Hydrogen Cyanamide Induces Budbreak of Peaches and Nectarines Following Inadequate Chilling

W.A. Dozier, Jr., A.A. Powell, and A.W. Caylor

Horticulture Department and Alabama Agricultural Experiment Station, Auburn University, AL 36849

N.R. McDaniel, E.L. Carden, and J.A. McGuire

Alabama Agricultural Experiment Station, Auburn University, AL 36849

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Abstract. Hydrogen cyanamide (Dormex) treatments were applied to 17 insufficiently chilled peach and nectarine cultivars ≈ 6 weeks after normal budbreak. Treatment effectively induced vegetative budbreak and reduced shoot dieback. The responses to Dormex treatments were linear, with the 2% rate being more effective than the 0 and 1% rates in most cases.

Dormant deciduous fruit trees have a chilling requirement that is satisfied by exposure to low temperature (Samish, 1954). Chemical inducement of budbreak of insufficiently chilled deciduous fruit trees is practiced in some areas of the world (Diaz et al., 1987; Erez, 1987; Erez and Lavi, 1985). Materials that have been used to induce budbreak of insufficiently chilled buds include: hydrogen cyanamide, thiourea, potassium nitrate, oil plus dinitrophenols, gibberellins, and cytokinins (Diaz et al., 1987; Erez, 1987; Erez and Lavi, 1985; Erez et al., 1971; Shulman et al., 1986). These chemicals have been more effective when used in combination with proper timing of cultural practices, such as defoliation, water stress, and pruning (Diaz et al., 1987; Erez and Lavi, 1985), and effectiveness depends on rate and time of application (Erez, 1987; Erez et al., 1971; Shulman et al., 1986). The response of individual buds to treatment depends on the stage of bud development (Erez et al., 1971).

Hydrogen cyanamide has been reported to be a useful dormancy-breaking agent for peaches (Diaz et al., 1987; Shulman et al., 1986). Shulman et al. (1986) reported that when hydrogen cyanamide was applied several weeks before natural budbreak in peach, the most consistent and complete bloom development was seen.

In the southeastern United States, peach cultivars are adversely affected, in some years, by insufficient chilling and/or higher than normal winter temperatures (Erez et al.,

1979b; Weinberger, 1967). High temperature during the chilling period can have a negative effect on the termination of rest and subsequent budbreak of peach (Erez et al., 1979a; Weinberger, 1954). The extent of chilling negation depends on the temperature and exposure time at a given temperature (Couvillon and Erez, 1985).

Of 55 peach and nectarine cultivars growing at the Gulf Coast Substation, Fairhope, Ala., insufficient chilling was received during the 1988-89 dormant season to satisfy the chilling requirement of 17 of these cultivars. All cultivars with a chilling requirement ≤ 650 hr bloomed and foliated during or before March, except for 'La White', which has a reported 650-hr chilling requirement. Some cultivars with reported chilling requirements of 750 hr, such as 'Sunbrite', 'Brighton', and 'Sunland', foliated and bloomed normally.

Trees set in Mar. 1985 foliated and fruited normally in previous seasons. Not only was insufficient chilling for certain cultivars received during the 1988-89 dormant season (Table 1), but temperatures were higher during dormancy than in previous years (Table 2). This mild weather could have had a greater negation effect on chilling during 1988-89 than in previous seasons (Couvillon and Erez, 1985; Erez et al., 1979a, 1979b). By 13 Apr., floral bud abortion and varying degrees of terminal dieback were evident on the 17 insufficiently chilled cultivars.

This study was undertaken to determine if treatments with hydrogen cyanamide applied following normal budbreak would induce buds to break. All previously reported treatment applications of hydrogen cyanamide had been applied before normal budbreak.

Trees in the experimental planting were spaced 6.1×7.6 m. Recommended cultural practices for peaches and nectarines were followed. The trees were pruned by hand to

an open center in late January. Bloom and foliation data were collected on each cultivar as they occurred. On 13 Apr., the 17 insufficiently chilled cultivars showed no sign of bud swell and were treated with hydrogen cyanamide (Dormex; SKW Trostberg AG, Trostberg, Federal Republic of Germany). Units of four trees from each cultivar were randomized within each of four blocks at the beginning of the experiment. Dormex at 0, 1%, or 2% plus 0.25% X-77 surfactant was applied to different sectors of each tree. This provided a set of cultivars as whole plots, with sectors of each tree treated as sub-plots in a split-plot design. Analyses of variance were computed for percent shoot mortality and percent budbreak as affected by Dormex. Orthogonal polynomials were computed to determine forms of the responses to levels of Dormex.

