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Tergitol TMN-6 for Thinning Peach Blossoms

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***Abstract*. This study was conducted to determine efficacy of Tergitol TMN-6 in thinning peach blossoms. A pretest was conducted and demonstrated no difference between TMN-6 and TMN-10 in efficacy when applied at full bloom or petal fall and at rates of 20 and 40 mL·L^{-1}. In the main test, Tergitol TMN-6 was sprayed once at 10, 20, or 30 mL·L^{-1} at full bloom or petal fall and compared to an unsprayed control for 3 years. Tergitol caused widespread necrosis of flower parts including sepals, petals, pistils, stamens and peduncles. There was a difference among chemical treatments with more fruit removed at higher concentrations, although the amount of fruit removed was similar for the 20 and 30 mL·L^{-1} rates. There was no difference in thinning response at full bloom or petal fall, indicating a wide window of efficacy. There was also a difference among years, which was apparently not related to temperature or relative humidity during time of application. Tergitol caused some leaf yellowing and tip burn especially at the higher rates when leaves were present, but the trees did not appear to be seriously affected. Fruit weight was either not affected or larger in some years from treatment. Unlike higher concentrations, tergitol at 10 mL·L^{-1} did not negatively impact fruit number per tree at harvest. At harvest, fruit weight, skin blush, firmness, and soluble solids at harvest were not affected by treatment. Tergitol TMN-6 proved to be an effective thinning agent and when applied from full bloom to petal fall at 10 mL·L^{-1} it did not adversely affect the tree or fruit.**

Successful commercial peach production requires crop thinning early in the season so remaining fruit can grow to acceptable market size (Havis, 1962). Most of the crop thinning performed in commercial peach orchards is by hand labor, which is costly and difficult due to labor restrictions and supply. The need to reduce labor requirements has driven extensive research to find suitable chemical thinners for peaches (Byers, 1999), but no chemical thinner has been commercially adopted by the peach industry. Prebloom sprays, such as Gibberellins applied a couple of weeks before harvest (Southwick and Fritts, 1995; Taylor and Geisler-Taylor, 1998) and soybean oil applied during winter (Myers et al., 1996), have been shown to be effective; however, producers are reluctant to spray chemical thinners until the danger of spring frost has passed. Efficacy of bloom sprays typically varies due to weather patterns and stage of bloom and some are not cost effective compared to hand thinning (Byers, 1999; Byers and Lyons, 1983; 1984; Coetzee and Theron, 1999; Fallahi, 1997; Lemus, 1998; Southwick et al., 1996, 1998). Mechanical approaches to thinning are typically conducted at full bloom or shortly after (Baugher et al., 1988, 1991; Berlage, and Langmo, 1982) but have not been widely adopted by commercial producers.

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From studies conducted in the late 1980s in Alabama, the best thinner we found was Surfactant WK (E.I. Dupont deNemours and Co., Inc.), a dodecyl ether of polyethylene glycol with the principal active agent trimethylnonylpolyethoxyethanol (Ebel et al., 1999). Surfactant WK was formerly labeled as a surfactant for herbicides. Surfactant WK, also called DuPont WK, was studied extensively and found to be a highly effective blossom thinner by others (Byers and Lyons, 1983, 1985), with a mode of action that kills pistils and peduncles (Byers and Lyons, 1985). Dupont has sold its surfactant division to Union Carbide, a subsidiary of DOW Chemical Co., which is currently marketing this group of chemicals as Tergitol. The Tergitol series of surfactants have been labeled for agricultural uses (EPA 40 CFR 180.1001(c) and FDA 21 CFR 182.99). There are currently few agricultural labels for these products, but DOW is seeking to expand uses of its chemicals for agriculture.

This study was conducted to determine efficacy of Tergitol in thinning peach blossoms. In earlier work, Surfactant WK was only applied at full bloom (Ebel et al., 1999). In the current study, Tergitol TMN-6 was applied at full bloom or at petal fall to gain an understanding of the window of efficacy. The rates used were similar to that used in our earlier study with Surfactant WK.

