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Peach Bloom Delay and Tree Response to Fall Application of Ethephon

Bulletin 1055 -- August 1996

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Published by the Office of Agricultural Communications (Publications), Division of Agriculture, Forestry, and Veterinary Medicine, Mississippi State University. Edited by Keith H. Remy, Senior Publications Editor. Cover designed by Betty Mac Wilson, Graphic Artist.

Introduction

Spring freezes during peach tree bloom limit peach yields in Mississippi. In northern Mississippi during the usual bloom period between March 14-April 1, 1951-1987, temperatures below 32 °F occurred in 66% of the years. Temperatures below 28 °F have been recorded in 32% of the years at Mississippi State University (Wax et al., 1987).

The use of a growth regulator sprayed on peach trees to delay bloom would be a relatively easy and inexpensive method of preventing spring frost damage. Ethephon, 2-chloroethyl phosphonic acid, is an ethylene-producing compound, which has attracted attention as a possible growth regulator to induce bloom delay.

Increased cold hardiness and bloom delay were noted in sweet cherry following fall applications of ethephon at 100 and 500 ppm (Proebsting and Mills, 1976). Dennis made fall applications of ethephon at 250 and 550 ppm to sweet cherry, plum, and peach (1976). Bloom delay of 3-5 days and severe flower bud injury

were observed in peach with ethephon at 500 ppm (Dennis, 1976).

Other studies have demonstrated that fall ethephon applications of 125-250 ppm delayed peach bloom 3-5 days, while applications at 500 ppm resulted in tree injury (Coston et al., 1985; Gianfagna et al., 1986). Durner and Gianfagna (1988, 1991) increased flower bud winter hardiness and delayed bloom approximately 7 days with a fall application of 100 ppm ethephon. Ethephon is thought to increase the chilling requirement of peach flower buds (Durner and Gianfagna, 1991).

The objective of the study summarized here was to evaluate the influence of ethephon on floral bud development, bloom delay, and fruit weight of three peach cultivars. This bulletin presents the results of a 3-year ethephon study conducted at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1992 through 1994.

Materials and Methods

The peach cultivars used in this experiment were 'Correll', 'Redhaven', and 'Cresthaven'. The peach trees were planted in 1987 at the Pontotoc Branch Station in an Atwood silt loam soil. All trees were pruned to an open center, and fertilizer and pesticides were applied following Mississippi Cooperative Extension Service (MCES) guidelines. Fruit was thinned by hand to a 6-inch spacing. Treatments were arranged in a split plot design with cultivars being main plots and ethephon treatments subplots. Main plots were replicated four times. The experimental unit was a single tree.

Treatments were applied during 1991, 1992, and 1993. In 1991, the treatments of 0, 100, 200, and 400 ppm ethephon were applied on November 1 and 2. A second treatment of 200 or 400 ppm ethephon was applied on November 14, 1991 to the trees that received 200 and 400 ppm on the first spray date. In 1992, treatments of 0, 50, 200, and 400 ppm ethephon were applied on November 5. Each ethephon treatment was applied with or without Surf Aid® 80/20, a nonionic surfactant, at a rate of 6 oz/100 gallons water. In 1993, ethephon at 0, 50, 200, 400, and 500 ppm was applied on November 10-11. The entire tree was sprayed to runoff with a handgun and an Argotec® sprayer (Model ASA0451).

Four twigs, one in each quadrant of the tree, were selected and tagged for visual observations of floral buds every other day. The terminal three floral buds on each twig were evaluated to determine stage of floral development; where 1 = no visible flower bud swelling, and 7 = flower completely opened as described by Westwood (1978) and illustrated in Figure 1. Floral bud development stages at each observation date were subjected to analysis of variance.

Days of bloom delay were determined by plotting stage of floral bud development against full bloom date. The number of days to achieve full bloom after full bloom of the control (Stage 7) were identified as days of bloom delay. For example, if the control trees reached full bloom (Stage 7) on March 19 and the trees treated with 100 ppm ethephon attained full bloom on March 22, bloom delay was 3 days, as illustrated in Figure 1. Fruit was harvested by hand, and yield and fruit size were recorded.

