Comparison of CPPU, Dormex, CAN17 and Other Treatments in Dormant Season Applications on Sweet Cherry in 2006

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Problem and its significance:

California cherry growers have had mixed results in their use of rest-breaking chemicals, partly because the amount and distribution of chilling accumulated in any given year can be very different, making application timing hard to judge. CPPU and the similar synthetic phenyl urea cytokinin TDZ have been used in rest-breaking applications elsewhere in the world (Stino and Attala, 1997; Almaguer-Vargas et al, 2000; Alvarado-Raya et al., 2000; Calderon-Zavala and Rodriguez-Alcazar, 2000; Costa et al., 2003). Amnon Erez reports that TDZ is a powerful rest-breaking agent in his experience (personal communication). In some cases, cytokinins have provided similar results to Dormex with respect to bud break (Dormex tends to give the strongest response among rest-breaking agents). Many cherry growers have found few alternatives that are acceptable to their farming practices, as was exemplified in the current low-chill year 2005-2006.

Objectives:

1. Test CPPU in combination with appropriate surfactant at 25 and 50 ppm for rest-breaking in sweet cherry.

2. Compare results with industry standard applications of Dormex, CAN17 + Entry, CAN17 + RNA Activator 85, Dormant Plus Oil, Dormant Flowable oil and EvenBreak + BreakThru.

Plans and Procedures:

The trial was conducted in a commercial ‘Bing’ orchard in Morgan Hill, CA, in an area which typically suffers from inadequate chilling. Pollenizers included ‘Rainier’, ‘Black Tartarian’ and ‘Black Republican’. Trees were medium-sized, planted at 99 trees per acre in a 20.5 x 21.5’ spacing. The orchard was planted in 1991 to 1992 and was watered by microsprinklers.

Treatments were applied to single-tree replicates in the following numbers: untreated control, CPPU, CAN17 + surfactants, EvenBreak + BreakThru—2, Dormex—5, Dormant Emusion and Dormant Plus—1. All treatments were applied by mistblower or backpack sprayer at an estimated carrier volume of 100 gallons per acre. Prior to bloom, 3 shoot per tree were selected for evaluation of treatments by bloom progression, fruit set and fruit maturity. Shoots were evenly spaced around each tree in mid-canopy. Treatment timings were based on current recommendations for each product, and by chill accumulation (Table 2). Applications occurred from 31 January through 24 February. Bloom progression was measured every 3 to 9 days throughout the bloom period by counting number of trussbuds (mixed reproductive and vegetative buds with flowers in typically averaging 4 flowers per trussbud) with at least one flower open on given date, from 16 March through 8 April.. First flower open dates were observed for earliest blooming treatments. Flowers and trussbuds were evaluated for signs of phytotoxicity (bud browning and death, petal browning).

Fruit set was evaluated as number of fruit per trussbud and per estimate of four flowers per trussbud on average. Because fruit set was quite low due to weather conditions, fruit set was also expressed as a percentage of the control trees’ fruit set (representing a norm). Fruit were collected on 1 June when commercial harvest of earliest-maturity fruit began. All fruit from tagged shoots were removed for evaluation and cropload was evaluated on a per tree basis by visual observation. Harvested fruit were graded for maturity (color class).

Statistical analyses of data were perfomed using Statistical Analysis Systems software (SAS version 9.1; SAS Institute Inc., Cary, NC). Weather data for purposes of calculating chill accumulation were obtained from the Morgan Hill CIMIS station.

Results and Discussion:

Weather patterns during the dormant season resulted in conditions of low to moderate chill accumulation (Fig. 1), with a total accumulation of 592 chill hours (calculated as number of hours below 45°F). Chill accumulation was also calculated as 'chill portions' using the Dynamic Model (Fishman et al., 1987). Several days of record high temperatures followed by record low temperatures below freezing in early February (Fig. 1) accelerated bud internal development, making buds more sensitive to frost damage. Many buds were observed to die subsequent to these conditions, both prior to and during bloom (Fig. 2). While no particular rest-breaking treatment appeared to cause greater bud death, one may presume that those treatments that most advanced bud development might also cause buds to become more susceptible to freezing temperatures. Those rest-breaking agents applied well in advance of freezing temperatures, Dormex, CAN17, Dormant Emulsion and Dormant Plus, may be expected to advance bud development by increasing respiratory rates, thus increasing susceptibility in 2006. Critical spring temperatures for freeze damage of sweet cherry have been established in climatic areas in which chill accumulation is not problematic (such as Washington and Michigan). However, under poor chilling conditions in California, we might conclude that bud dormancy is not as deep as in colder conditions and early warming periods push buds further into an active state, enhancing frost susceptibility even without rest-breaking treatments. Under the conditions found in this season, frost damage was found in untreated trees as well as treated, and fruit set was affected both by low chill accumulation and freeze damage.

