Use of Plant Growth Regulators for Freeze Protection and Increasing Fruit Set, 2009

Kitren Glozer[1] and Rachel Elkins[2]

[1] Associate Project Scientist, Plant Sciences Department, U.C. Davis
[2] University of California Cooperative Extension Farm Advisor, Mendocino and Lake Counties

Summary:

Whole tree and branch applications were made to 'Bartlett' pear before and after repeated freeze events during the week of April 20, 2009. Temperature data from Scotts Valley indicated a series of frost events during inflorescence expansion, bloom and early fruit set. No treatment provided improved fruit yield or quality when compared to the untreated controls. Significant freeze and disfigurement damage was found in all treatments; some disfigurement may have been due to chemical treatments, however, that is unlikely as there was no difference in expression among chemical treatments and the untreated control. Damage ranged from ~20-80% across both branch and whole tree trials. Crop load (count of fruit per branch or tree) did not vary among treatments, thus there was no perceived increase in fruit set as a result of treatment.

Problem and its Significance:

Inadequate winter chilling or cycles of warm and cold dormant season weather, unseasonably warm temperatures prior to a freeze, and the increasing potential for global warming emphasize the importance of freeze damage mitigation to pear production in California, as well as improving parthenocarpic set when pre-bloom and bloom conditions are poor. Inadequate chilling interferes with the normal process of floral bud development by reducing vascular development into the bud so that nutritional and plant growth regulator resources may not be at adequate levels for good sink strength and reproductive growth. These factors alter bloom patterns and can impact fruit set. Inadequate chilling or warm-cold cycling in the dormant season also reduces cold-hardiness and predisposes buds to lower tolerance to freezing conditions, both in critical temperatures and in critical length of exposure.

Numerous studies show benefits of plant growth regulators, nutrients, vitamins and various other substances on fruit set and/or cold hardiness. Nutrient treatments and plant growth regulators can affect both return bloom and in-season fruit set in pome species, depending on cultivar, and application timing, form(s) and concentration(s) of gibberellin used, as well as the age of the bearing wood (1 year-old vs 2 year-old), as reported by Deckers and Schoofs (2006). Thus, any treatments for freeze mitigation and/or in-season fruit set improvement must be followed with data on return bloom and cropping.

Repeated freeze events are periodic and relatively common in the North Coast region (Figure 1).

Objectives:

1. Reduce the potential for freeze damage to buds by pre-freeze and post-freeze treatments.
2. Improve fruit set, particularly through parthenocarpy, when bloom conditions are poor (spread-out bloom, inclement temperature and rain conditions, post freeze) by application of PGRs, BlightBan and BioForge™

Plans and Procedures:

European pear trees ['Bartlett', ~40 yr old; (Pyrus communis (L.)] were selected at the Carpenter Ranch in

Lake County, an orchard prone to freeze damage during bloom development. The orchard spacing was 12’ x 20’ for 182 trees per acre. Treatments were applied by mistblower at ~100 gallons per acre, either pre- or post-freeze, depending on the chemical (Tables 1 and 2); 4 single-tree replicates were used for each treatment in the whole tree applications; 4 single-branch replicates were used per treatment in the branch tests. Both trials were complete randomized block design.

Temperature data from Scotts Valley indicated a series of frost events during inflorescence expansion, bloom and early fruit set (Figure 2). Fruit were harvested on August 29 and evaluated for damage on September 10. Disfigurement was rated as 1=no disfigurement and 2=disfigurement present (Figure 3). Freeze damage were rated on a scale of 1-3 (0=none, 1= slight, 2= medium, and 3=severe damage; Figure 3). Analysis of variance was applied to the data for means separation and significance.

Results and Discussion

No treatment increased yield when measured as (1) number of fruit per branch or tree, or (2) weight of all fruit harvested (Tables 3 and 4). Although there appeared to be a slight treatment effect in yield per branch due to treatment, no treatment was different than the untreated control in the branch tests (Table 4). Fruit size was unaffected by treatment (when measured by fruit weight). All treatments incurred a significant level of disfigurement and freeze damage; there were no benefits from any treatment applied.

Pertinent literature

Deckers, T. and Schoofs, H. 2002. Improvement of fruit set on young pear trees cultivar conference with gibberellins. Acta Hort. (ISHS) 596:735-743.

