Project Title: **2006 Trials for Testing BlueStim for Cherry Rain-cracking**

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Summary:

Treatments with BlueStim (glycine betaine) significantly reduced rain-cracking and slightly delayed maturity in 'Garnet' sweet cherry. Cracking of mahogany fruit was reduced by approximately 53% in fruit treated at early straw color + later treatment(s). Cracking of mahogany fruit in trees treated at colorbreak and later treatment cracked 38% less than untreated fruit. Split applications of 4lb + 4 lb BlueStim or 2+2+2 lb BlueStim were very effective in reducing rain-cracking without negative effects on other quality measures. Application of BlueStim with a penetrant/surfactant proved to be very effective.

Introduction:

Glycine betaine (BlueStim, Greenstim; Verdera Oy) has been shown to have efficacy as an osmoregulator, suppressing fruit cracking in sweet cherry in trials in Washington State, USA, Spain, and in Australia (technical bulletin, Verdera www.verdera.fi). In 2005 we tested BlueStim on 'Bing' sweet cherry in the following design:

2005 Plot design: Randomized complete block design, ten replications, single-tree plots

2005 Treatments:

Product	Formulated product per acre	Treatment Timing	Date
Bluestim	4.5 lb	Early straw color development	29 April
Bluestim	4.5 lb.	50% pink fruit	13 May
Bluestim	4.5 lb.	Early straw and 50% pink fruit	29 April and 13 May
Rainguard	2.28 gal (10%) v/v	Early straw and 50% pink fruit	29 April and 13 May
Untreated			

Additives: No-Foam A (3 ounces/acre) added to Bluestim treatments only

Results from the 2005 trial were: In the first harvest single Bluestim application treatments were not different from the untreated control. The double application of Bluestim, however, reduced total cracking significantly compared to all other treatments. In the second harvest, no treatment effect of BlueStim was found with respect to cracking. In collaboration with representatives from Verdera, we determined that results might be improved with the use of a penetrant adjuvant for improved uptake. In a 2006 trial on 'Brooks' cherries in California, conducted in parallel to this trial, a statistically significant reduction in rain-cracking was obtained with BlueStim. Two applications at 4 lb per acre each resulted in less than 1% cracking, compared to the untreated control 3.6% cracking (L. Beem, personal correspondence).

2006 Trial:

Orchard/Location: E. Kettleman Lane, Lodi, CA

Crop and experimental design: The orchard used consisted of 'Garnet' sweet cherries on 'Mahaleb' rootstock planted in 1990 at a spacing of 18' between rows and 20' between trees on sandy-loam soil, microsprinkler-irrigated. A complete randomized block with treatments in full tree rows, three blocks, one row per treatment, was used. Five trees per treatment/block combination were selected for evaluation

of fruit based on 'blocking' for cropload as 2006 was a year of extreme weather pressures on budbreak, bloom, pollination, freezing temperatures, rain and cool weather. Thus, selection of sampled trees represented 'blocking' on the main factor that increased variability. As cropping was relatively light overall and tree-to-tree variability within the orchard was greatest in this variable, trees selected represented those moderately- to well-cropped (for this year), as light cropping increases cracking incidence.

Treatments: Treatments were applied at three timings determined by fruit developmental stages represented by specific color changes = late light green/start of straw color; color break (straw/pink transition); light red. Each color stage was identified when 10-20% of fruit on the tree showed the target color. In 2006 these timings were May 13, 17 and 19. Product was applied by electrostatic orchard sprayer at 100 gallons per acre with ½ pint per 100 gallons of Monterey Super 7 (0.0625% v/v; Monterey AgResources) as a penetrants/surfactant adjuvant. Treatments were as follows:

1. 4 lb/A BlueStim + 4 lb/A @ Timings 1 + 2
2. 4 lb/A BlueStim + 4 lb/A @ Timings 2 + 3
3. 2 lb/A BlueStim + 2 lb/A + 2 lb/A @ Timings 1 + 2 + 3
4. UTC (untreated control)

All trees also received an application of Vapor Gard® (Miller Chemical and Fertilizer Co.) antitranspirant on May 19, after BlueStim treatments had dried. All other cultural practices were constant among treatments.

Weather and rain-cracking, 2006: Measurable rain fell on April 2-16 (total = 3.49 inches) and May 19 (0.04 inches, nighttime), May 21 (0.35 inches) and May 22 (0.44 inches), for a total of 4.32 inches during April and May, 2006.

Fruit evaluation: On May 24 fruit samples were collected from treated trees for evaluation, immediately prior to commercial harvest. Variable numbers of fruit from each tree were collected, however at least 100 fruit per tree were sampled. Fruit were sampled from all exposures of the trees, from approximately 1 meter above ground surface to approximately 2.75 meters above ground surface, from the interior and exterior of the canopy. All fruit selected at random, except that all fruit were of marketable color (dark red to mahogany; CTIFL colors 4 and 6). Fruit maturity was fairly uniform among all trees sampled, regardless of treatment.

