

Table 1. Response of phony peach trees to treatments applied as foliar sprays on June 22 and July 26.

Treatment <sup>z</sup>	Rate g/liter ai	Shoot length (cm) <sup>y</sup>	
		Pretreatment June 16	Response Sept. 19
Water	—	21.1a	0a
Sodium isoascorbate	27.0		
Urea	9.6	19.5a	1.5a
Calcium nitrate	5.9		
Sodium isoascorbate	27.0	17.0a	0.3a
Urea	9.6		
Calcium nitrate	5.9	19.1a	0.1a
Sodium isoascorbate	54.0		
Urea	9.6	17.0a	2.1a
Calcium nitrate	5.9		
Cytokinin <sup>x</sup>	.00125	19.3a	0.4a
Sodium isoascorbate	27.0		
Urea	9.6		
Calcium nitrate	5.9	19.8a	1.0a
Citric acid	3.5		
Gibberellic acid	0.264	19.2a	12.5b
Healthy, untreated	—	45.1b	19.0c

<sup>z</sup>Source of materials: sodium isoascorbate (Mycoshield) Pfizer, Inc. NY; cytokinins (Cytex) Atlantic and Pacific Research, Inc., N. Palm Beach, FL; gibberellic acid (Pro Gib Plus) Abbott Laboratories, Chicago, IL.

<sup>y</sup>Mean separation in columns by nonparametric procedure of Kruskal and Wallis (5).

<sup>x</sup>Cytex contains mixed cytokinins, mostly zeatin-like. Cytokinin activity is 100 ppm kinetin equivalent based on bioassay (8).

acteristics of phony affected trees will be evaluated in future studies.

The use of growth regulators to reverse disease symptoms without affecting the pathogen would offer only a

temporary solution to this difficult problem. The pathogen is apparently not affected by GA treatments. Post-treatment examinations (2) of root and stems from GA and water treatments

showed no significant differences between treatments in the numbers of bacteria present. This indicates that the trees are still infectious. It is, therefore, important to continue the practice of removing diseased trees to prevent the further spread of PPD throughout the orchard.

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## Chemical Thinning of Prune: Relation of Assimilate Deprivation to Ethylene-mediated Fruit Abscission<sup>1</sup>

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**Abstract.** Dry matter accumulation by immature 'French' prune (*Prunus domestica* L. cv Agen) fruit was reduced significantly within 7 days by (A) branch girdling plus defoliation (G+D), or (B) 300 ppm ethephon. Ethephon, but not G+D, reduced fruit removal force (FRF) significantly over the same interval. These data do not support the hypothesis that ethylene (C<sub>2</sub>H<sub>4</sub>)-induced thinning is initiated by assimilate deprivation. We propose that reduced mobilization of assimilates by ethephon-treated fruit is a consequence of the incipient fruit senescence which precedes abscission rather than the causative factor.

Competition for metabolites is frequently invoked to explain June drop in deciduous fruit trees (1, 5, 7, 9, 11-15). It has also been suggested that the effects of certain chemical thinning agents, i.e., NAA and ethephon, are mediated by a reduction of assimilates reaching young apple and peach fruit (14, 15).

The requirement of rapidly enlarging fruit for assimilates (6) is not in

question, nor is the reduced mobilization of nutrients by senescing fruit (11). These observations, however, do not preclude the possibility of direct effects of chemical thinning agents on fruit independent of assimilate deprivation.

Post-bloom ethephon applications stimulate abscission of French prunes (8). The objective here was to determine whether substrate deprivation was sufficient to reduce FRF over the time course of ethephon-induced abscission. If C<sub>2</sub>H<sub>4</sub>-induced fruit abscission (Fig.

1, Step 3) is a direct consequence of carbon stress (Fig. 1, Step 2), then other treatments, e.g., limb defoliation, which generate carbon stress comparable to that of ethephon should initiate fruit abscission during the same time interval as that affected by ethephon. In other words, if ethephon-induced thinning is mediated by assimilate deprivation, assimilate deprivation *per se* should initiate abscission over the same time interval in the absence of exogenous C<sub>2</sub>H<sub>4</sub>.

The experiment comprised a factorial combination of 3 dosage levels of ethephon with 3 dosage levels of carbon deprivation. Each of the 9 treatments (Table 1) was applied 25 days after full bloom (11 mm seed length) to 6 limbs randomized among 8 ten-year-old 'French' prune/Marianna 2624 trees. Reduction of assimilates available to fruit (carbon stress) was attempted by 2 different means: (A) girdling plus defoliation (G+D) or (B) shading. In treatments which combined ethephon plus carbon stress, ethephon was sprayed to run off after G+D or just before shading. Limbs (Table 1; S<sub>1</sub>E<sub>0</sub>, S<sub>1</sub>E<sub>100</sub>, S<sub>1</sub>E<sub>300</sub>) were shaded with black polyethylene bags which were, in turn, enclosed in white cloth bags to reflect incident radiation. Achievement of carbon stress was

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presumed if treatment reduced dry matter accumulation in fruit. The progress of fruit abscission was quantified by measuring fruit removal force (FRF) with a Chatillon dial push-pull gauge adapted with a 2-prong hook for attaching to prune fruits. FRF of 5 fruits per limb (30 fruits per treatment) was determined periodically. These fruit were weighed fresh and dried at 70°C to constant weight. Data obtained 4 and 7 days after treatments were selected for presentation.