Table 1. Freezing duration during the dormant period in 2006, Morgan Hill, CA.

Date	Hour	Air Temp (°F)
2/16/2006	500	32.2
2/16/2006	600	30.9
2/16/2006	700	29.4
2/16/2006	800	32.1
2/21/2006	500	31.5
2/21/2006	600	30.6
2/21/2006	700	30.2
2/22/2006	500	32.0
2/22/2006	600	31.6
2/22/2006	700	31.2

As flowers opened, we observed some browning of petals that was non-specific to any given treatment as it was without pattern in the orchard, on treated and untreated trees (Fig. 3). This browning was assumed to be due to low-level frost damage, rain damage, or low-level brown rot damage.

Dormex + Agridex advanced bloom more than other agents (Table 2) and the first flowers to open on Dormex-treated trees were observed on March 11 through 14. Bloom on Dormex-treated trees began in a widespread manner between March 16 to 21 and by March 25 Dormex-treated trees averaged half of all trussbuds with open flowers; no other treatment had measurable bloom. On March 29, 80% of all trussbuds on Dormex-treated trees had open flowers and trees treated with CAN17 + RNA Activator 85 had 42% of trussbuds with open flowers. CAN17 + Entry had less than 9% of trussbuds with open flowers, Dormant Plus-treatment resulted in ~10% open trussbuds and 25 ppm CPPU treatment had 4% of trussbuds with open flowers. First flowers to open on control trees' tagged shoots were observed on 29

March. By April 1 Dormex- and CAN17 + Activator 85-treated trees were similar in bloom development and this relationship continued. The pattern of bloom advance by Dormex ahead of CAN17 treatments is typical under California conditions, as is the 'catching-up' of bloom in these rest-breaking agents. Choice of surfactant had a profound effect on the rest-breaking activity of CAN17 in this trial; surfactant choice should be re-examined with respect to other rest-breaking agents as well. Leafout developed simultaneously on Dormex-treated trees (1 April, Fig. 4); small fruits were present by 9 April.

CPPU at 25 ppm exhibited some rest-breaking activity when compared to the untreated control (April 5; Table 2), however, this result may be biased by the choice of trees used for the 25 ppm CPPU treatment. One of these was an 'end of the row' tree, and its bloom and fruit set (Table 3) far exceeded that of the other tree immediately next to it used for the same treatment. Figure 5 illustrates the extreme differences in bloom of these two trees; the foreground shows the 'end' tree and immediately behind it in the row (both with green ribbons) is the second tree. Bloom in the trees treated with 50 ppm CPPU was similar to that of the control (Table 2), and appeared normal (Figure 6). Fruit set on the trees treated with 50 ppm CPPU, however, was very low (13% of the control; Table 3). Fruit set was increased by the following treatments: 25 ppm CPPU, Dormex, CAN17 + Activator 85, Dormant Flowable Emulsion and EvenBreak + BreakThru (Table 3). These results, however, should be judged as very preliminary, given that numbers of trees evaluated ranged from 1 to 5, depending on treatment. Fruit set was low overall, given the conditions of lack-of-chilling and freezing conditions. It is interesting to note that the Dormant Emulsion increased fruit set by 1000% compared to the control, and it may prove valuable to test a combination of rest-breaking treatments for improved bud break and fruit set, as well as to consider reducing concentrations of some of these chemicals from that used in single applications, to reduce risk and costs. It appears that concentrations of CPPU used may be too high for this application and lower concentrations should be tested. A re-evaluation of adjuvants is also appropriate.

Cropload in the 2 trees treated with 25 ppm CPPU was extremely variable as previously described. The cropload on the 'end row' tree used in this pair set a heavy crop by this year's standard (Fig. 7). Maturity was variable when the fruit was evaluated on 1 June (Fig. 7; Table 4). Cropload on an adjacent, untreated 'end row' tree was much lighter (Fig. 8). It may be possible that CPPU at the lower concentration improved fruit set, but these results must be interpreted cautiously. Cropload was good on Dormex-treated trees (Fig. 9) and maturity was most advanced in this treatment when evaluated on 1 June (Table 4). Only the Dormant Plus treatment had lower maturity than the control on this date. Maturity can be affected by cropload in that a heavily-cropped tree tends to have delayed fruit maturation; with small sample sizes (number of replicate trees) and the irregularities in weather patterns contributing to experimental results in 2006, one must again view results as preliminary, except in cases when treatment effects are well-established, such as bloom and maturity advancement by Dormex and CAN17. A comparison of fruit maturity from Dormex- and 25 ppm CPPU- treated trees with similar croploads demonstrated the maturity advance found with Dormex (Fig. 10).