Results

There was an ethephon x year interaction with regard to floral bud development, percentage of dead flowers, and fruit size. Therefore, the results are presented by year.

In 1992, floral bud development was delayed by ethephon. The amount of delay varied depending on data collection date and ethephon concentration. Bloom delay (expressed as the number of days to achieve full bloom after full bloom of the control) was 3, 7, and 11 days for ethephon at 100, 200, and 400 ppm, respectively (Table 1).

In 1993, there was a treatment x cultivar interaction, and bloom delay data are presented for each cultivar. Similar to 1992, flower bud development of all three cultivars was delayed, and the delay varied depending on

data collection date and concentration. Bloom delay was 1, 4, 4, and 6 days for 'Cresthaven' at 50, 200, 400, and 500 ppm, respectively (Table 2). Bloom delay for 'Correll' was 1, 3, 4, and 3 days at 50, 200, 400, and 500 ppm, respectively (Table 3). For 'Redhaven', bloom delay was 1, 3, 3, and 5 days for 50, 200, 400, and 500 ppm, respectively (Table 4).

In 1994, the same trend in bloom delay by ethephon as in the previous years was observed. As in 1993, there was a treatment x cultivar interaction, indicating that the cultivars responded differently to a given treatment. Bloom delay for 'Correll' was 2, 3, 5, and 4 days for 50, 200, 400, and 500 ppm, respectively (Table 6). Bloom delay for 'Cresthaven' was 1, 3, 3, and 4 days for the same concentrations (Table 5); and 2, 3, 5, and 4 days for 'Redhaven' (Table 7).

In 1993, all concentrations increased the percentage of dead floral buds. In 1994, however, ethephon only at 200 ppm resulted in a lower percentage of floral bud death than the control. The remaining treatments had no effect (Table 8).

In 1992, ethephon at 100 and 200, but not 400 ppm, increased yield of 'Correll' compared to the control. Ethephon did not influence yield of 'Cresthaven' or 'Redhaven' (Table 9). In 1993, ethephon did not influence yield of any cultivar (data not shown). In 1994, all ethephon concentrations increased yield equally for all cultivars except ethephon at 500 ppm (Table 10).

Ethephon at 400 ppm reduced fruit weight of 'Correll' in 1992, and the same concentration increased fresh weight in 1993 (Table 11). Fruit weight of 'Cresthaven' and 'Redhaven' were not influenced by ethephon in either 1992 or 1993. However, in 1994, fruit weight of 'cresthaven' was reduced by ethephon at all concentrations except 500 ppm. Ethephon did not influence fruit weight of 'Correll' or 'Redhaven' in 1994 (Table 11).

Conclusion

In this study, fall applications of ethephon delayed floral bud development each spring for 3 years and consequently delayed bloom. Each year, the amount of floral bud development was dependent on ethephon concentration and data collection date. In general, the higher ethephon concentrations were more effective. In two out of three years, bloom delay depended on cultivar indicating that 'Cresthaven', a late-maturing cultivar, responded less to ethephon.

In one out of three years, ethephon increased floral bud death indicating that perhaps climatological variations may influence ethephon effects.

Yield increases attributed to ethephon may be expected, depending on cultivar and year. No yield reductions were reported.

Fruit weight effects at the high concentrations were not consistent and varied from year to year. In general, a reduction in fruit weight would not be expected except with high ethephon concentrations and depending on cultivar.

Based on the overall results of this study, ethephon sprays at 100 to 200 ppm applied in November are recommended for peach bloom delay in the spring. However, ethephon is not labeled for bloom delay in peaches. The company that produces ethephon is currently pursuing a minor crop use label for ethephon to delay bloom in peaches. This label should be available in 2 years.

Acknowledgments

Appreciation is extended to all the technical staff, support staff, and graduate students for their valuable contributions to this research. Special thanks are extended to those from each research station who made this research possible and to Dr. Patrick D. Gerard, Assistant Professor/Statistician, for his review of the

manuscript for statistical accuracy.

