Interactions of Ethephon, Whitewashing, and Dormant Oil on Peach Pistil Growth, Hardiness, and Yield

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Additional index words. fruit set, *Prunus persica*

Abstract. Six-year-old peach trees [*Prunus persica* (L.) Batsch] were sprayed with ethephon (100 mg-liter⁻¹) in Oct. 1989, whitewashed in Jan. 1990, and sprayed with dormant oil on one or two dates in Mar. 1990 to study possible interactive effects on flower bud hardiness, pistil growth, time of bloom, and yield. Flower buds from ethephon-treated trees supercooled to a lower temperature [mean low temperature exotherm (MLTE) of -18.5°C] than buds from nontreated trees (MLTE of -17.7°C) in February; there was no main effect of whitewashing or any interaction with ethephon. No treatment effects on hardiness were detected in March. Ethephon-treated pistils were smaller than nontreated pistils, and pistils from buds on whitewashed trees were smaller than those on nonwhitewashed trees. No main effects or interactions of dormant oil on pistil size were detected. Ethephon and whitewashing delayed bud development during bloom, but prebloom oil application(s) had no effect. Buds from ethephon-treated and whitewashed trees were more tolerant of freezes during bloom than buds from oil-sprayed trees, and yield was enhanced by ethephon and whitewashing. Prebloom oil sprays reduced yield compared with controls. Chemical name used: 2-chloroethylphosphonic acid (ethephon).

Peach bloom can be delayed by ≈ 1 week by increasing the chilling requirement of flower buds with a fall application of ethephon (Durner and Gianfagna, 1991). Ethephon-treated buds are also more cold hardy than nontreated buds (Durner and Gianfagna, 1988, 1991). Whitewashing entire trees in mid-January can add an additional day or two of bloom delay to that provided by ethephon, and whitewashing alone can delay bud development enough to enhance bud survival after freezes during bloom (Durner and Gianfagna, 1990). Whitewashed buds have smaller pistils than nonwhitewashed buds (Durner and Gianfagna, 1990) and may therefore be harder (Howell and Dennis, 1981). Applications of dormant oil just before bloom delayed bloom by 5 days and increased flower bud hardiness by 2 to 4°C in peach (Call and Seeley, 1989). Our study was initiated to determine if there would be any interactive effects of ethephon, whole-tree whitewashing, and prebloom application(s) of dormant oil on flower bud cold hardiness, pistil growth, time of bloom, and yield of peach.

Ethephon, whitewashing, dormant oil
Expt. 1. Ethephon (100 mg-liter⁻¹) was ap-

plied to runoff on twelve 6-year-old 'Jerseydawn' peach trees on Lovell rootstock on 13 Oct. 1989. Regulaid (0.1% by volume) (Kalo Manufacturing, Overland Park, Kan.) was added to assist spreading and was also used as a control on 12 trees. Six each of the ethephon-treated and control trees were sprayed on 3 Jan. 1990 with white interior flat latex wall paint (C and M Manufacturing, Minneapolis) diluted with water (2:5, v/v, paint : water). Three trees of each ethephon/whitewash treatment combination were sprayed to runoff on 5 Mar. 1990 with dormant oil (8% by volume) (Sunspray 6E, Sunoco Oil, Philadelphia). Three trees of each ethephon/whitewash treatment combination were sprayed to runoff with water as a control. The design was completely random with three replications per treatment. Flower buds were randomly sampled for exotherm analysis from unbranched terminal shoots around the periphery of the canopy 1.5 m above the orchard floor; the analysis was performed as described by Durner (1990) on a minimum of 36, 40, and 10 flower buds on 8 Jan., 6 Feb., and 13 Mar., respectively. The cooling rate was 5°C/h. Pistil lengths of 10 flower buds per treatment were measured under a microscope on each sample date.