One comment is appropriate with respect to statistical differences as they appear in the tables. Letters showing means separation (a, b, c, etc) are less meaningful when sample sizes (number of tree replicates) are very small. For example, in Table 4, maturities from 0% to 33% mahogany fruit are all shown as equal. This is most likely due to the problem of small sample size, and results should be considered as more dependable only when larger replicate numbers are used.

<u>References</u>

Almaguer-Vargas, G., J.R. Espinosa-Espinosa, A. Luna-Contreras and J.C. Paz-Solorzano. 2000. Chemical bud break sprays in Japanese plum (*Prunus salicina* Lindl.) 'Shiro' and 'Santa Rosa'. Revista Chapingo Serie Horticultura IV: 111.

Alvarado-Raya, H., J. Rodriguez-Alcazar, G. Calderon-Zavala and E. Cardenas-Soriano. 2000. Thidiazuron, flower budbreak and ovary dimensions in Japanese plum (*Prunus salicina* L.) 'Shiro'. Agrociencia 34:321-7.

Calderon-Zavala, G. and J. Rodriguez-Alcazar. 2000. Thidiazuron (N-phenyl-N^1-(1,2,3-thidiazol-5-YL) urea) as a promoter of budbreak on peach (*Prunus persica* L. Batsch) and Japanese plum (*Prunus salicina* Lindl.). Revista Chapingo Serie Horticultura IV: 117.

Costa, C., P.J.C. Stassen and J. Mudzunga. 2003. Chemical rest breaking agents for the South African pome and stone fruit industry. Acta Hort. 636:295-302.

Fishman, S., Erez, A., And Couvillon G.A., (1987a). The temperature dependence of dormancy breaking in plants: Two-step model involving a co-operation transition. J. Theor. Bio. 124: 437-483.

Stino, G.R. and E.M. Attala. 1997. Laboratory studies on the effect of Dormex and CPPU on vegetative bud burst and dormancy of sweet cherries. J. Agric. Sci. 22L2955-2970.

Figure 1. Daily temperatures for dormant season 2005-2006, Morgan Hill, CA. Treatment timings for rest-breaking agents Jan 31, Feb 7, 8, 24.

