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"Surfactant WK" for Thinning Peach Blossoms

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Abstract

The surfactant, "Surfactant WK" (dodecyl ether of polyethylene glycol), was applied to peach trees [*Prunus persica* (L.) Batsch] at full bloom three consecutive years. Blossoms died rapidly so that within 1 week dead blossoms could be distinguished easily from live blossoms. There were significant, linear relationships between concentration of "Surfactant WK" applied and percent blossoms removed, which was determined 1 to 2 weeks after treatment ($R^2 = 0.78^{***}$), and fruit set, which was determined 4 to 5 weeks after treatment ($R^2 = 0.86^{***}$). Trees were hand thinned according to commercial practices after treatment. Cropload, fruit weight and yield were similar across treatments at harvest indicating no negative effects by the chemical on productivity. "Surfactant WK" caused slight limb damage and overthinning at the highest concentrations. Based on the effectiveness, consistency, and lack of significant phytotoxicity, "Surfactant WK" demonstrated acceptability as a blossom thinner for peach trees in the southeastern U.S.

Introduction

Peach trees normally set an excessive crop that suppresses market value by reducing fruit size and price. Thinning at bloom or shortly after can increase fruit size and yield by 20% or more (9). There are three periods in reproductive development of peaches that cropload can be reduced: before flowering, during flowering, and after fruit set. Gibberellins (4, 10, 12, 14) applied the previous season and soybean oil applied in winter (11) can decrease flower bud density of peach trees. However, growers in the southeastern U.S. have expressed reservations about thinning before bloom because of increased risk to crop loss by cold temperatures in winter and early spring. The most common method of reducing cropload in the southeastern U.S. is by hand thinning fruit. Hand thinning is very expensive and has become increasingly difficult with changing labor laws. Mechanical rope thinning has been partially successful, but this method has not been extensively studied (1, 2). A major drawback of mechanical thinning is the high cost of the equipment, which could be prohibitive for small growers. Currently, there are no chemicals that thin peach fruit acceptably for commercial orchards.

There has been considerable research of chemical thinners during bloom. Acceptable bloom thinners should: 1) thin flowers predictably, 2) show thinning effects relatively quickly so that additional flowers or fruit can be thinned early if needed 3) not be phytotoxic to fruit or vegetative tissues and 4) be economically feasible. Phytotoxic chemicals such as surfactants and ammonium nitrate have been tested as peach blossom thinners (5, 6, 7), but most violate one of the four qualifications.

Byers and Lyons (6) tested several surfactants as peach blossom thinners and found that "Surfactant WK" (E.I. Dupont deNemours and Co., Inc.), a surfactant labelled for use with certain herbicides, was most effective compared to several other chemicals even though it was somewhat phytotoxic to vegetative tissues (5, 6, 7). Byers stopped conducting research on this chemical because the company was not interested in pursuing a label (6). The Rhone-Poulenc Agriculture Company (Research Triangle Park, NC) has recently expressed interest in seeking a label for this product as a peach blossom thinner. Byers (3) later recommended ammonium thiosulfate as the most promising blossom thinner of

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peaches. Ammonium thiosulfate has become a popular peach bloom thinner in the Southeastern U.S., but many fruit develop parthenocarpically for a few weeks, stop growing and hang on the tree through harvest. Until the fruit stop growing, it is difficult to differentiate which fruit are parthenocarpic thus complicating hand thinning. From all the research on blossom thinners, none has yet emerged as an industry standard for peaches.

In an initial study conducted in 1987, we used "Surfactant WK" as a surfactant with ammonium thiosulfate and ammonium nitrate to determine efficacy of thinning peach flowers. We found that all treatments with "Surfactant WK" provided excellent thinning which was similar to "Surfactant WK" alone. We also discovered that there was no tree damage with any treatment. We initiated a new study to test further the efficacy, consistency and phytotoxicity of "Surfactant WK" as a blossom thinner.

Materials and Methods

The experiment was conducted on full-grown 'Harvester' peach planted in 1979 at a 6 m x 6 m spacing. The experiment was conducted on a Luverne sandy loam at the Chilton Area Horticulture Substation in central Alabama. The experimental design was a completely randomized block with single tree experimental units in each block and 4 blocks. Each block consisted of a single row of trees with one untreated tree serving as a buffer between treated trees. Between each treated row was an untreated row that blocked spray drift during treatment application. In 1988 and 1989, 3 secondary structural branches from 4 different scaffold limbs (primary branches) were selected for bloom counts from each tree. In 1990, 5 one-year old shoots were selected from each tree and blossoms counted from the tip back to about 40 cm. All blossoms on selected limbs were counted immediately before treatment.