Acknowledgements

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Table 1. Whole tree treatments				
1	ProGibb + Promalin	BreakThru		before freeze at inflor expansion
2				6-24 hr after first freeze event
3			BlightBan	before freeze at inflor expansion
4				6-24 hr after first freeze event
5	BlightBan	BreakThru		before freeze at inflor expansion
6				6-24 hr after first freeze event
7	ReZist (Stoller)	BreakThru		before freeze at inflor expansion
8	BioForge (Stoller)			before freeze at inflor expansion
9				6-24 hr after first freeze event
10	UTC			

Table 2. Branch treatments		
1	CPPU	3-5 days before freeze
2		6-24 hr after first freeze event
3	MaxCel (6-BA)	3-5 days before freeze
4		6-24 hr after first freeze event
5	N-pHource urea + phosphate	3-4 weeks before freeze
6		3-5 days before freeze
7		6-24 hr after first freeze event
8	Polyamine B	3-5 days before + 6-24 hr after freeze
9		6-24 hr after first freeze event
10	UTC	

Table 3. Results of whole tree tests. Harvest occurred August 29 and fruit evaluation[3] on September 10.

Treatment[1]	#Fruit/tree	Fruit wt (g)	Yield (kg/tree)	Frost rating [4]	Disfigurement[5]		Rattail fruit/tree
					Score	Percent per 5 fruit	
ProGibb/Promalin/Breakthru before freeze	449	137	61.8	2.1	1.80	80	0.5
ProGibb/Promalin/Breakthru after freeze	546	137	75.0	2.1	1.55	55	0.3
ProGibb/Promalin/Breakthru + BlightBan before freeze	366	131	48.1	2.1	1.60	60	0.5
ProGibb/Promalin/Breakthru + BlightBan after freeze	419	149	62.1	2.1	1.60	60	0.5
BlightBan/Breakthru before freeze	428	128	54.9	1.8	1.60	60	0.8
BlightBan/Breakthru after freeze	361	139	50.3	1.7	1.60	55	0.3
Stroller ReZist/Breakthru before freeze	456	137	61.7	1.5	1.35	35	0.5
BioForge before freeze	409	133	53.8	1.7	1.30	30	0.3
BioForge after freeze	421	139	58.3	1.9	1.55	55	0.3
Untreated Control	322	143	46.0	1.6	1.45	45	0.8
ANOVA[2]							
Treatment (P-Value)	NS (0.73)	NS (0.30)	NS (0.77)	NS (0.42)	NS (0.25)	NS (0.28)	NS (0.97)
Block (P-Value)	NS (0.20)	NS (0.41)	NS (0.29)	NS (0.91)	**	**	NS (0.95)
Treatment x Block	NS (0.27)	NS (0.70)	NS (0.23)	NS (0.58)	NS (0.75)	NS (0.72)	*

[1] Within columns treatment means significantly different (LSD multiple range test).

[2] *, ** Indicate significance at $P \leq 0.1$ and 0.01. NS indicates not significant ($P>0.1$).

[3] Quality evaluation of five fruit samples per tree.

[4] Frost rating assignment: 0=none, 1= slight, 2= medium, and 3=severe damage.

[5] Disfigurement numerical assignments: 1 = no disfigurement present, 2 = disfigurement present.

Table 4. Results of branch tests.

Treatment[1]	# Fruit/branch	Fruit wt (g)	Yield/branch (kg)	Frost rating[4]	Disfigurement[5]		#Rattail fruit
					Score	%Occurence	
CPPU (KT-30) prefreeze	6.8	109	0.74 bc	1.8	1.5	52	0.5
CPPU (KT-30) postfreeze	14.0	113	1.58 ab	2.1	1.4	40	2.8
MaxCel (6-BA) prefreeze	6.0	110	0.62 bc	2.4	1.6	54	0.8
MaxCel (6-BA) postfreeze	5.3	58	0.62 bc	1.9	1.2	23	0.7
N-pHource urea + phosphate: prebloom	10.8	84	1.18 abc	1.4	1.3	22	1.3
N-pHource urea + phosphate: prefreeze	2.3	49	0.23 c	1.9	1.5	52	1.9
N-pHource urea + phosphate: postfreeze	8.0	106	1.05 abc	1.6	1.3	34	0.7
Polyamine B: pre + postfreeze	9.8	92	1.18 abc	2.0	1.2	20	1.3
Polyamine B: postfreeze	16.3	121	1.92 a	2.2	1.3	39	1.8
Untreated Control	8.3	121	0.98 abc	2.0	1.3	27	1.3
ANOVA[2]							
Treatment (P-Value)	NS (0.15)	NS (0.23)	*	NS (0.49)	NS (0.39)	NS (0.27)	NS (0.88)
Block (P-Value)	*	*	*	NS (0.77)	**	**	NS (0.88)
Treatment x Block	NS (0.85)	NS (0.77)	NS (0.89)	---	---	---	---