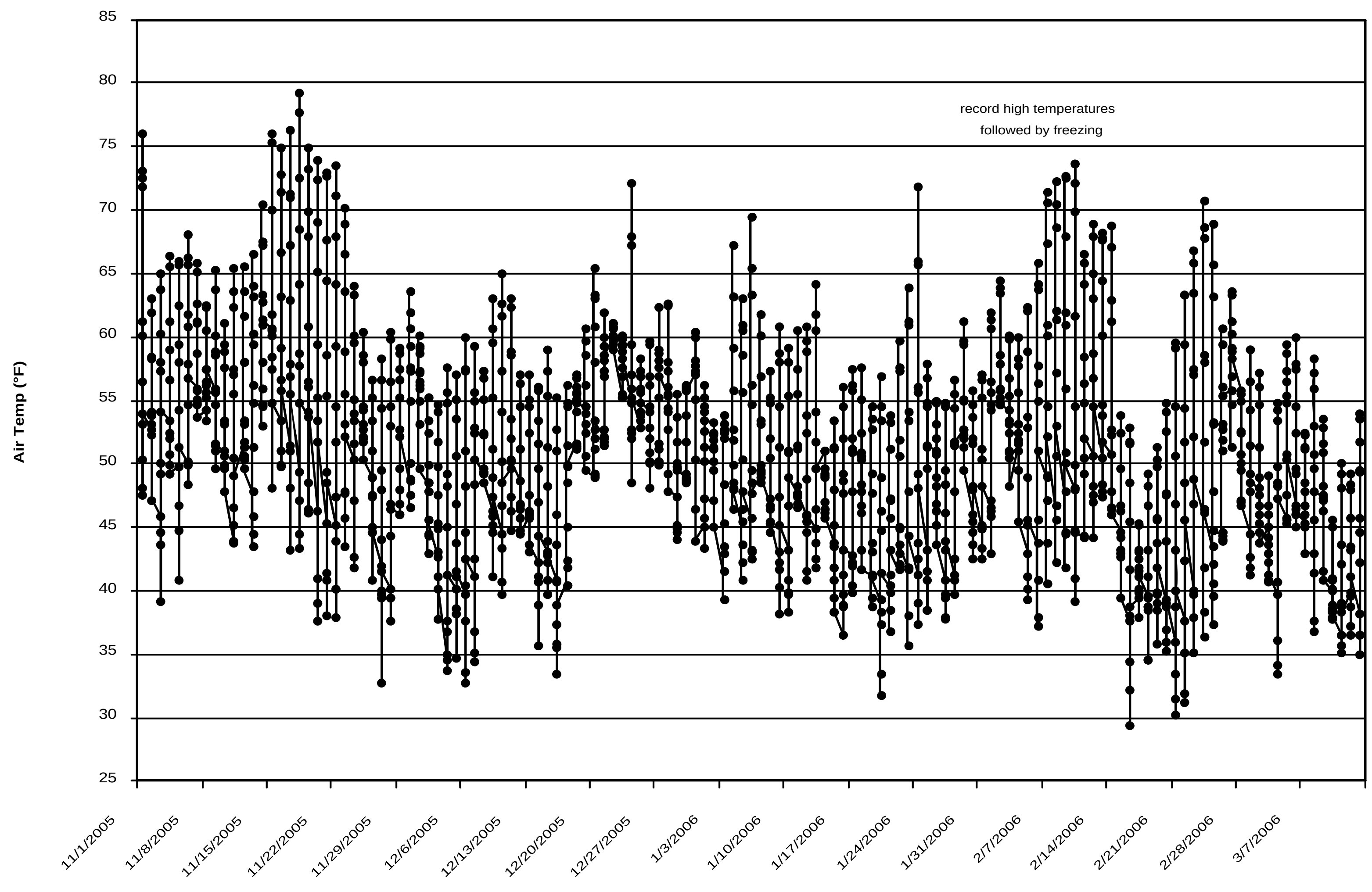

Figure 2. Dead truss buds resulting from freeze damage, 2006.

Figure 3. Petal browning observed during bloom in 2006.

Figure 4. Bloom development and leafout 1 April; petal fall and small fruit development 9 April on tree treated with Dormex 31 January, 2006.

Figure. 5. Paired trees treated with 25 ppm CPPU on 31 January, 2006; bloom development on 9 April. Tree in foreground in full bloom; tree in rear with very little bloom.

Figure 6. Bloom development of ‘Bing’ cherry trees treated with 50 ppm CPPU on 31 January, 2006. Upper photograph illustrates trussbuds opening normally on 1 April; lower photograph illustrates full bloom stage on 9 April.

Table 2. Bloom progression response of 'Bing' sweet cherries in Morgan Hill, CA, to various rest-breaking agents in 2006.

Treatment (all treatments applied at ~100 gallons per acre by mistblower)	Applied/chill portions/chill hours [y]	Bloom measured as percentage of truss buds open					
		16 March	21 March	29 March	1 April	5 April	8 April
Untreated		0.0a [x]	0.0b	0.5c	3.5d	7.5e	36.5b
25 ppm CPPU (2-chloro-4-pyridyl)-N=-phenylurea) + 0.5% UAP Activator 90	31 Jan/46/406	0.0a	0.0b	4.2c	17.4cd	36.9d	50.1b
50 ppm CPPU + 0.5% UAP Activator 90		0.0a	0.0b	0.0c	1.5d	8.9e	37.9b
4% Dormex + 0.5% Agridex		8.7a	44.3a	79.3a	83.7a	86.2a	90.1a
25% CAN17 + 2% Entry	7 Feb/50/430	0.0a	0.0b	8.6c	39.5bc	63.4bc	86.8a
25% CAN17 + 1.5% RNA Activator 85		0.0a	0.0b	42.2b	85.1a	91.6a	95.6a
3% Dormant Flowable Emulsion (UAP-Loveland)	8 Feb/50/433	0.0a	0.0b	0.9c	16.3cd	57.1bcd	92.0a
3% Dormant Plus (UAP-Loveland)		0.0a	0.0b	9.5c	45.2b	78.4ab	92.1a
1% EvenBreak + 6 oz. Break-Thru (~0.05% v/v; Western Farm Service)	24 Feb/67/578	0.0a	0.0b	1.9c	18.9cd	52.5cd	85.4a

[x] Means separation within columns by Duncan=s Multiple Range Test, *P* = 0.05%.

[y] Chill hours defined as number of hours below 45°F. Chill portions defined by the Dynamic Model (Fishman et al., 1987).

Table 3. Fruit set response of >Bing= sweet cherries to various rest-breaking agents in 2006.