"Surfactant WK" was applied at various concentrations and a rate of 200 gal/acre with a CO_2 pressurized hand sprayer at 40 psi on clear days, with air temperature in the range of 25-29 C, and blossoms at full bloom. 'Harvester' has non-showy flowers characterized by emergence of the stigma through the petals before the flowers opened. Blossoms were considered "open" when the stigma protruded through the petals, and full bloom of the whole tree was defined to have occurred when 90% of blossoms had their stigma protruding. Trees were sprayed to drip with "Surfactant WK" concentrations of 0 (control), 10, 20, 40 and 80 ml•liter^{-1} in 1988. The 80 ml•liter^{-1} treatment caused some limb injury and excessive thinning so was not used in subsequent years. Rates were changed in 1989 and 1990 to 0, 20, 25, 30, 35 and 40 ml•liter^{-1}. Undamaged flowers were counted within one to two weeks after treatment. Fruit set was determined 4 to 5 weeks after treatment.

Normal commercial practices were followed after blossom thinning. Fruit were hand thinned 4 to 5 weeks after treatment to a spacing of about 15 cm. Immediately after hand thinning, a 0.1 m^2 ring was randomly tossed 4 times under each tree and fruit counted per ring. Number of fruit removed by hand were estimated for each tree by multiplying the average number of fruit per ring by the approximate surface area under each tree. The surface area was assumed to be a circle with a 2.5 m radius (20 m^2). Fruit were selectively harvested 4 times at 3 to 5 day intervals in June with fruit selected based on skin ground color. On each date, fruit harvested were segregated into 4 size categories, counted and weighed.

Dependent variables were originally tested in a completely randomized block analysis with data from all three years combined in a single analysis as a split-plot using the General Linear Models procedure of SAS (13). There was no significant interaction between "Surfactant WK" treatment and years in percent blossoms removed, percent fruit set, or number of fruit hand thinned, so these dependent variables were regressed against "Surfactant WK" concentration using the Regression Model procedure of SAS (13).

Results and Discussion

Within 1 week after treatment, treatment effects were clearly visible as evidenced by browning and desiccation of the entire flower. These data concur with that of Byers and Lyons (8) who showed that "Surfactant WK" kills flowers by killing the peduncle and pistils. There was a significant, linear relationship in percent blossoms thinned ($R^2 = 0.78$***) and percent fruit set ($R^2 = 0.86$***) across "Surfactant WK" treatments (Fig. 1). Counting undamaged blossoms 1 to 2 weeks after treatment was a highly accurate predictor of fruit set. For example, of the blossoms counted before applying "Surfactant WK" at 20 ml•liter^{-1} concentration, 42% survived treatment and 39% set fruit. Few of these fruit developed parthenocarpically. The high degree of predictability would provide growers with early information on fruit set for additional thinning if needed. This would be beneficial since the earlier the fruit are thinned the larger the fruit size at harvest (9). "Surfactant WK" at all concentrations reduced the number of fruit that needed to be hand thinned from about 3000 fruit/tree for the controls to about 300 fruit/tree at 40 ml•liter^{-1}.

There was a higher thinning rate near the center of branches since most fruit were observed to set in clusters near the tip and base, which was likely a function of the stage of flower bud development. Peach flowers generally open from the base to the tip and treatments were applied when the stigma was showing in the center of the branches. Fertilization had probably already occurred near the base and the stigma was not showing near the tip when treated. Some fruit survived treatment in the center of branches but this was less true at higher "Surfactant WK" concentrations. The higher rates of "Surfactant WK" tended to have fruit spaced farther apart than the target 15 cm and thus over thinned the trees. There was no statistical difference in cropload across