Ethephon and dormant oil (Expt. 2). Ethephon (100 mg-liter⁻¹) was applied to runoff on nine 6-year-old 'Jerseydawn' peach trees on Lovell rootstock on 13 Oct. 1989. Regulaid (0.1% by volume) was used as a control on nine trees. Six trees of the ethephon and control treatments were sprayed to run-

off on 5 Mar. 1990 with dormant oil (8% by volume). Three of the original six oil-sprayed trees were resprayed with oil on 15 Mar. 1990. Three each of the ethephon-treated and control trees were sprayed to runoff with water on both 5 and 15 Mar. as controls. The design was completely random with three single-tree replications.

For both experiments, flower bud development during bloom was monitored as described by Durner and Gianfagna (1990). Five twigs per tree were tagged and the development of flower buds was monitored from late quiescence through full bloom. The percentage of total buds per twig in each of four developmental stages (quiescent, pink tip, balloon, and full bloom) on each observation date were calculated. Observations were made on 14, 16, 19, 22, and 26 Mar., and 2, 6, and 12 Apr. 1990. Bud development rates were calculated as the number of days on which a majority of buds on a tree remained in each developmental stage (quiescent, pink tip, balloon, and fully open). This value was calculated as the number of days it took to decrease the proportion of buds in the quiescent stage from 75% to 25% and to increase the proportion of buds in the pink-tip, balloon, and full bloom stages from 25% to 75%. Values were calculated for individual trees. Fruit were thinned by hand to 15 to 20 cm apart if needed. Fruit were hand-harvested from 7 to 14 July 1990 and fruit weight and count recorded. All data were subjected to an analysis of variance. Dates and experiments were analyzed separately and treatment effects were separated with Fisher's protected LSD, $\alpha = 0.05$.

Expt. 1. No effect of ethephon on the mean low temperature exotherm (MLTE) of flower buds was observed on 8 Jan. (MLTE, -18.1°C). On 6 Feb., buds from ethephon-treated trees supercooled to a significantly lower temperature (MLTE, -18.5°C) than buds from nontreated trees (MLTE, -17.7°C). No main effect of whitewashing or interaction with ethephon on flower bud cold hardiness was detected. No ethephon, whitewash, or dormant oil treatment effects were detected on 13 Mar. (MLTE, -8.7°C).

Pistils on ethephon-treated trees were significantly smaller than those from untreated trees on 8 Jan. (59.9 vs. 67.6 mm) and 6 Feb. (89.6 vs. 94.1 mm). Additionally, on 6 Feb., pistils from buds on whitewashed trees were shorter than those on nonwhitewashed trees (89.8 vs. 93.8 mm). On 13 Mar., pistils from whitewashed, ethephon-treated buds were shorter (175 mm) than pistils from nonwhitewashed, ethephon-treated buds (194 mm). Pistil length of buds from trees not treated with ethephon was not affected by whitewashing (mean pistil length 216 mm). Pistils from ethephon-treated trees were shorter than those from control trees (185 and 216 mm, respectively). No main effects or interactions of dormant oil treatment were detected for pistil length.

The single prebloom application of dormant oil did not affect flower development. Ethephon delayed development to the 75% pink stage by an average of 1.5 days com-

Received for publication 28 May 1991. New Jersey Agricultural Experiment Station, Publication no. D-12111-9-91, supported by state funds. 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.

pared with trees not treated with ethephon, and ethephon sprayed buds remained in the pink stage an average of 0.5 day longer than buds from trees not treated with ethephon. Whitewashed trees reached the 75% pink bud stage an average of 0.7 day later than non-whitewashed trees. Ethephon delayed development to the 75% balloon stage by 7.4 days, and to the 75% fully open stage by 2.4 days. Whitewashing and oil application did not affect time to the balloon or fully open stage.

Yield was significantly reduced by a single prebloom application of dormant oil, which caused a reduction in the number of fruit per tree (12.2 kg fruit per tree for controls, 5.2 kg fruit per tree for single application of oil, with 84 and 29 fruit per tree, respectively). Whitewashing increased yield (12.1 kg/tree for whitewashed and 5.3 kg/tree for controls). Ethephon also increased yield (11.3 kg/tree and 6.1 kg/tree, respectively). No interactions among main effects were detected for yield or fruit count.