Shading alone (S<sub>1</sub>E<sub>0</sub>) did not generate carbon stress in fruit during the 7 days subsequent to treatment (Table 1). Presumably carbon redistribution occurred within shaded limbs and/or carbon was mobilized from adjacent limbs. Ethephon (S<sub>0</sub>E<sub>300</sub>) and G+D (S<sub>2</sub>E<sub>0</sub>) resulted in apparent carbon stress since the accumulation of fruit dry matter ceased within 4 days (Table 1). This effect preceded significant fresh wt and FRF reductions (Table 1). Also, dry wt (S<sub>2</sub>E<sub>0</sub>, S<sub>0</sub>E<sub>300</sub>) which decreased slightly between days 4 and 7 following treatments (Table 1) was around 30% lower than control (S<sub>0</sub>E<sub>0</sub>). During the same time course as ethephon-induced reduction of FRF, G+D resulted in no significant weakening of the abscission zone (compare S<sub>2</sub>E<sub>0</sub> with S<sub>0</sub>E<sub>300</sub>, Table 1). These data do not support the hypothesis that C<sub>2</sub>H<sub>2</sub>-induced fruit thinning is mediated by assimilate deprivation. Carbon stress, however, increased rates of C<sub>2</sub>H<sub>4</sub>-enhanced fruit abscission. The data allow distinction between (A) a predisposition of carbon-stressed fruit to C<sub>2</sub>H<sub>4</sub> action and (B) carbon stress *per se* as the causative agent in fruit abscission. Analysis of variance indicated a significant interaction between shade

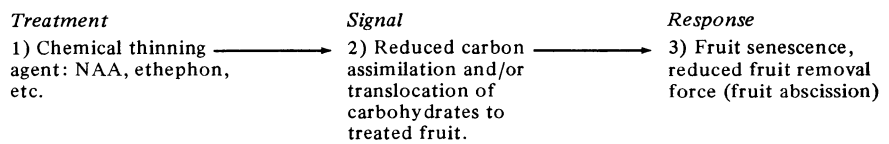


Fig. 1. Nutrient competition hypothesis of chemically-induced fruit abscission as interpreted by Schneider (14, 15), i.e., chemically-induced fruit thinning is a direct consequence of assimilate deprivation.

and ethephon (that data not presented but see Table 1; S<sub>1</sub>E<sub>0</sub>, S<sub>1</sub>E<sub>100</sub>) i.e., shading was effective in reducing dry wt and FRF only when combined with ethephon.

Despite the fact that our plant material and experimental system were not the ones employed by Schneider (14), we question his interpretation of his data. Schneider proposes that "a series of events, associated with fruit abscission, do in fact occur after an NAA spray, starting with a reduction of metabolites reaching the young fruit . . ." We have taken Schneider's data (14, 15) and logic to construct the following model (Fig. 1). His data, in fact, do not reveal whether assimilate deprivation is a (A) cause of fruit abscission or a (B) consequence of incipient organ senescence.

Transport of assimilates from leaves to fruit depends on a number of processes, i.e., source activity, sieve-tube loading, longitudinal transfer, sieve-tube unloading, and sink activity (10). Any one of these processes may be rate limiting. Reduced translocation of assimilates to NAA or ethephon-treated fruit may be a direct consequence of reduced sink (fruit) activity. This interpretation is more consistent with our data and the concept of selective fruit removal. Furthermore, sink regula-

tion of carbon assimilation and transport is well documented (2-4, 7, 10), if not fully appreciated (14, 15).

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Table 1. Effects of ethephon and assimilate deprivation on fresh wt, dry wt, and fruit abscission (FRF) following treatments.

Assimilate deprivation	Ethephon (ppm)	4 days <sup>z</sup>			7 days <sup>y</sup>		
		Fr wt/fruit (g)	Dry wt/fruit (g)	FRF (kg)	Fr wt/fruit (g)	Dry wt/fruit (g)	FRF (kg)
Control (S <sub>0</sub> )	0 (E <sub>0</sub> )	2.59 a	0.31 a	1.04 a	3.35 a	0.38 a	1.17 a
	100 (E <sub>100</sub> )	2.50 ab	0.31 a	1.13 a	3.24 a	0.37 a	1.09 a
	300 (E <sub>300</sub> )	2.25 ab	0.25 b	0.92 ab	2.26 b	0.23 bc	0.61 b
	Mean	2.45	0.29	1.03	2.95	0.33	0.96
Shade (S <sub>1</sub> )	0 (E <sub>0</sub> )	2.69 a	0.32 a	1.15 a	3.00 a	0.34 a	1.13 a
	100 (E <sub>100</sub> )	1.66 c	0.19 c	0.56 c	1.58 c	0.16 c	0.16 c
	300 (E <sub>300</sub> )	1.98 b	0.22 bc	0.77 b	1.95 bc	0.18 bc	0.15 c
	Mean	2.11	0.24	0.83	2.18	0.23	0.48
Girdling + defoliation (S <sub>2</sub> )	0 (E <sub>0</sub> )	2.19 ab	0.25 b	0.99 ab	2.24 bc	0.25 b	1.01 a
	100 (E <sub>100</sub> )	1.74 bc	0.22 bc	0.97 ab	1.70 bc	0.20 bc	0.30 c
	300 (E <sub>300</sub> )	2.18 ab	0.23 bc	0.89 ab	2.18 bc	0.20 bc	0.14 c
	Mean	2.04	0.23	0.95	2.04	0.22	0.48

<sup>z</sup>Means separated in columns by Duncan's multiple range test, 5% level.

<sup>y</sup>Means separated in columns by Duncan's multiple range test, 1% level.