Treatments were applied to run-off with a hand-held spray gun. At time of application, the air was at 21C and a slight wind was blowing.

Six shoots, each 25 cm long, of the previous season's growth were randomly selected in the center of each treatment quadrant on 2 May (21 days after treatment application). The percent budbreak and the degree of shoot dieback was determined. Ten shoots that had not been pruned were randomly selected in each treatment quadrant to determine treatment effect on percent terminal budbreak and growth.

All cultivars that did not bloom and foliate have a reported chilling requirement of ≥ 750 hr, except 'La White', which has a reported chilling requirement of 650 hr (Table 3).

Dormex treatments had a linear affect on percent budbreak (Table 3). Mean budbreak was 15.9% for 0% Dormex and 70.7% for 2% Dormex. The response was quadratic on two peach and two nectarine cultivars because in three of the cases the response was higher and in one case it was lower than the average for 1% Dormex.

The mean percent shoot dieback was greater on the nontreated than on the Dormex-treated shoots (Table 4). Except for three peach and three nectarine cultivars, the response was

Table 1. Chilling hours received by peaches each season during the past 6 years at Fairhope, Ala.

Year	Hours chilling below 7.2C and above 0C ^a		
	15 Feb.	1 Mar.	15 Mar.
1988-89	466	549	622
1987-88	806	885	924
1986-87	572	594	645
1985-86	735	777	---
1984-85	882	906	907
1983-84	898	970	1066
Mean	726	780	833

^aData obtained from Southeastern Agricultural Weather Service Center, National Weather Service, Auburn Univ., Ala.

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Table 2. Average temperatures (°C) and departures from average (DFA) at Fairhope, Ala.^z

Year	December		January		February		March	
	Average DFA		Average DFA		Average DFA		Average DFA	
1983	9.4	-2.50	---	---	---	---	---	---
1984	15.9	+3.94	8.0	-2.94	11.5	-0.78	14.3	-1.39
1985	9.2	-2.83	6.0	-4.89	11.2	-1.00	17.6	+1.83
1986	11.1	-0.94	9.5	-1.39	13.3	+1.06	14.5	-1.22
1987	12.9	+0.89	8.8	-2.06	11.8	-0.44	15.4	-0.33
1988	11.6	-0.39	8.2	-2.78	9.9	-2.33	14.8	-0.94
1989	---	---	14.0	+3.11	11.9	-0.28	16.2	+0.50

^zMonthly average of the daily mean maximum and minimum and departures from average for month indicated. Data obtained from Southeastern Agricultural Weather Service Center, National Weather Service, Auburn Univ., Ala.

Table 3. Percent lateral budbreak on 17 cultivars of peaches and nectarines following insufficient chilling and Dormex treatments, 1989.

Cultivar	Chilling requirement (hr)	Dormex concn			Significance	
		0%	1%	2%	Linear	Quadratic
		<i>Percent budbreak</i>				
Peach						
BY78-289	(?)	28.1	45.2	78.9	**	NS
Goldilocks	750	0.0	10.3	36.0	**	NS
La Premier	1050	16.8	33.2	67.0	**	NS
La White	650	13.2	60.6	86.6	**	NS
Loring	750	14.3	46.5	70.2	**	NS
Redskin	750	17.5	69.8	72.9	**	**
Sun Prince	800	18.6	66.3	77.1	**	*
White Hale	750	15.9	40.9	63.8	**	NS
Wild Rose	750	9.6	28.7	49.0	**	NS
Winblo	850	10.5	30.4	66.2	**	NS
Nectarine						
Summer Beauty	750	15.7	46.1	72.8	**	NS
Early Bird	750	11.8	47.3	84.8	**	NS
Carolina Red	750	25.2	68.0	79.6	**	*
Crimson Gold	750	15.3	45.9	74.0	**	NS
Durbin	850	7.0	24.6	56.8	**	NS
Red Gold	850	24.5	39.5	86.5	**	*
Sun Glo	850	27.5	53.8	77.1	**	*
Mean		15.9	44.9	70.7	**	NS

*, **, NS Significant at $P = 0.05$ or 0.01 or not significant at $P > 0.05$, respectively. Data shown are means of 24 observations.

Table 4. Percent shoot dieback on 17 cultivars of peaches and nectarines following insufficient chilling and Dormex treatments, 1989.

