Reprinted from HortScience, Vol. 25(4), April 1990
A Publication of the American Society for Horticultural Science, Alexandria, VA 22314

HortScience 25(4):426–428. 1990.

Effect of Fall Ethephon Applications on Bloom Delay, Flowering, and Fruiting of Peach and Prune

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Additional index words. *Prunus persica, Prunus domestica*, yield, fruit set, defoliation

Abstract. **Studies in the use of fall ethephon to delay bloom in peach and prune were carried out during 1985–87. In 'Italian' prune, ethephon at 250 and 500 mg·liter^{-1} at 10% leaf-drop stage delayed bloom 13 and 16 days, respectively. Only a 5- and 7-day bloom delay occurred when applied at 50% leaf-drop stage. Fruit set and yield were not reduced in 'Italian' prune when ethephon was applied at the 50% leaf-drop stage. Early applications, from vegetative maturity to the 10% leaf-drop stage, did not reduce yield in prune when trees had been previously defoliated with 3.0% urea. Early leaf removal, before vegetative maturity, caused reduction in peach flower and fruit number. In several peach cultivars, all the ethephon treatments were detrimental to flower density, fruit set, and yield, in spite of bloom delay. The ethephon-treated prune trees yielded more than the untreated trees in 1987 as a result of frost avoidance.**

Ethephon applications at 500 to 4000 mg·liter^{-1} in the fall have delayed bloom the following spring (Dennis, 1976; Gianfagna et al., 1986; Proebsting and Mills, 1972). This benefit was offset by such side effects as gummosis, flower abscission or failure of flora bud opening, low fruit set, and yield reduction (Proebsting and Mills, 1972; Dennis, 1976; Webster, 1984; Gianfagna et al., 1986). Coston et al. (1985) used the ethylene-releasing chemical CGA-15281 to delay bloom of 'Redhaven' peach by 4 days without reducing flower number, but they did not report the effect on fruit set and yield. However, Dennis (1976) found that early fall defoliation of fruit trees delayed bloom the following spring. Also, Fuchigami et al. (1977) found budbreak was delayed in *Cornus stolonifera* by fall defoliation. Abnormal growth resulted if trees were defoliated too early. In a preliminary report, Crisosto et al. (1986) found that 100 mg ethephon/liter, applied on 'Redhaven' peach trees after early fall hand-defoliation, delayed bloom as much as on foliated trees, but without phytotoxicity.

The objective of the experiments described here was to continue to study bloom delay of peach and prune trees with ethephon and evaluate the residual effect on tree yield.

Experiment 1. Ethephon at 120 mg·liter^{-1} plus 0.01% Tween-80 or Tween-80 alone were applied 1 Oct. 1985 to five hand-defoliated and five normal 'Redhaven' trees in a completely randomized design. Hand-defoliation was done on 28 Sept., 15 days before vegetative maturity as determined according to Fuchigami et al. (1977), and before leaf drop. Bloom delay was determined by subtracting time of anthesis of the control from that of the treatments. Leaf and flower number per node and fruit set were taken on five branches per tree. Yield per tree was also determined. Fruit weight and maturity, expressed as soluble solids concentration (SSC), were taken on 25 fruit per tree at harvest using a hand-held refractometer (American Optical Co., Keene, N.H.).

Experiment 2 a and b. Ethephon was applied at 0, 50, 100, or 200 mg·liter^{-1} plus 0.01% Tween-80 to each of five 'Suncrest' peach trees per treatment at 10% leaf drop on 25 Oct. 1985 and to another group of five trees per treatment 7 days after complete leaf drop (14 Nov. 1985) in a completely randomized design (Expt. 2a). In another trial, ethephon at 0, 300, or 600 mg·liter^{-1} with 0.01% Tween-80 was applied on the same dates with similar defoliation treatments to 10 'Italian' prune trees per treatment arranged in a completely randomized design (Expt. 2b). Bloom and yield components as described in Expt. 1 were obtained in 1986 on five branches per tree in Expt. 2a. Yield per tree was measured for 'Italian' prune trees in Expt. 2b. Fruit weight and maturity were

Table 1. Effect of Fall 1985 ethephon and hand-defoliation treatments before vegetative maturity on bloom delay, flowering, and fruiting of 'Redhaven' peach trees in 1986 (Expt. 1).

