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Effect of a Dormant Application of Surfactants on Bud Development and Disease Control in Selected Deciduous Fruit Plants[1]

R. A. Spotts and D. C. Ferree[2,3]
Ohio Agricultural Research and Development Center, Wooster, OH 44691

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Abstract. **Spray treatment a single dormant application of high concentrations of anionic (Triton CS7) and nonionic (Triton N57 and Triton X100) surfactants caused up to 5 days delay in bud break in apple (*Malus domestica* Borkh.), but had less effect on grape (*Vitis* spp.) and peach (*Prunus persica* (L.) Batsch) and none on pear (*Pyrus* spp.). Surfactants tended to extend the bud break period but were frequently lethal to buds, particularly at concentrations of 3% and 5% active ingredient. In field studies, surfactants delayed the early stages of flower bud development but not bloom of apple or peach and did not control apple scab caused by *Venturia inaequalis* (Cke.) wint. or powdery mildew caused by *Podosphaera leucotricha* (Ell & Ev.) Salm.**

Surfactants are a broad group of compounds used in formulations to reduce surface tension of aqueous solutions. Surfactants are also known to have diverse effects on a variety of microorganisms and higher plants and are capable of altering biological systems at the bio-chemical level (4, 7).

Although many surfactants are toxic to apple foliage at 0.5% (3), application during dormancy avoided phytotoxicity and gave excellent eradication of powdery mildew (1, 2, 5, 6) and reduced *Venturia inaequalis* ascospore discharge (4). In addition, an autumn application delayed bloom up to 2 weeks while treatment in March caused a 4 to 6 week delay (1, 6). Bloom delay may prove valuable in frost protection. We reported that a single dormant application of several surfactants at 5% active ingredient (a.i.) to 'Cortland' trees delayed bloom by 9 days but did not eradicate powdery mildew (8). The concentration of surfactants used in these disease eradication studies (1, 2, 5, 6, 8) were 10 to 500 times higher than required for routine use as wetting agents in standard pesticide application programs.

In this study, the effect of a single application of 3 surfactants on bud break of dormant cuttings of 5 apple, 2 grape, and single cultivars of both peach and pear was tested. They were also tested in the field on mature apple trees for powdery mildew and scab control and on apple and peach trees for effect on bud break and fruit set.

Dormant cuttings of the following cultivars were collected between March 23 and 28 and refrigerated at 0±2°C until use on March 29: 'Cortland', 'Delicious', 'Golden Delicious', 'McIntosh', and 'Rome Beauty' apple, 'Aurore' (*Vitis vinifera* L. × *Vitis labrusca* L.) and 'Concord' grape (*Vitis labrusca* L.), 'Redhaven' peach and 'Keiffer' pear (*Pyrus communis* L. × *Pyrus serotina* Rehd.). Cuttings of uniform length (33, 21, 25, and 26 cm for apple, grape, peach and pear, respectively) were placed in flasks of water and sprayed to runoff with a hand sprayer with Triton X100, Triton N57, or Triton CS7 (Rohm and Haas Co., Philadelphia, PA 19105). Each was applied at 1, 3, or 5% a.i. (weight/volume). Cuttings sprayed with distilled water were used as a control. Twelve cuttings of each cultivar were treated with each rate of surfactant, and placed in a growth chamber at 23±2°C, 80±10% relative humidity, 12 hr photoperiod, and light intensity of 26 klx. Bud development was observed 3 times per week for 3 weeks.

In the orchard, 'Cortland' trees and 'Redhaven' limbs were treated with 5% a.i. Triton X100, Triton N57, and Triton CS7. 'Cortland' trees, 16 replicates per treatment, were sprayed to runoff at 31.5 kg/cm^2 (450 psi) with a hand gun on April 5. Dikar 76WP at 1 g/2.4 liters was applied weekly to a group of 'Cortland' trees (16 replicates) from April 24 to May 30 and biweekly from June 14 to August 10. 'Redhaven' limbs, 8 replicates per treatment, were sprayed to runoff at 2.1 kg/cm^2 (30 psi) with a hand sprayer on April 7. Control trees and limbs were sprayed with tap water. On apple, the incidence of powdery mildew and scab were counted on all leaves at 6 terminals per tree on May 18 and June 29. Percent fruit set was determined by counting about 125 blossom clusters per limb on 6 limbs per treatment. Stages of apple and peach bud development were determined weekly from April 19 to June 1.

Growth chamber experiment (Table 1). On apple, Triton X100 at 3 and 5% delayed bud break of all cultivars 2 to 5 days. Results with Triton N57 were similar, except for 'Golden Delicious'. Triton CS7 was least effective, failing to delay bud break of 'Delicious' or 'Golden Delicious'. Delay in bud break was often accompanied by bud mortality. Generally, a 2 to 3 day bud break delay was associated with a 30-50% bud kill. However, Triton X100 at 3% a.i. caused a 2-day bud break delay of 'Rome Beauty' but only 8-17% bud kill. Triton N57 at 3 and 5% a.i., while causing 2- and 5-day bud break delay, caused less than 8% bud kill of 'McIntosh'. Surfactants extended the duration of bud break in 87% of the cultivar-surfactant combinations tested.

Triton CS7 at 3 and 5% a.i. delayed bud break of 'Concord' grape, but no other treatment effects on bud break were observed. Triton CS7 was more toxic to 'Aurore' than to 'Concord', whereas Triton X100 and Triton N57 were more phytotoxic to 'Concord' than to 'Aurore'. The effect of surfactants on duration of bud break was variable and no trends were obvious.