Expt. 2. Two prebloom applications of dormant oil did not affect flower development. Ethephon delayed flower development to the 75% pink stage by an average of 1.9 days compared with trees not treated with ethephon, and ethephon-treated buds remained in the pink stage an average of 1.0 day longer than buds not treated with ethephon. Ethephon delayed development to the 75% balloon stage by 9.0 days, and to 75% fully open stage by 2.4 days. Neither whitewashing nor oil application affected bud development.

Yield was reduced by two prebloom applications of dormant oil, caused by a reduction in fruit count per tree (8.3 kg/tree for controls, and 4.2 kg/tree for a double oil application, with 55 and 26 fruit per tree, respectively).

Our results confirm the bloom-delaying phenomenon observed with a fall ethephon application or a January tree whitewashing (Dumer and Gianfagna, 1990). Call and Seeley (1989) reported a significant bloom delay and delayed deacclimation with prebloom oil applications with no subsequent effect on yield. However, we did not observe any effect of prebloom oil application on bud development. We also observed a significant reduction in yield. Perhaps more fruit abscised during "June-drop," even though no obvious phytotoxicity occurred. The concentration of oil that we used (8%) was within the range suggested for trial by Call and Seeley (1989). The effect of oil on yield was not obvious on 28 Mar., since there were no effects of oil, ethephon, or whitewash on live flower bud density (mean of 0.15 flower/cm shoot for Expt. 1, and 0.11 flower for Expt. 2). Six freezing events occurred between 29 Mar. and 19 Apr. (−7.2 on 29 Mar., −3.6 on 9 Apr., −1.7 on 12 Apr., −3.0 on 13 Apr., −2.0 on 14 Apr., and −1.7°C on 19 Apr.), which resulted in significant pistil death and a lower fruit count per tree at harvest. Yield from ethephon-treated or whitewashed trees was higher than from nontreated, nonwhitewashed, or dormant oil-treated trees; thus, buds from ethe-

phon-treated and whitewashed trees must have been significantly more tolerant of the freezes. We have previously observed that buds from ethephon-treated or whitewashed trees are more cold hardy during bloom than non-ethephon treated or nonwhitewashed buds (Durner and Gianfagna, 1988, 1990). Prebloom oil sprays apparently decreased blossom hardiness, since yield was significantly lower in treated than in control trees. Fall ethephon application and midwinter bud whitewashing are feasible methods for delaying bloom in peach in the mid-Atlantic region of the United States, provided that ethephon becomes labelled for use or a low-cost whitewash can be obtained. Prebloom oil sprays do not appear to have a potential for bloom delay in our region and may decrease flower bud tolerance to freezes during bloom.

Literature Cited

- Call, R.E. and S.D. Seeley. 1989. Flower bud coatings of spray oils delay dehardening and bloom in peach trees. *HortScience* 24:914-915.
- Dumer, E.F. and T.J. Gianfagna. 1988. Fall ethephon application increases peach flower bud resistance to low-temperature stress. *J. Amer. Soc. Hort. Sci.* 113:404-406.
- Durner, E.F. and T.J. Gianfagna. 1990. Peach pistil growth inhibition and subsequent bloom delay by midwinter bud whitewashing. *Hort-Science* 25:1222-1224.
- Dumer, E.F. and T.J. Gianfagna. 1991. Ethephon prolongs dormancy and enhances supercooling in peach flower buds. *J. Amer. Soc. Hort. Sci.* 116:500-506.
- Howell, G.S., Jr. and F.G. Dennis, Jr. 1981. Cultural management of perennial plants to maximize resistance to cold stress, p. 175-204. In: C.R. Olein and M.N. Smith (eds.). *Analysis and improvement of plant cold hardiness*. CRC, Boca Raton, Fla.