Treatment	Bloom delay (days)	Flowers per node (no.)	Fruit per flower (no.)	Yield (kg/tree)
Ethephon (mg·liter^{-1})[z]				
0	1.1	0.46	0.12	28
120	9.4	0.22	0.06	9
	*	*	*	*
Defoliation[y]				
None	4.6	0.42	0.14	30
Hand-defoliation	5.8	0.27	0.04	7
	NS	*	*	*
Ethephon × defoliation	NS	NS	NS	NS

[z]Ethephon sprays were applied on 1 Oct. 1985.
[y]Trees were defoliated on 28 Sept. 1985.
NS,*Nonsignificant or significant at $P = 0.05$. Mean separation by F test. Each mean represents an average of five trees.

Received for publication 22 Feb. 1988. Published with the approval of the Director of the Oregon Agriculture Experiment Station as Technical Paper no. 8726. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

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Table 2. Effect of Fall 1985 ethephon timing and rate on bloom delay, flowering, and fruiting of 'Suncrest' peach in 1986 (Expt. 2a).

Application time	Ethephon (mg·liter^{-1})	Bloom delay (days)	Flowers per node (no.)	Fruit per flower (no.)	Yield (kg/tree)
10% leaf drop (25 Oct. 1985)	0	0	1.2	0.2	48
	50	6.0	0.8	0.2	26
	100	8.3	0.5	0.2	21
	200	8.8	0.4	0.2	13
Linear		*	*	NS	*
Quadratic		*	*	NS	*
Complete leaf drop (14 Nov. 1985)	0	0	1.2	0.2	48
	50	0.5	1.0	0.2	41
	100	2.2	0.9	0.2	38
	200	3.0	0.7	0.2	37
Linear		*	*	NS	*
Quadratic		*	*	NS	*
Ethephon × application time		**	NS	NS	**

NS,*,**Nonsignificant or significant at $P = 0.05$ or 0.01, respectively. Each mean represents an average of five trees.

Table 3. Effect of Fall 1985 ethephon timing and concentration on bloom delay and yield of 'Italian' prune trees in 1986 (Expt. 2b).

	Bloom delay (days)		Yield (kg/tree)	
	Time of application (1985)			
Ethephon (mg·liter^{-1})	10% Leaf drop (25 Oct.)	Complete leaf drop (14 Nov.)	10% Leaf drop (25 Oct.)	Complete leaf drop (14 Nov.)
0	0	0	38	38
300	6.7	2.4	31	36
600	9.5	3.6	22	41
Linear	*	*	*	NS
Quadratic	*	*	*	*
Ethephon × application time	**		**	

NS,*,**Nonsignificant or significant at $P = 0.05$ or 0.01, respectively. Each mean represents an average of 10 trees.

Table 4. Effect of Fall 1986 ethephon applied at the 50% leaf-drop stage on 'Suncrest' peach tree performance and bloom delay in 1987 (Expt. 3a).

Ethephon (mg·liter^{-1})	Bloom delay (days)	Fruit per branch cross-sectional area (no./cm^2)	Fruit per flower (no.)	Yield (kg/tree)
0	0	4.7	0.3	50
100	4	6.5	0.6	59
200	5	7.6	0.6	57
300	6	6.3	0.6	60
Linear	*	NS	*	NS
Quadratic	*	NS	*	NS

NS,*Nonsignificant or significant at $P = 0.05$. Each mean represents an average of five trees.

Table 5. Effect of ethephon applied Fall 1986 on bloom delay and yield of 'Italian' prune trees in 1987 (Expt. 3b).

	Bloom delay (days)		Yield (kg/tree)	
	Time of application (1986)			
Ethephon (mg·liter^{-1})	10% Leaf drop (15 Oct.)	50% Leaf drop (22 Oct.)	10% Leaf drop (15 Oct.)	50% Leaf drop (22 Oct.)
0	0	0	17	17
250	13	5	34	31
500	16	7	32	32
Linear	*	*	*	*
Quadratic	*	*	*	*
Ethephon × application time	**		NS	

NS,*,**Nonsignificant or significant at $P = 0.05$ or 0.01. Each mean represents an average of eight trees.

determined from a 25-fruit sample per tree as in Expt. 1.