Materials and Methods

Plant material and field layout. In January 1994, trees of 'FirePrince' [*Prunus persica* (L.) Batsch] on 'Lovell' rootstock were planted in a Bama fine sandy loam (fine sand loam, siliceous, subactive, thermic, Typic Paleudults) at the Chilton Area Research and Extension Center, Clanton, Ala. The trees were spaced 4.6 × 6.1 m in a randomized complete-block design with five blocks, each containing one-tree treatment plots. A buffer tree was located between each treatment tree and a buffer row between treatment rows.

Prespray blossom counts were conducted on five tagged shoots per tree and bloom stages determined throughout the blossom period.

Pretest: Comparison of Tergitol TMN-6 and TMN-10. In a pretest conducted in 2000, Tergitol (2,6,8-trimethyl-4-nonyloxypolyethyleneoxyethanol) TMN-6 and TMN-10 (90% aq.) were applied to whole trees using a hand gun to the point of run-off when windspeed was <5 mph. Tergitol was applied at full bloom (70% of flowers were open) and at petal fall, at rates of 20 or 40 mL·L^{-1} and compared to an unsprayed control.

Main test: Efficacy of Tergitol TMN-6 over 3 years. In the main test, Tergitol TMN-6 was applied using an airblast sprayer at rates of 10, 20 or 30 mL·L^{-1} and compared to an unsprayed control in 2001, 2002, and 2003. Trees were treated at full bloom or petal fall. The data from the main test plus the data for the control and 20 mL·L^{-1} from the pretest conducted in 2000 were included in the statistical analysis.

Data collected. Four to six weeks after full bloom when hand-thinning is typically performed, a ground cover was placed under half of the tree and hand-thinning was conducted using standard commercial practices. When hand-thinning was finished, the fruit that landed on the ground cloth were collected, counted, and a random 10 fruit sample was weighed.

Fruit were harvested at 3 to 4-d intervals with fruit selected on the basis of ground color change from green to yellow and size. Fruit were sorted on a grader and separated into five diameter categories including <5.1 cm, <5.7 cm, <6.4 cm, <7.0 cm, <7.6 cm, and >7.6 cm. Total number of fruit and fruit weight were determined in each category and were used to determine individual fruit weight.

Fruit quality was determined on the second harvest date each season on 10 fruit from the 7.0 cm size class from each treatment replication. Firmness was measured using a handheld penetrometer with a 0.8-cm tip (McCormick Fruit Tech, Yakima, Wash.). Soluble solids were measured using a portable refractometer (Westover Model RHB 32ATC). Fruit skin was visually rated for the percent of red blush.

Experimental design and statistical analysis. All data were analyzed as a randomized complete block design using the general linear models (GLM) procedure of the Statistical Analysis System (SAS, 1988). Duncan's Multiple Range Test was used to separate main effect means ($P \leq 0.05$) when all interactions were not significant.

Results and Discussion

Pretest: Comparison of Tergitol TMN-6 and TMN-10. Both chemicals caused widespread necrosis of flower parts including sepals, petals, pistils, stamens and peduncles, similar to Surfactant WK as reported in our earlier study (Ebel et al., 1999). There were no significant interactions for all possible combinations of chemical used, rates of application, and time of application. There was a strong thinning response by both chemicals compared to controls (Table 1). Spraying with either chemical reduced the amount of hand-thinning from >780 fruit/tree to <200 fruit/tree, with no difference between the two chemicals. However, it should be noted that subsequent hand-thinning did not equalize cropload at harvest. Both chemical rates caused some over-thinning, leaving some bearing wood without fruit. The control trees did not have enough fruit removed during the time of hand-thinning. There was no difference in thinning when Tergitol was applied at full bloom or petal fall.

The chemical thinners improved fruit size by about 14% at the time of hand-thinning. There was no difference between chemicals, the two rates of chemical concentrations, or the stage of bloom. Improvement in early fruit growth is a common advantage of thinning during full bloom (Havis, 1962).