Treatment (all treatments applied at ~100 gallons per acre by mistblower)	Applied/chill portions/chill hours [z]	Fruit set measured as percentage of		
		Number of trussbuds per shoot	Estimated number of flower buds per shoot [y]	Control treatment fruit set
Untreated		4.5 bc [x]	1.1 bc	100
25 ppm CPPU (2-chloro-4-pyridyl)-N=-phenylurea) + 0.5% UAP Activator 90	31 Jan/46/406	32.6 ab	8.2 ab	724
50 ppm CPPU + 0.5% UAP Activator 90	31 Jan/46/406	0.6 c	0.2 c	13
4% Dormex + 0.5% Agridex	31 Jan/46/406	12.1 bc	3.0 bc	269
25% CAN17 + 2% Entry	7 Feb/50/430	2.2 c	0.6 c	49
25% CAN17 + 1.5% RNA Activator 85	7 Feb/50/430	20.2 abc	5.1 abc	449
3% Dormant Flowable Emulsion (UAP-Loveland)	8 Feb/50/433	45.0 a	11.3 a	1000
3% Dormant Plus (UAP-Loveland)	8 Feb/50/433	16.5 bc	4.1 bc	40
1% EvenBreak + 6 oz. Break-Thru (~0.05% v/v; Western Farm Service)	24 Feb/67/578	9.2 bc	2.3 bc	204

[x] Means separation within columns by Duncan=s Multiple Range Test, P = 0.05%.

[y] Number of flowers estimated based on an average of 4 flowers per trussbud.

[z] Chill hours defined as number of hours below 45°F. Chill portions defined by the Dynamic Model (Fishman et al., 1987).

Table 4. Maturity (color) response of >Bing= sweet cherries at harvest (1 June, 2006) to various rest-breaking agents.

Treatment (all treatments applied at ~100 gallons per acre by mistblower)	Applied/chill portions/chill hours [y]	Percentage of fruit in each color (maturity) class [z]						
		green	straw	color break/pink [x]	light red	dark red	mahogany	dark mahogany
Untreated		40.0b [w]	33.3ab	16.7a	0.0b	0.0a	10.0a	0.0a
25 ppm CPPU (2-chloro-4-pyridyl)-N=-phenylurea) + 0.5% UAP Activator 90	31 Jan/46/807	2.9b	39.4ab	54.0a	0.0b	3.7a	0.0a	0.0a
50 ppm CPPU + 0.5% UAP Activator 90		0.0b	33.3ab	33.3a	0.0b	0.0a	33.3a	0.0a
4% Dormex + 0.5% Agridex		0.5b	0.4b	17.7a	10.5ab	15.6a	23.0a	32.2a
25% CAN17 + 2% Entry	7 Feb/50/	22.2b	11.1ab	55.6a	0.0b	0.0a	11.1a	0.0a
25% CAN17 + 1.5% RNA Activator 85		0.0b	6.0ab	49.1a	37.2a	5.7a	2.1a	0.0a
3% Dormant Flowable Emulsion (UAP-Loveland)	8 Feb/50/433	12.3b	29.5ab	46.9a	9.4ab	1.9a	0.0a	0.0a
3% Dormant Plus (UAP-Loveland)		85.4a	10.7ab	3.8a	0.0b	0.0a	0.0a	0.0a
1% EvenBreak + 6 oz. Break-Thru (~0.05% v/v; Western Farm Service)	24 Feb/67/1029	35.7b	47.6a	14.3a	0.0b	2.4a	0.0a	0.0a

[w] Means separation within columns by Duncan=s Multiple Range Test, *P* = 0.05%.

[x] Green/straw colored fruit; color break fruit are straw + pink color or pink color.

[y] Chill hours defined as number of hours below 45°F. Chill portions defined by the Dynamic Model (Fishman et al., 1987).

[z] Fruit maturity evaluated visually by assigning fruit to one of six color classes (green = 1, straw = 2, colorbreak/pink = 3, light red = 4, dark red = 5, mahogany = 6). Light red, dark red and mahogany correspond to CTIFL color comparators 1, 3 and 6, respectively.

Figure 7. Cropload and maturity on ‘row end’ tree treated with 25 ppm CPPU on 31 January, 2006. Evaluation made June 1.

Figure 8. Cropload on ‘row end’ tree adjacent to that treated with 25 ppm CPPU on 31 January, 2006. Evaluation made June 1.

Figure 9. Cropload and fruit maturity, respectively, on tree treated with Dormex 31 January, 2006; evaluation on 1 June, 2006.

Figure 10. Comparison of fruit maturity of Dormex and 25 ppm CPPU treatments made on 31 January; evaluation 1 June, 2006.