[1] Within columns treatment means significantly different where letters differ (LSD multiple range test).

[2] *, ** Indicate significance at P<0.1 and 0.01. NS indicates not significant P>0.1.

[3] Quality evaluation of five fruit samples per tree, insufficient data to determine interactions.

[4] Frost rating assignment: 0=none, 1= slight, 2= medium, and 3=severe dammage.

[5] Disfigurement numerical assignments: 1 = no disfigurement present, 2 = disfigurement present.

Figure 1. Historic (114 year period) temperature fluctuations during April. The last bar is for 2009, showing the relative mildness compared to the previous year. This data is for the entire North Coast region and temperatures for Scotts Valley are significantly lower than these.

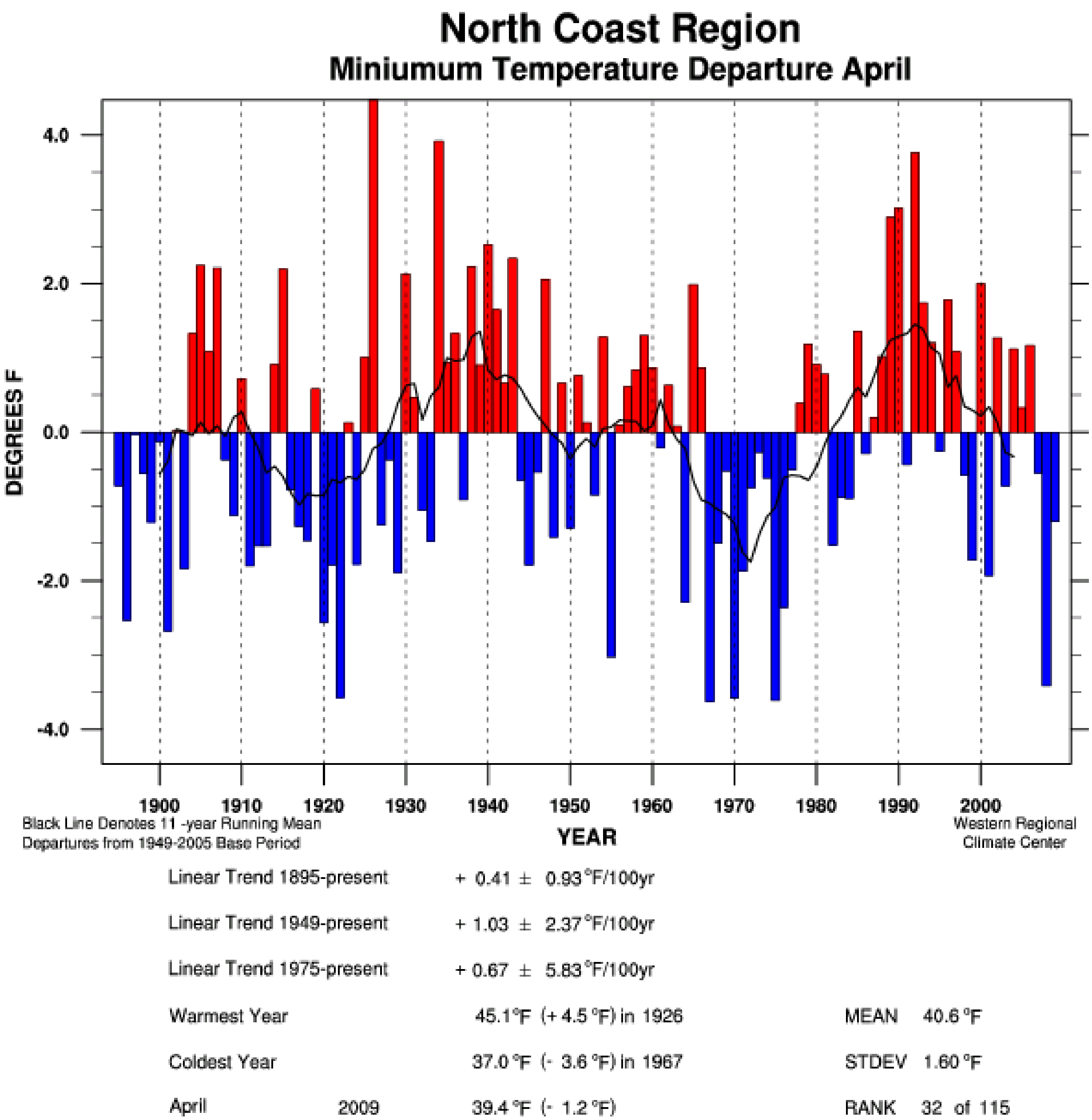

Figure 2. Temperature fluctuations during bloom and early fruit set, 2009.

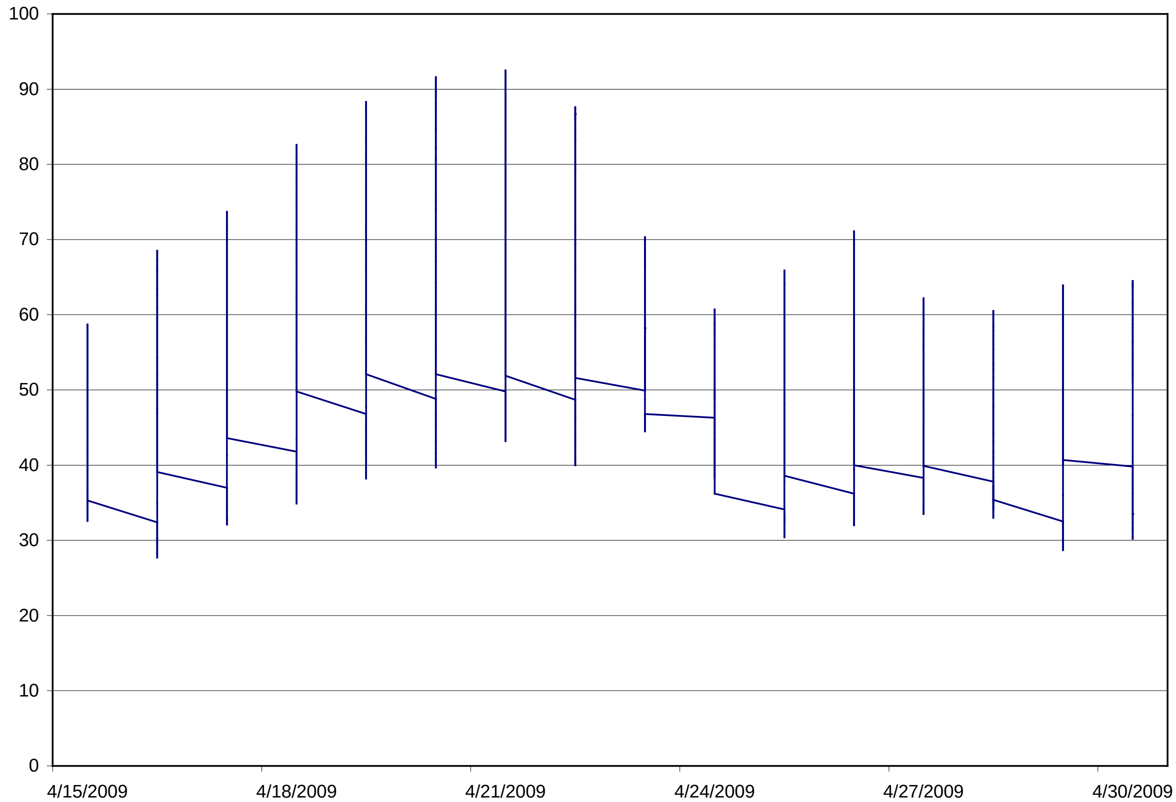

Figure 3. Ratings (1-3) for freeze damage; examples of disfigured fruit.