Experiment 3 a and b. Ethephon at 0, 100, 200, or 300 mg·liter^{-1} plus 0.01% Tween-80 was applied at the 50% leaf-drop stage (22 Oct. 1986) to five 'Suncrest' trees per treatment in a completely randomized design (Expt. 3a). Separately, ethephon at 0, 250, or 500 mg·liter^{-1} plus 0.01% Tween-80 was applied to eight replicate 'Italian' prune trees at 10% or 50% leaf drop (15 and 22 Oct. 1986, respectively), also in a completely randomized design (Expt. 3b). Flower and fruit number were counted and basal circumference was measured on four branches per tree. Fruit weight and SSC were measured from 25 fruit per tree as described for Expt. 1.

Experiment 4 a and b. Ethephon was applied to defoliated 'Veteran' peach and 'Italian' prune trees in completely randomized designs. The 'Veteran' peach trees were defoliated at early leaf drop (8 Oct. 1986) by three methods: hand-defoliation, 0.5% CuEDTA, and 3.0% urea plus 0.01% Tween-80. Ethephon at 0, 150, or 300 mg·liter^{-1} plus 0.01% Tween-80 was applied 4 days later to five replicate trees of each defoliation treatment (Expt. 4a). In a separate trial, ethephon at 0 or 120 mg·liter^{-1} plus 0.01% Tween-80 was applied when 10% natural leaf drop occurred (15 Oct. 1986) to eight 'Italian' prune trees either previously defoliated using 3.0% urea (7 Oct.) or untreated. Yield per tree was recorded for these plots.

The stage of flower bud development was recorded daily during the following spring on a six-stage rating scale (Ballard et al., 1972). Bloom delay was determined by subtracting the time of 80% anthesis of the control from that of the treatments and was expressed as number of days delay. No fruit thinning was carried out on any of the experiments.

The data were subjected to analysis of variance (ANOVA) and regression analysis where appropriate. Means were calculated from composited branch data per tree replicate. These means were used in the ANOVA. The Number Cruncher Statistical System Package (NCSS, Kaysville, Utah) was used.

Experiment 1. Bloom delay of 9.4 days was achieved from fall ethephon applications on foliated and hand-defoliated 'Redhaven' trees in 1985 (Table 1). However, flower number per node, fruit set, and yield were reduced with hand defoliation and/or when ethephon was applied. This reduction may have been a result of leaf removal before vegetative maturity.

Experiment 2. Ethephon applied at either 10% leaf drop or after complete leaf drop significantly delayed bloom in 'Suncrest' peach (Table 2) and 'Italian' prune (Table 3) in 1986. At the earlier timing, ethephon delayed bloom more than the late application. However, a greater reduction in peach yield was observed when ethephon was applied at the 10% leaf-drop stage (Table 2). For prune, the early application reduced yield, but the late application of 600 mg·liter^{-1} increased

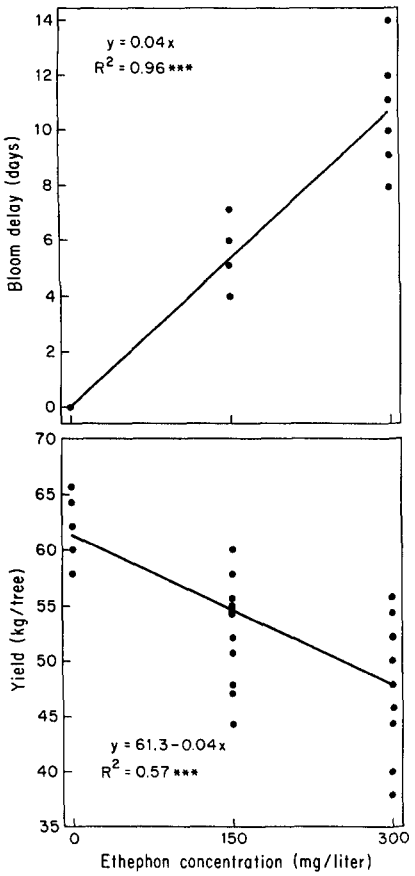

Fig. 1. Effect of ethephon applied in 1986 after vegetative maturity on (**top**) bloom delay and (**bottom**) yield of 'Veteran' peach in 1987 across control and defoliated trees (Expt. 4a).
***Significant at $P = 0.001$. Each ethephon concentration represents 15 observations with 32 and 22 data points hidden in top and bottom, respectively.

yield, especially relative to the lower dose (Table 3).

Fruit number per flower in 'Suncrest' was unaffected at any ethephon concentration applied at either timing, while flowers per node and yield were reduced significantly at both timings.