Cultivar	Chilling requirement (hr)	Dormex concn			Significance	
		0%	1%	2%	Linear	Quadratic
<i>Percent shoot dieback</i>						
Peach						
BY78-289	(?)	58.4	50.6	30.3	*	NS
Goldilocks	750	79.4	94.2	37.8	**	**
La Premier	1050	34.0	35.5	8.7	*	*
La White	650	26.5	9.2	2.6	*	NS
Loring	750	10.3	1.7	0.6	NS	NS
Redskin	750	25.5	3.2	2.5	*	*
Sun Prince	800	16.6	8.8	4.7	NS	NS
White Hale	750	10.3	8.1	1.2	NS	NS
Wild Rose	750	38.8	16.7	3.5	**	NS
Winblo	850	62.9	75.1	9.8	**	**
Nectarine						
Summer Beauty	750	22.5	8.5	15.0	NS	NS
Early Bird	750	42.4	15.2	14.3	*	NS
Carolina Red	750	37.9	14.2	17.8	*	NS
Crimson Gold	750	44.0	33.4	13.2	*	NS
Durbin	850	66.6	61.6	16.2	**	*
Red Gold	850	20.2	16.7	8.3	NS	NS
Sun Glo	850	9.0	0.5	2.4	NS	NS
Mean		35.2	26.3	10.9	**	NS

*, **, NS Significant at $P = 0.05$ or 0.01 or not significant at $P > 0.05$, respectively. Data shown are means of 24 observations.

linear and shoot dieback decreased with increasing Dormex rates. Percent shoot dieback in four peach and one nectarine cultivar responded quadratically to treatment. In these cases, shoot dieback with 1% Dormex was equal to or greater than that of the control.

Mean percent terminal budbreak following Dormex treatments was curvilinear (Table 5). i.e., it increased with increasing Dormex rates, with a similar response at 1% and 2%. The response of terminal buds to Dormex was nonsignificant for four nectarine and one peach cultivar, but curvilinear for four peach and one nectarine cultivar due to an equal or greater response to 1% than 2% Dormex.

Scalabrelli and Couvillon (1986) reported terminal buds to have the shortest chilling requirement and to exhibit less differential response to various temperatures than the other bud types. Our data support this finding since a greater number of terminal than lateral buds broke on untreated shoots, as well as those treated with 1% Dormex. There was no difference between lateral and terminal budbreak with the 2% Dormex rate. Hydrogen cyanamide was reported to induce early, uniform, and full budbreak in peach (Shulman et al., 1986). However, it was suggested by Erez (1987) that hydrogen cyanamide should not be applied to peaches <4 weeks before bud swell due to possible heavy damage to flower buds and young shoots from interaction between cool conditions and hydrogen cyanamide phytotoxicity. In this study, applications were made late in the spring after temperatures were above 20C and flower buds had aborted. This may explain why no phytotoxicity was observed.

Dormex treatments resulted in a higher level of lateral and terminal budbreak and less shoot dieback than that which occurred on the non-treated shoots; in most cases, 2% was more effective than 1%. New growth arising from the Dormex-treated shoots was more vigorous than that from the nontreated shoots and no adverse effects appeared to be associated with the Dormex treatments. 'Goldilocks' was the only cultivar that exhibited major scaffold limb death. Many nontreated shoots of trees of all cultivars died. This dieback, coupled with reduced budbreak and vigor, likely will reduce next season's fruiting potential of the controls, but not of those treated with Dormex.

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Table 5. Percent terminal budbreak on 17 cultivars of peaches and nectarines following insufficient chilling and Dormex treatments. 1989.

Cultivar	Chilling requirement (hr)	Dormex concn			Significance	
		0%	1%	2%	Linear	Quadratic
<i>Percent terminal budbreak</i>						
Peach						
BY78-289	(?)	17.8	83.3	44.4	*	**
Goldilocks	750	4.2	16.7	25.0	NS	NS
La Premier	1050	27.8	77.8	88.9	**	NS
La White	650	50.0	75.0	75.0	*	NS
Loring	750	37.5	87.5	87.5	**	*
Redskin	750	66.7	91.7	91.7	*	NS
Sun Prince	800	29.2	75.0	62.5	**	**
White Hale	750	45.8	79.2	87.5	**	NS
Wild Rose	750	28.9	94.4	100.0	**	*
Winblo	850	8.3	41.7	66.7	**	NS
Nectarine						
Summer Beauty	750	50.0	66.7	58.3	NS	NS
Early Bird	750	41.7	64.6	55.6	NS	NS
Carolina Red	750	20.8	79.2	66.7	**	**
Crimson Gold	750	16.7	41.7	58.3	**	NS
Durbin	850	16.7	45.8	79.2	**	NS
Red Gold	850	79.2	91.2	91.2	NS	NS
Sun Glo	850	83.3	91.2	91.2	NS	NS
Mean		37.7	70.1	72.4	**	**

*, **, NS Significant at $P = 0.05$ or 0.01 or nor significant at $P > 0.05$, respectively. Data shown are means of 40 observations.

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