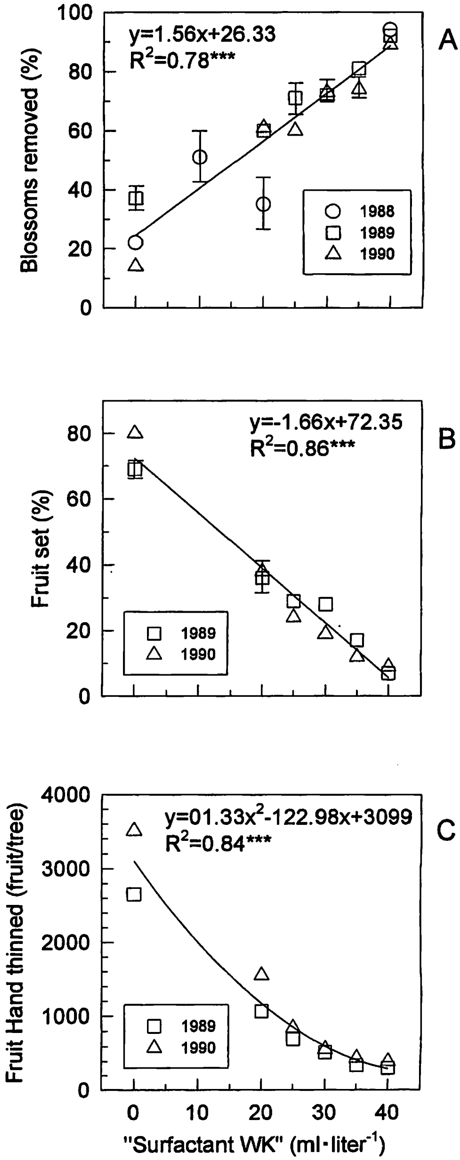

Figure 1. Blossom removal (A), percent fruit set (B) and fruit hand thinned after treatment (C) with "Surfactant WK" on 'Harvester' peach. Regressions and regression coefficients were determined using data from the individual replications; however, only the means for each treatment and year are shown. The bars indicate 2x the standard error of the means. All regressions were significant at the 0.001 level.

Table 1. Effect of "Surfactant WK" surfactant and hand thinning on fruit size distribution, yield and its components in 1989 and 1990.

Dupont WK concentration (ml•liter^{-1})	Fruit per tree	Yield (kg/tree)	Percent of fruit in each diameter size group (mm)				
			<50	50-57	58-64	65-70	>71
0	703	95	10.2	22.4	51.3	15.5	0.6
20	759	100	5.3	15.4	57.9	20.8	0.7
25	752	96	6.9	14.8	55.2	21.7	1.5
30	637	92	5.7	10.2	57.5	25.0	1.6
35	602	82	6.1	13.2	47.9	28.5	4.1
40	499	70	6.9	14.6	48.9	27.0	2.6
Significance							
Model	ns	ns	ns	*	ns	*	ns
Treatment	--	--	--	*	--	*	--
Year	--	--	--	*	--	*	--
T*Y	--	--	--	*	--	ns	--
Polynomial contrasts							
Linear	--	--	--	*	--	*	--
Quadratic	--	--	--	*	--	ns	--
Cubic	--	--	--	ns	--	ns	--
Means							
1989	544	84	0	2.3	52.8	41.1	3.7
1990	688	94	13.7	27.8	53.4	5.1	0

*,ns indicate significance at the 0.05 level or nonsignificant, respectively.
--is used to indicate that no further analysis was conducted because the overall model was nonsignificant.

treatments (Table 1), however there was an observed trend towards lower cropload at the highest treatment rates, before and after handthinning.

Fruit were heavier in 1989 (154 g/fruit) than in 1990 (137 g/fruit), due to a drought in 1990. The difference in weight between years was also reflected in a greater percentage of fruit in the 65-70 mm group than the 50-57 mm group in 1989 which was reversed in 1990. Further analysis of individual diameter size groups revealed that "Surfactant WK" decreased the percent of fruit in the 50-57 mm diameter size group and increased it in the 65-70 mm diameter size group. The significant treatment by year interaction in the 50-57 mm diameter size group was due to very few fruit in 1989 which did not vary across treatments whereas in 1990 the percent of fruit in that category decreased with increased "Surfactant WK" concentration (data not shown). Yield was not significantly different across treatments although there was a trend to a slight decrease at the highest treatment rates.

"Surfactant WK" at 35 ml•liter^{-1} and higher caused slight limb injury, but at lower concentrations no damage was observed. These results differ from Byers and Lyons (6) who reported significant limb injury on trees sprayed with 20 ml•liter^{-1}. The reason for the difference in injury between their study and ours is not clear. Byers and Lyons (6) used an airblast sprayer likely explained the different response compared to the backpack sprayer used in this study. However, they also may have had a longer drying time due to the cooler climate of Virginia where their work was conducted rather than the typically faster drying times in the warmer climate of Alabama. Nevertheless, based on the high degree of predictability, the quick response and potential of not being phytotoxic, "Surfactant WK" demonstrated acceptability as a bloom thinner for peaches in the southeastern U.S. Further research is needed to determine conditions that cause limb injury by this chemical.

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Orchard Row Canopy Discontinuity- On Light and Apple Leaves

Total daily light in the lower canopy was higher for wider spaced trees than for close spaced trees. These differences were evident under both diffuse and direct light conditions. The patterns of irradiance under partly cloudy conditions were similar to those under direct light. Light interception was 59% at the 3 m in row spacing and 64% at the 2 m spacing. LAI was higher at the 2 m spacing mostly due to greater shoot leaf area in mid to upper canopy regions. Many of the irradiance and leaf canopy properties of trees planted 5.0 x 3.0 m approached optimum values modeled for efficient orchard systems. The importance of conical tree form and discontinuity between adjacent trees along the rows are emphasized. From Tustin et al. 1998. J. Hort. Sci. And Biotech 73(3):289-297.