Main test: Efficacy of Tergitol TMN-6 over 3 years. Because Tergitol TMN-6 and TMN-10 were similar in their efficacy in the preliminary study, TMN-6 was arbitrarily chosen to study further. All interactions were not significant for hand-thinned fruit for each treatment (Table 2). There was a difference among chemical rates with more fruit removed at higher rates, although the amount of fruit removed was similar for the 20 and 30 mL·L^{-1} rates. There was also a difference among years, which did not appear to be related to the climate variables (temperature and relative humidity) during treatment application (Table 3). For example, 586 and 691 fruit per tree had to be hand-thinned in 2001 and 2002, respectively, and yet these two years represented large differences in temperature and relative humidity at full bloom and petal fall. There also appeared to be no relationship between total chilling hours the previous winter and the amount of thinning. Insufficient chilling can stagger flowering, but chilling in this study was sufficient to satisfy rest for flower buds. Fireprince requires 850 h of chilling to break dormancy (Okie, 1998), and the total chilling hours were 1026, 1420, 923, and 1348 before the 2000, 2001, 2002, and 2003 growing seasons, respectively. One effect that did occur was that flower buds emerged earlier than leaf buds in 2000 and 2002 as a result of low chilling, whereas the flower and leaf buds emerged at the same time in 2001 and 2003. There was some leaf yellowing and tip burn in the higher rates when leaves were present, but the trees did not appear to be seriously affected. There was very little leaf yellowing and tip burn in the 10 mL·L^{-1} treatment.

There was a significant time of application × year interaction with cropload at harvest, but there was no clear pattern that was consistent across years (Fig. 1). At harvest, no interactions involving rate were significant. There was a slight reduction in cropload at the 20 and 30 mL·L^{-1} rates but not the 10 mL·L^{-1} rate. The 20 and 30 mL·L^{-1} rates were considered excessive because they resulted in fruiting branches without fruit.

Table 1. Comparison of Tergitol TMN-6 and TMN-10 in thinning ‘Fireprince’ peach blossoms in 2000.

Main effect means	Fruit hand-thinned (fruit/tree)	Cropload at harvest (fruit/tree)	Avg fruit wt at hand-thinning (g/fruit)
Chemical			
Control	783 a[z]	837 a	14.4 b
TMN-6	113 b	283 b	16.1 a
TMN-10	192 b	364 b	16.7 a
Chemical rate (mL·L^{-1})			
0	783 a	837 a	14.4 b
20	202 b	398 b	16.4 a
40	104 b	248 b	16.4 a
Bloom stage			
Control	783 a	837 a	14.4 b
Full bloom	192 b	362 b	16.7 a
Petal fall	114 b	284 b	16.0 ab

[z]Means followed by different letters indicate significant differences using Duncan’s multiple range test, $P \leq 0.05$.

Table 2. Efficacy of Tergitol TMN-6 in thinning ‘Fireprince’ peach blossoms from 2000 through 2003. Only main effect means that are not involved in a significant interaction are shown.

Parameter	Fruit hand-thinned (fruit/tree)	Cropload at harvest (fruit/tree)	Fruit wt at hand-thinning (g/fruit)	Avg fruit wt at harvest (g/fruit)
Significance				
Bloom stage × rate × year	NS	NS	NS	NS
Rate × year	NS	NS	**	NS
Bloom stage × year	NS	*	NS	NS
Bloom stage × rate	NS	NS	NS	NS
Year	**	NS	***	NS
Rate	***	**	***	***
Time	NS	NS	NS	NS
Main effect means[z]				
Chemical rate (mL·L^{-1})				
0	1004 a[z]	694 a	---	129 b
10	657 b	652 a	---	143 b
20	416 c	498 b	---	166 a
30	360 c	477 b	---	187 a
Bloom stage				
Control	1004 a	---	14.4 b	129 b
Full bloom	502 b	---	17.2 a	163 a
Petal fall	441 b	---	16.9 a	168 a
Year				
2000	371 c	---	---	162
2001	568ab	---	---	165
2002	691a	---	---	146
2003	502bc	---	---	166