Fruit were divided into color classes and scored for incidence of cracking (cracked vs non-cracked), based on USDA standards in use at the time at the packing house (see United States Standards for Grades of Sweet Cherries at www.ams.**usda**.gov/standards/cherswt.pdf). Fruit were rejected as culls when they had cracks conforming to the following:

(a) Cracks within the stem cavity when deep or not well healed, or when the appearance is affected to a greater extent than that of a cherry which has a superficial well healed crack one-sixteenth inch in width extending one-half the greatest circumference of the stem cavity;

(b) Cracks outside of the stem cavity when deep or not well healed, or when the crack has weakened the cherry to the extent that it is likely to split or break in the process of proper grading, packing, and handling, or when materially affecting the appearance.

Uncracked fruit were evaluated for firmness, size (diameter), sugar (Brix) and stem pull force by FirmTech II (firmness and size), Atago digital refractometer (Brix) and Imada digital force gauge (pull force). Number of fruit within each color class was used to evaluate treatment effects on maturity.

Statistical analyses:

All analyses were performed using Statistical Analysis Systems software (SAS version 9.1; SAS Institute Inc., Cary, NC), using PROC GLM and separation of means by PROC MEANS and Duncan's Multiple Range Test. Maturity at harvest was analyzed as the proportion of fruit of marketable color (dark red and mahogany) in each replicate sample. Incidence of cracking was measured as a function of treatment, within each maturity (color class) and as total percentage of cracked fruit across colors, measured as the proportion of fruit in a given sample that was cracked, based on USDA standards. Percentage data was found to be normal and, thus, did not require transformation. Pull force, size, firmness and Brix were measured as a function of treatment, within color classes.

Results and Conclusions:

Rainfall during the critical period of fruit maturation, when fruit are most sensitive, was sufficient to cause severe cracking in the 'Garnet' cultivar throughout the region (Figure 1). The averages for rain-induced cracking (percentage of 'serious' cracks resulting in culled fruit) of 'Garnet' cherries from a similar orchard, 1 mile distant were calculated for low, down-hanging limbs (90%), limbs from bottom to mid-range of trees (48%), upper canopy light red fruit (57%) and upper canopy dark red fruit (62%). These evaluations were made on May 23 at the packing house used by the trial's grower, based on USDA cracking standards.

Cracking was significantly reduced by all BlueStim treatments, within and across maturity (color) classes (Table 1). Total cracking for all colors was 57% in the untreated control. Cracking was reduced by 30 to 60% by treatment, with those treatments that included the earliest timing resulting in the greatest reduction in cracking overall, and within mahogany colored fruit. There was no significant difference in cracking among dark red fruit in different treatments. Maturity was slightly delayed by those treatments that included the earliest application, compared to the untreated control (Table 2), within the two classes of marketable fruit found on sampled trees. No visible differences on the trees were observed, with regard to maturity, and the difference in maturity of sampled fruit was not so great as to affect marketability. No other fruit quality measure (pull force, firmness, size, Brix) was affected by treatment, when fruit were divided by maturity classes (data not shown). Although fruit color, as a measure of developmental stage, is a determining factor of sweet cherry cracking response to rain, in that fruit that are lighter than colorbreak fruit, or darker than dark red fruit at the time of rain are less likely to crack, the treatment with the highest percentage of mahogany fruit at harvest (the untreated control) still showed the highest amount of cracking. The interval between the causative rain events and harvest evaluation for rain-cracking was short enough to preclude large color changes within that 2 to 3 day period, particularly as ambient temperatures were quite low (79 °F highest) during the period of rain and harvest (Figure 2). Severity of cracking is illustrated in Figure 3; Figure 4 shows minor cracks that did not result in culled fruit.

Use of BlueStim with the penetrant/surfactant Monterey Super 7 provided excellent reduction of rain-cracking in 'Garnet' sweet cherry in 2006, a severe rain-cracking year in California.

Acknowledgements:

We appreciate the cooperation of the grower, Pat Hale, in the use of his orchard and in his application of all products.

Figure 1. Daily rainfall recorded at Live Oak Station (San Joaquin WEATHERNET) from April 1 through trial period, approximately 2 miles from test orchard. ↓ = Spray treatments applied (May 13, 17, 19) and fruit harvested (May 24).

