compete effectively for future water needs, the most efficient water management practices must be used.

In arid and semi-arid regions of the world, where small amounts of rainfall are generally insufficient to grow food crops, supplemental irrigation water must be obtained from some external source by costly systems of aqueducts, canals, or by wells. Since these sources of water are not only expensive but are limited in terms of an input for food crop production, continuous efforts must be made by agriculture to devise the most efficient means of water use. The maintenance of salt balance in the soil is also essential to the existence of irrigated agriculture. A buildup of excess soluble salts in soil under irrigation has caused total crop failures and disastrous social consequences within ancient civilizations—and is still a major barrier to maintaining high production on irrigated lands.

Transpiration by plants and evaporation from the soil surface (evapotranspiration) account for the greatest water losses during crop production. Even though transpiration serves as a cooling mechanism for plants, and is often referred to as a "necessary evil," efforts have been made to decrease water loss by retarding transpiration. Studies have involved use of metabolic inhibitors as well as physical transpiration barriers applied to leaf surfaces. Both methods show promise for future use, providing the metabolism of the plants does not change to cause an inferior or unacceptable plant product.

In an effort to reduce evaporation from