[z]Means followed by different letters indicate significant differences using Duncan’s multiple range test, $P \leq 0.05$. Some results are less conserved as indicated by nonsignificant main effect means in the ANOVA.
[NS,*,**,***]Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

There was a significant rate by year interaction on fruit weight at the time of hand-thinning. In some years thinning improved fruit weight (Fig. 2). Differences in fruit weight at hand-thinning did not continue through harvest. Fruit weight at harvest was only affected by rate of chemical with fruit from the control and 10 mL·L^{-1} rate similar in size but smaller than fruit from the 20 and 30 mL·L^{-1} treatments, which were similar. The differences in fruit size related to the differences in cropload. Firmness, soluble solids and blush color were not affected by thinning treatment.

Table 3. Climate conditions during treatment application.

Year	Bloom stage	Temp (°C)	Relative humidity (%)
2000	Full	21	74
	Petal fall	10	71
2001	Full	15	55
	Petal fall	13	37
2002	Full	19	95
	Petal fall	20	90
2003	Full	16	100
	Petal fall	16	100

Based on the results of this study, Tergitol TMN-6 can be applied from full bloom to petal fall without adversely affecting the tree or fruit. The 10 mL·L^{-1} rate provided excellent thinning and was not phytotoxic. Thinning was effective despite large differences in temperature and relative humidity during application. In some years, fruit weight at hand-thinning was improved by chemical treatment. Tergitol TMN-6 was demonstrated to be an excellent thinner for peach blossoms with a relatively wide window of application (full bloom to petal fall), which provides commercial growers flexibility in choosing days with favorable climate conditions (especially low wind) for application.

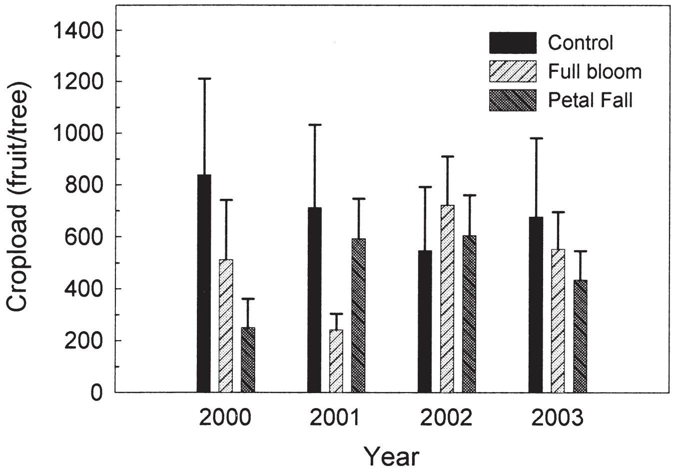

Fig. 1. Interaction of stage of bloom and year on total number of fruit at harvest. Means were pooled across Tergitol TMN-6 treatments. Vertical bars represent the standard error of the mean.

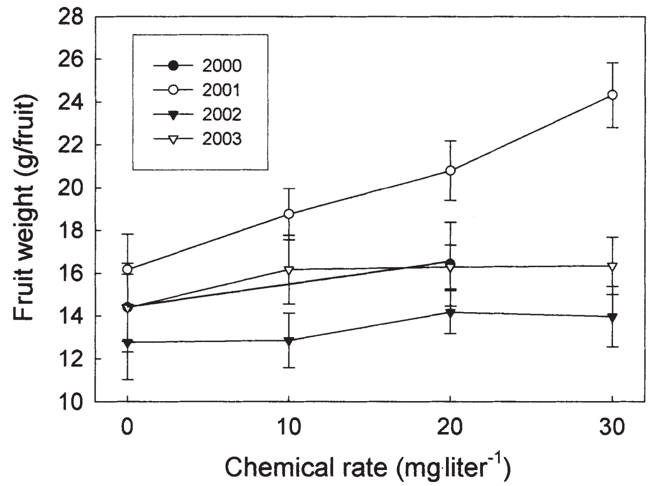

Fig. 2. Interaction of chemical rate and year on fruit weight at time of hand-thinning for 'Fireprince' peach treated with Tergitol TMN-6. Vertical bars represent 2× the standard error of the mean.