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Table 1. Effect of ethephon on 'Redhaven' peach floral bud development at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1992.

	Observation Date				
Ethephon ppm	**3/4**	**3/11**	**3/19**	**3/26**	**Full Bloom Delay [y]**
	Stage of Floral Bud Development				
0	3.6 a[x]	6.7 a	7.0 a	7.0 a	0
100	2.8 b	5.7 b	6.7 ab	7.0 a	3
200	2.3 c	5.0 c	6.4 b	6.8 a	7
400	1.8 d	3.9 d	5.7 c	6.5 b	11

[x]Mean comparison within columns by Fisher's Protected LSD at P=0.05.
Means with the same letter do not differ at the 5% probability level.

[y]Days delay in full bloom compared to control.

Table 2. Effect of ethephon on 'Cresthaven' peach floral bud development at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1993.

	Observation Date					
Ethephon ppm	**3/1**	**3/11**	**3/18**	**3/25**	**3/31**	**Full Bloom Delay [y]**

	Stage of Floral Bud Development					
0	1.5 a[x]	2.3 a	2.6 a	4.4 a	6.9 a	0
50	1.2 b	1.9 b	2.3 b	3.4 a	6.4 a	1
200	1.0b	1.2 c	1.5 c	2.1 c	5.0 b	4
400	1.0 b	1.0 c	1.1 d	1.5 c	5.1 b	4
500	1.0 b	1.1 c	1.1 d	1.5 c	4.1 b	6

[x]Mean comparison within columns by Fisher's Protected LSD at P=0.05.
Means with the same letter do not differ at the 5% probability level.

[y]Days delay in full bloom compared to control.

Table 3. Effect of ethephon on 'Correll' peach floral bud development at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1993.

	Observation Date					
Ethephon ppm	**3/1**	**3/11**	**3/18**	**3/25**	**3/31**	**Full Bloom Delay [y]**
	Stage of Floral Bud Development					
0	1.8 a[x]	2.5 a	2.8 a	4.6 a	6.8 a	0
50	1.3 b	2.1 b	2.4 b	3.9 a	6.5 ab	1
200	1.0 c	1.3 c	1.5 c	2.1 b	5.5 bc	3
400	1.1 bc	1.0 d	1.0 d	1.4 b	4.9 c	4
500	1.0 c	1.1 cd	1.4 c	1.9 b	5.5 bc	3

[x]Mean comparison within columns by Fisher's Protected LSD at P=0.05.
Means with the same letter do not differ at the 5% probability level.

[y]Days delay in full bloom compared to control.

Table 4. Effect of ethephon on 'Redhaven' peach floral bud development at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1993.

	Observation Date					
Ethephon ppm	**3/1**	**3/11**	**3/18**	**3/25**	**3/31**	**Full Bloom Delay [y]**
	Stage of Floral Bud Development					
0	1.9 a[x]	2.6 a	3.0 a	5.0 a	8.9 a	0
50	1.2 b	2.0 b	2.5 b	3.7 b	6.7 a	1
200	1.0 c	1.4 c	1.6 c	2.4 c	6.1 b	3
400	1.0 c	1.1 d	1.3 d	1.9 c	5.2 c	3
500	1.0 c	1.2 cd	1.3 cd	2.0 c	5.9 c	5

[x]Mean comparison within columns by Fisher's Protected LSD at P=0.05.

Means with the same letter do not differ at the 5% probability level.
[y]Days delay in full bloom compared to control.

Table 5. Effect of ethephon on 'Cresthaven' peach floral bud development at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1994.

	Observation Date				
Ethephon ppm	3/2	3/10	3/18	3/25	Full Bloom Delay [y]
	Stage of Floral Bud Development				
0	2.0 a[x]	3.4 a	5.6 a	7.0 a	0
50	1.7 a	2.5 b	5.2 a	7.0 a	1
200	1.2 b	1.9 c	3.9 b	6.8 a	3
400	1.2 b	1.9 bc	3.9 b	6.8 a	3
500	1.1 b	1.4 c	3.9 b	6.6 a	4

[x]Mean comparison within columns by Fisher's Protected LSD at P=0.05.
Means with the same letter do not differ at the 5% probability level.
[y]Days delay in full bloom compared to control.