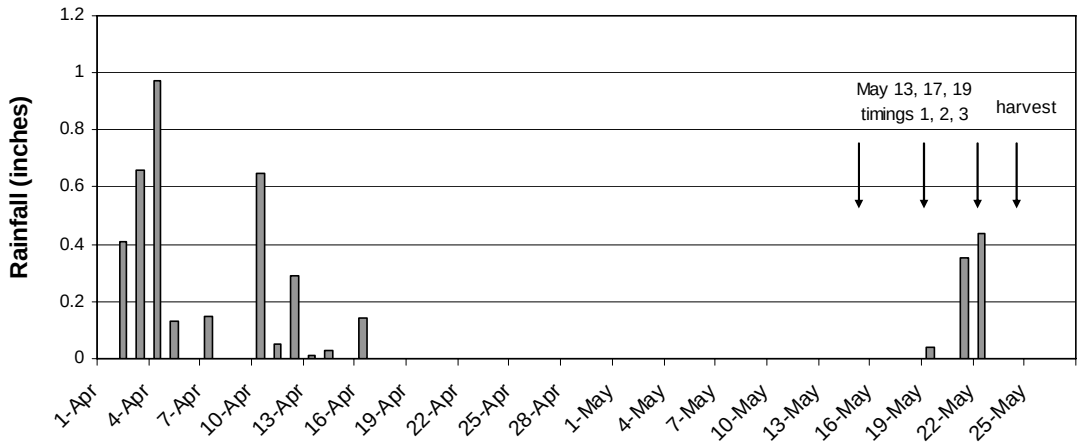

Figure 2. Figure 1. Daily maximum temperature recorded at Live Oak Station (San Joaquin WEATHERNET) from April 1 through trial period, approximately 2 miles from test orchard. Fruit harvested (May 24).

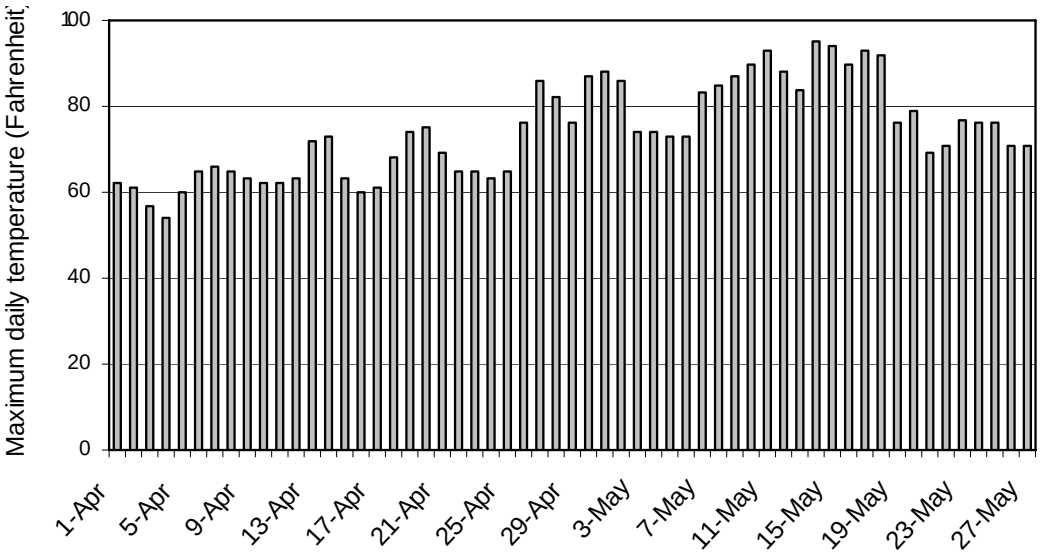

Table 1. Effects of treatment and maturity of 'Garnet' sweet cherries on incidence of rain-cracking, harvested May 24, 2005. Treatment timings 1, 2 and 3 were as follows, respectively: late light green/start of straw color May 13; color break (straw/pink transition) May 17; light red May 19. All treatments applied at 100 gallons per acre with ½ pint Monterey Super 7 per 100 gallons.

Treatment	Total %cracked for all colors	Within-color percentage of cracked fruit	
		Dark red	Mahogany
4 lb/A BlueStim + 4 lb/A @ Timings 1+2	23.4 c	5.2 a	18.1 c
4 lb/A BlueStim + 4 lb/A @ Timings 2+3	39.8 b	9.1 a	30.8 b
2 lb/A BlueStim + 2 lb/A + 2 lb/A @ Timings 1+2+3	26.2 c	8.2 a	18.0 c
Untreated control	57.0 a	7.6 a	49.4 a

Mean separation by Duncan's Multiple Range Test (P = 0.05%).

Table 2. Effects of treatment on maturity of 'Garnet' sweet cherries, harvested May 24, 2005. Timings 1, 2 and 3 were as follows, respectively: late light green/start of straw color May 13; color break (straw/pink transition) May 17; light red May 19. All treatments applied at 100 gallons per acre with ½ pint Monterey Super 7 per 100 gallons.

Treatment	%Fruit in each color (maturity) class	
	%Dark red	%Mahogany
4 lb/A BlueStim + 4 lb/A @ Timings 1+2	34.7 a	65.3 b
4 lb/A BlueStim + 4 lb/A @ Timings 2+3	26.2 ab	73.8 ab
2 lb/A BlueStim + 2 lb/A + 2 lb/A @ Timings 1+2+3	36.6 a	63.4 b
Untreated control	17.9 b	82.1 a

Mean separation by Duncan's Multiple Range Test (P = 0.05%).

Figure 3. Severe cracking of ‘Garnet’ sweet cherry in 2006.

Figure 4. Minor cracking in ‘Garnet’ sweet cherry in 2006; non-cullage fruit.