Literature Cited

Baugher, T.A., K.C. Elliot, D.W. Lach, B.D. Hort, and S.S. Miller. 1991. Improved methods of mechanically thinning peaches at full bloom. J. Amer. Soc. Hort. Sci. 116:766–769.

Baugher, T.A., K.C. Elliot, S.H. Blizzard, S.I. Walter, and T.A. Keiser. 1988. Mechanical bloom thinning of peach. HortScience 23:981–983.

Berlage, A.G. and R.D. Langmo. 1982. Machine vs. hand thinning of peaches. Trans. Amer. Soc. Agr. Eng. 25:538–543.

Byers, R.E. 1999. Effects of bloom-thinning chemicals on peach fruit set. J. Tree Fruit Prod. 2:59–78.

Byers, R.E. and C.G. Lyons, Jr. 1983. Chemical peach thinning with surfactants and ammonium nitrate. J. Hort. Sci. 58:517–519.

Byers, R.E. and C.G. Lyons, Jr. 1984. Flower thinning of peach with desiccating chemicals. HortScience 19:545–546.

Byers, R.E. and C.G. Lyons, Jr. 1985. Peach flower thinning and possible sites of action of desiccating chemicals. J. Amer. Soc. Hort. Sci. 110:662–667.

Coetzee, J.H. and K.I. Theron. 1999. Efficacy of Armothin® as a chemical thinner applied during different flowering stages of 'Sunlite' nectarines. J. So. African Soc. Hort. Sci. 9:8–12.

Ebel, R.C., A. Caylor, J. Pitts, and D.G. Himelrick. 1999. "Surfactant WK" for thinning peach blossoms. Fruit Var. J. 53:184–188.

Fallahi, E. 1997. Applications of endothalic acid, pelargonic acid, and hydrogen cyanamide for blossom thinning in apple and peach. HortTechnology 27:1304–1305.

Havis, A.L. 1962. Effect of time of fruit thinning of 'Redhaven' peach. Proc. Amer. Soc. Hort. Sci. 80:172–176.

Lemus, G. 1998. Evaluation of two promising peach chemical thinners in Chile. Acta Hort. 465:663–671.

Myers, R. E. D.E. Deyton, and C.E. Sams. 1996. Applying soybean oil to dormant peach trees alters internal atmosphere, reduces respiration, delays bloom, and thins flower buds. J. Amer. Soc. Hort. Sci. 121:96–100.

Okie, W.R. 1998. Handbook of peach and nectarine varieties. USDA–ARS, Agr. Hndbk. 714, p. 109.

SAS Institute Inc. 1988. SAS/STAT guide for personal computers. V. 6.03. SAS Inst. Inc., Cary, N.C.

Southwick, S.M. and R. Fritts, Jr. 1995. Commercial chemical thinning of stone fruit in California by gibberellins to reduce flowering. Acta Hort. 394:135–147.

Southwick, S.M., K.G. Weis, and J.T. Yeager. 1996. Bloom thinning 'Loadel' cling peach with a surfactant. J. Amer. Soc. Hort. Sci. 121:334–338.

Southwick, S.M., K.G. Weis, J.T. Yeager, M.E. Rupert, and J.K. Hasey. 1998. Chemical thinning of cling peach. Acta Hort. 465:647–653.

Taylor, B.H. and D. Geisler-Taylor. 1998. Flower bud thinning and winter survival of 'Redhaven' and 'Cresthaven' peach in response to GA3 sprays. J. Amer. Soc. Hort. Sci. 123:500–508