Experiment 3. 'Suncrest' peach bloom was delayed by increasing the ethephon concentration applied at 50% leaf-drop stage (Table 4). At this stage of development, the ethephon application was not deleterious to fruit number, and increased fruit set, but had no effect on yield. Ethephon delayed bloom on 'Italian' prune up to 16 days when applied at 10% leaf-drop stage, but only up to 7 days when applied at 50% leaf-drop stage (Table 5). After a frost (−2C) during full bloom, we observed damaged flowers on control trees. Trees treated with ethephon escaped frost damage since they bloomed 5 to 13 days later. Although no flower counts were made, the higher yields were probably a result of avoiding frost.

Table 6. Effect of ethephon, applied at the 10% leaf-drop stage in Fall 1986, on the 1987 performance of 'Italian' prune trees previously defoliated by urea (Expt. 4b).

Treatment	Bloom delay (days)	Fruit set (no./flower cluster)	Yield (kg/tree)
Ethephon (mg·liter^{-1})[z]			
0	0	0.3	26
120	8	0.7	68
	*	*	*

[z]Ethephon was applied 15 Oct. 1986.
*Significant at $P = 0.05$. Means separation by F test. Each mean represents an average of eight trees.

Experiment 4. Ethephon delayed bloom and decreased yield on 'Veteran' peach trees in proportion to concentration (Fig. 1). Defoliation with urea did not affect bloom delay or yield. The interaction with ethephon was nonsignificant. Ethephon-treated 'Italian' prune trees had an 8-day bloom delay and a significant increase in yield (Table 6). Frost damage to nonethephon-treated trees probably accounted for this difference. Defoliation with urea did not affect bloom delay, fruit set, or yield, and the interaction with ethephon was not significant.

Fruit maturity of peach cultivars, as determined by SSC, was delayed by the fall ethephon treatment (data not shown). The 'Suncrest' and 'Redhaven' harvests were delayed by 5 and 4 days in 1986, respectively. Funt and Ferree (1986) also reported a delay of maturity after fall ethephon sprays in peaches. Prune fruit weight and SSC in 1987 were not significantly different than the control.

Ethephon delayed bloom, but decreased yield in peach. It appears unlikely that a lower concentration of ethephon would produce a significant delay in bloom. Ethephon at higher concentrations was successful in delaying bloom and increasing yield in 'Italian' prune in 1 year of trials. A frost at full bloom the year after treatment accounted for the yield increase. However, yield was decreased by ethephon on 'Italian' prune when no frost occurred during bloom the following year. Further trials are needed to clarify ethephon effects on yield in both peach and prune when used to delay bloom.

Literature Cited

Ballard, J.K., E.L. Proebsting, Jr., and R.B. Tukey. 1972. Critical temperatures for blossom buds. Peaches. Washington State Univ. Ext. Circ. 373.

Coston, D.C., G.W. Krewer, T.E. Elkner, J.B. Williamson, and E.T. Sims, Jr. 1985. Chemical treatments to delay bloom in peach. J. Amer. Soc. Hort. Sci. 110:874–877.

Crisosto, C.H., P.B. Lombard, and L.H. Fuchigami. 1986. Effect of fall ethephon and handdefoliation on dormant bud ethylene levels, bloom delay, and yield components of 'Redhaven' peach. Acta Hort. 201:203–212.

Dennis, F.G., Jr. 1976. Trials of ethephon and other growth regulators for delaying bloom in tree fruits. J. Amer. Soc. Hort. Sci. 101:241–245.

Fuchigami, L.H., M. Hotze, and C.J. Weiser. 1977. The relationship of vegetative maturity to rest development and spring bud-break. J. Amer. Soc. Hort. Sci. 102:450–452.

Funt, R.C. and D.C. Ferree. 1986. Ethephon induced bloom delay of peach trees, Ohio, USA. Acta Hort. 179:163–169.

Gianfagna, T.J., R. Marini, and S. Rachmiel. 1986. Effect of ethephon and GA_3 on time of flowering in peach. HortScience 21:69–70.

Proebsting, E.L., Jr., and H.H. Mills. 1972. Bloom delay and frost survival in ethephon-treated sweet cherry. HortScience 8:46–47.

Webster, A.D. 1984. Plant growth regulator sprays to delay blossoming of 'Victoria' plum. J. Hort. Sci. 59:377–386.