On peach, Triton N57 and Triton CS7 caused a 2 day delay in bud break of 'Redhaven' but Triton X100 had no effect. All surfactants, were toxic to buds, killing 67 to 100% even at 1% a.i.

Pear bud break was not affected by the surfactants tested. Surfactants did not kill pear buds nor did they alter bud break duration.

Field experiment (Table 2). The surfactants did not control primary or secondary powdery mildew or apple scab on 'Cortland' foliage. In contrast, significant mildew and scab control were obtained with a full season Dikar spray program.

Water-sprayed apple trees were at green tip stage on April 19, and surfactant-treated trees at green tip on April 26. By May 3, however, both treated and control trees were at 12.7 mm green, and all bloomed between May 17 and May 24.

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[2]Assistant Professor, Department of Plant Pathology; Associate Professor, Department of Horticulture. Present address of first author: Mid-Columbia Experiment Station, Oregon State University, Hood River, Oregon 97031.

[3]The authors acknowledge the technical assistance of John Nixon and John Schmid.

Table 1. Effect of a single application of surfactants on time of bud break and bud survival on dormant cuttings of apple, grape, peach and pear.

Cultivar	Surfactant and % active ingredient (wt/vol)																	
	Triton X100						Triton N57						Triton CS7					
	1%		3%		5%		1%		3%		5%		1%		3%		5%	
	Delay (days)[z]	Final buds[y] (%)	Delay (days)	Final buds (%)	Delay (days)	Final buds (%)	Delay (days)	Final buds (%)	Delay (days)	Final buds (%)	Delay (days)	Final buds (%)	Delay (days)	Final buds (%)	Delay (days)	Final buds (%)	Delay (days)	Final buds (%)
Apple																		
Cortland	0[x]	100	3	100	0	50	0	84	3	66	3	66	0	50	0	16	3	0
Delicious	0	100	2	92	2	58	0	100	0	100	2	66	0	100	0	67	0	100
Golden Delicious	0	100	0	100	2	59	0	100	0	100	0	100	0	100	0	100	0	100
McIntosh	2	100	2	67	5	8	0	100	2	100	5	92	0	100	2	100	0	100
Rome Beauty	0	100	2	59	5	25	0	100	2	92	0	83	0	100	2	83	0	59
Grape																		
Aurore	0	100	0	100	0	50	0	84	0	66	0	66	0	50	0	16	L[w]	0
Concord	0	78	L	0	L	0	0	89	L	0	L	0	0	78	4	22	4	11
Peach																		
Redhaven	0	33	0	25	0	16	0	16	2	25	2	16	2	16	0	33	L	0
Pear																		
Keiffer	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100

[z]Number of days from break of first control bud to break of first treated bud.

[y]Final surfactant-treated bud break as a % of the control.

[x]Each value represents the mean of 12 replicate cuttings.

[w]L=all buds dead.

Peach bud break occurred on April 26 on control, Triton X100, and Triton CS7-treated limbs, and on May 3 on Triton N57-treated limbs. By May 10, both treated and control limbs were at 12.7 mm green and in full bloom on May 17.

Percent fruit set of control and surfactant treated trees was significantly less than that of trees sprayed on a full season Dikar schedule due to disease pressure in surfactant-treated trees. There was no significant difference in fruit set between surfactant-treated and control trees sprayed with water.

Surfactant concentration used in this study were 10 to 500 times higher than required for reduction of surface tension (7). Toxicity of these surfactant concentration to grape and peach buds make further development and use on these crops unlikely. In apple, however, the delay in bud break and extension in duration of bud break could be viewed as a potential chemical technique for frost protection. In this study the delayed bud break seen under field conditions paralleled growth chamber observations but was much less than observed in other studies (1, 6), possibly due to differences in climate, cultivars, and timing of surfactant application.

Prebloom temperature during 1978 caused bloom to occur quickly, and surfactant treatments did not delay bloom as we reported for 1977 (8).

Powdery mildew eradication by surfactants reported elsewhere (1, 2, 5, 6) was not observed in this study or during 1977 in Ohio (8). In both years, only spring applications were made, whereas, autumn application of surfactants was reported to be superior to spring application for powdery mildew eradication (1, 6). Additional studies on timing of surfactant application for both disease control and bloom delay may be warranted.

Table 2. Effect of 1 dormant application of 3 surfactants on powdery mildew, apple scab, and fruit set on 'Cortland' trees.

Treatment[z]	Foliage infection (%)				Fruit set (%)
	Powdery Mildew[y]		Apple Scab[y]		
	May 18	June 29	May 18	June 29	
Triton X100	2.0a[x]	43a	3.4a	61a	4a
Triton N57	2.2a	39a	3.0a	58a	5a
Triton CS7	2.4a	43a	3.0a	62a	4a
Dikar	1.3a	9b	3.6a	31b	38b
Water	2.7a	37a	3.0a	61a	10a

[z]Dikar 76 WP lg/2.4 liter applied April 24; May 3, 10, 18, 30; June 14, 28; July 12, 26; and August 10. All other treatments applied April 5.

[y]Values represent average % diseased leaves on 96 terminals per treatment.

[x]Means separation within columns by Duncan's multiple range test, 5% level.

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