Table 6. Effect of ethephon on 'Correll' peach floral bud development at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1994.

	Observation Date				
Ethephon ppm	3/2	3/10	3/18	3/25	Full Bloom Delay [y]
	Stage of Floral Bud Development				
0	2.4 a[x]	3.6 a	6.1 a	7.0 a	0
50	2.2 a	3.3 a	5.5 ab	7.0 a	2
200	1.8 b	2.7 b	5.1 a-c	6.8 a	3
400	1.1 c	1.5 c	4.2 bc	6.7 a	5
500	1.1 c	1.6 c	4.7 c	6.9 a	4

[x]Mean comparison within columns by Fisher's Protected LSD at P=0.05.
Means with the same letter do not differ at the 5% probability level.
[y]Days delay in full bloom compared to control.

Table 7. Effect of ethephon on 'Redhaven' peach floral bud development at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1994.

	Observation Date				
Ethephon ppm	3/2	3/10	3/18	3/25	Full Bloom Delay [y]
	Stage of Floral Bud Development				
0	2.2 a[x]	3.6 a	6.2 a	7.0 a	0
50	2.0 a	2.9 b	5.7 a	7.0 a	2
200	1.5 b	2.1 c	4.4 b	6.7 ab	6
400	1.1 c	1.6 cd	3.4 c	6.6 b	6

500	1.0 c	1.3 cd	3.0 c	6.4 b	7

[x]Mean comparison within columns by Fisher's Protected LSD at P=0.05. Means with the same letter do not differ at the 5% probability level.

[y]Days delay in full bloom compared to control.

Table 8. Percentage of dead floral buds on peach trees grown at the Pontotc Ridge-Flatwoods Branch Experiment Station influenced by ethephon, 1993 and 1994.

	Year	
Ethephon (ppm)	**1993**	**1994**
	Dead Floral Buds (%)	
0	13.1 c[x]	78.3 ab
50	17.0 c	71.5 b
200	33.9 b	55.9 c
400	72.8 a	77.7 ab
500	73.2 a	85.7 a

[x]Mean comparison within columns by Fisher's Protected LSD at P=0.05. Means with the same letter do not differ at the 5% probability level.

Table 9. Effect of ethephon on fruit yield (kg) of three peach cultivars grown at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1992.

Ethephon ppm	Correll	Cresthaven	Redhaven
	Yield (kg)		
0	39.0 b[x]	137.7 a	25.0 a
100	51.4 a	88.7 a	29.2 a
200	54.1 a	79.2 a	33.7 a
400	46.7 ab	87.6 a	31.7 a

[x]Mean comparison within columns by Fisher's Protected LSD at P=0.05. Means with the same letter do not differ at the 5% probability level.

Table 10. Effect of ethephon on fruit yield (kg) of three peach cultivars grown at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1994.

Ethephon ppm	Yield (kg)[y]
0	42.6 b[x]
50	66.6 a
200	73.2 a
400	62.1 a
500	49.7 b

[x]Mean comparison within columns by Fisher's Protected LSD at P=0.05.

Means with the same letter do not differ at the 5% probability level.
[y]Combined average of 'Correll', 'Redhaven', and 'Cresthaven'.

Table 11. Effect of ethephon on fruit weight of 'Correll' peach trees grown at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1992, 1993, and 1994.

	Year		
Ethephon (ppm)	**1992**	**1993**	**1994**
	Correll		**Cresthaven**
	Fruit weight (%)[x]		
0	97.2 a[y]	86.7 b	301.2 a
100	85.2 a	87.0 b	233.3 b
200	85.3 a	92.7 ab	217.1 b
400	71.7 b	103.9 a	216.5 b
500	-	103.5 a	259.2 ab

[x]percentage of control
[y]Mean comparison within columns by Fisher's Protected LSD at P=0.05.
Means with the same letter do not differ at the 5% probability level.