MANAGING HEAT AT BLOOM IN 'FRENCH' PRUNE, 2014

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PROBLEM AND ITS SIGNIFICANCE

Excessive heat at bloom is linked to significantly reduced prune production in key California growing regions in three of the last ten years (2004, 2005, and 2007). Total grower economic losses in Sutter and Yuba Counties – with 40% of the prune acres in the state -- were in the range of $240 million for those three years, based on county ag commissioners' data. Overall economic damage to the regional economy was probably 1.5x that loss -- $360 million. As the probability of heat in March appears to be increasing (Rick Snyder, UCCE microclimate specialist, personal communication), California prune growers must develop management strategies to mitigate heat damage at bloom to remain economically viable.

Recent research results show that temperatures >75^{o}F begin to negatively affect pollen tube growth rate and viability, but research has not identified 1) temperature thresholds for actual crop damage and 2) practices to improve set once orchard temperature approaches those thresholds.

Prune growers currently use irrigation water as the most cost-effective means of modifying orchard temperature. Freezing of water releases energy that is used to protect crops from temperatures below 32^{o}F. Evaporative cooling is a common practice in apple production to reduce sunburn, and appears to be the most cost-effective approach to reducing temperatures in prune orchards when hot weather occurs at bloom. However, under-tree irrigation during bloom only produces a 1 or 2^{o}F maximum reduction in temperature. Additional practices to mitigate the effects of extreme heat at bloom are needed.

Research must answer two questions:

1. What is/are the threshold temperature(s) that affect prune set and crop yield?
2. Can one or more spray materials, sprayed at bloom if hot weather is forecast, be used to improve set when bloom temperatures reach crop-threatening levels?

OBJECTIVES

- Determine bloom-time temperature thresholds above which crop damage occurs.
- Test commercially available spray materials to assess their potential for improving prune fruit set under warm orchard conditions.

PROCEDURES

Sutter and Tehama Counties:

Temperature and relative humidity sensors were placed in commercial orchards in Butte and Sutter county. Sensors were located at 5-6' feet off the ground in exposed sites between trees in the tree row. They were not placed in tree canopies. Temperatures and relative humidity in each block were continually recorded during bloom at all sites.

Bloom progression was measured by counting open flowers on short branches at roughly 6' height around 3 trees in each orchard. Initial set was measured in May.

In a single orchard in Sutter County, a replicated, complete block designed experiment was established at 10-50% bloom (March 14) to test different materials intended to improve fruit set as warm temperatures approached. The study site was within the Dingville orchard location where bloom and set was tracked (Table 1). Treatments included:

- Control (no spray)
- 2% (v/v) 440 horticultural oil
- 4% (v/v) 440 horticultural oil
- 2 qt/acre seaweed extract
- Retain (333 gm/acre)

Treatments were applied to individual trees using a engine-driven backpack sprayer with a spray volume equivalent to 100 gallons per acre. Applications were made on March 14 between 7-9:20 AM before bees were active.

Whole trees were harvested on August 22. Fresh fruit weight per tree was determined by weighing all the fruit removed from each tree by mechanical harvester. Dry weight per tree was determined from total fruit fresh weight per tree and dry away determined by drying, to commercial standards, 4 lb samples of fresh fruit at the Live Oak dryer of Sunsweet Dryers, Inc.

RESULTS AND DISCUSSION

Warm temperatures (^{o}F), peaking at 80^{o}F on March 15 and 16 -- full bloom in Sutter County -- had no negative effect on fruit set (Table 1). Full bloom in Tehama Co orchards occurred during similarly warm weather, but fruit set was not reduced below 20%. Fruit set in Sutter Co. in 2014 season was a strong 29% (Table 1), although one orchard, which was thinned ahead of fruit set count showed a low set (14%).

Field data from the 2005 and 2007 bloom seasons, when very low set levels were observed, show that maximum temperatures at full bloom were between 80-85^{o}F for 2-3 consecutive days. In those years, flowers were exposed to 11 (2007) or 13 (2005) total hours of temperatures over

80°F, with continuous exposure to >80°F temperatures ranged from 3-6 hours per day. In Sutter County in 2014, the maximum hours of >80°F temperatures was 3 hours in the North Yuba City site. No temperatures above 80°F were recorded in Tehama County orchards where temperatures were recorded and reported.

There was no significant difference in dry fruit yield per tree among any of the treatments (Table 2) sprayed at bloom to improve set ($p=0.60$).

CONCLUSIONS

No clear-cut pattern relating fruit set to climatic conditions in the regions studied (Sutter and Tehama Counties) is apparent from a review of the 2014 bloom – (Table 1; Figure 2). Widespread reduction in fruit set in 2014 was reported from other regions of the Sacramento Valley, especially the west side of the valley – Yolo, Solano, and Glenn Counties. While no data was taken from that region due to lack of staff in those regions (solved by the end of 2014), weather data from Yolo County compared to Tehama County (Figure 3), suggests warmer weather at the later bloom timings that occurred west of I-5 in the Sacramento Valley, may have been at least partially responsible for the poor fruit set in those regions.

Table 1. Average prune fruit set, full bloom dates, and maximum temperatures in orchard at full bloom for individual orchards in Sutter, and Tehama Counties, 2014.

County	Site	3/15	3/16	3/17	3/18	3/19	3/20	3/21	3/22	3/23	% Fruit Set
Tehama	Red Bluff							**78**			**23**
Tehama	S. Los Molinos								**78**		**35**
Tehama	E. Corning								**79**		**35**
Sutter	North Yuba City		**80**								**14***
Sutter	South Yuba City			**67**							**36***
Sutter	Dingville	**80**									**33**

*Thinned

Table 2. Mean dry weight yield per tree following early bloom (March 14; 10-50% open flowers) application of materials intended to improve set under excessive heat at bloom. There was no significant difference in per tree yield between any treatment (p=0.60)

Treatment	Mean fruit dry weight per tree (lbs)
Control	56.54
2% oil (2 gallons 440 oil/acre)	62.28
4% oil (4 gallons 440 oil/acre)	68.42
Seaweed Extract (2 qt/acre	70.53
Retain (333 gm/acre)	76.68

Figure 1. Bloom time temperatures (hourly average) and daily % bloom progression for individual orchard in Sutter County, 2014

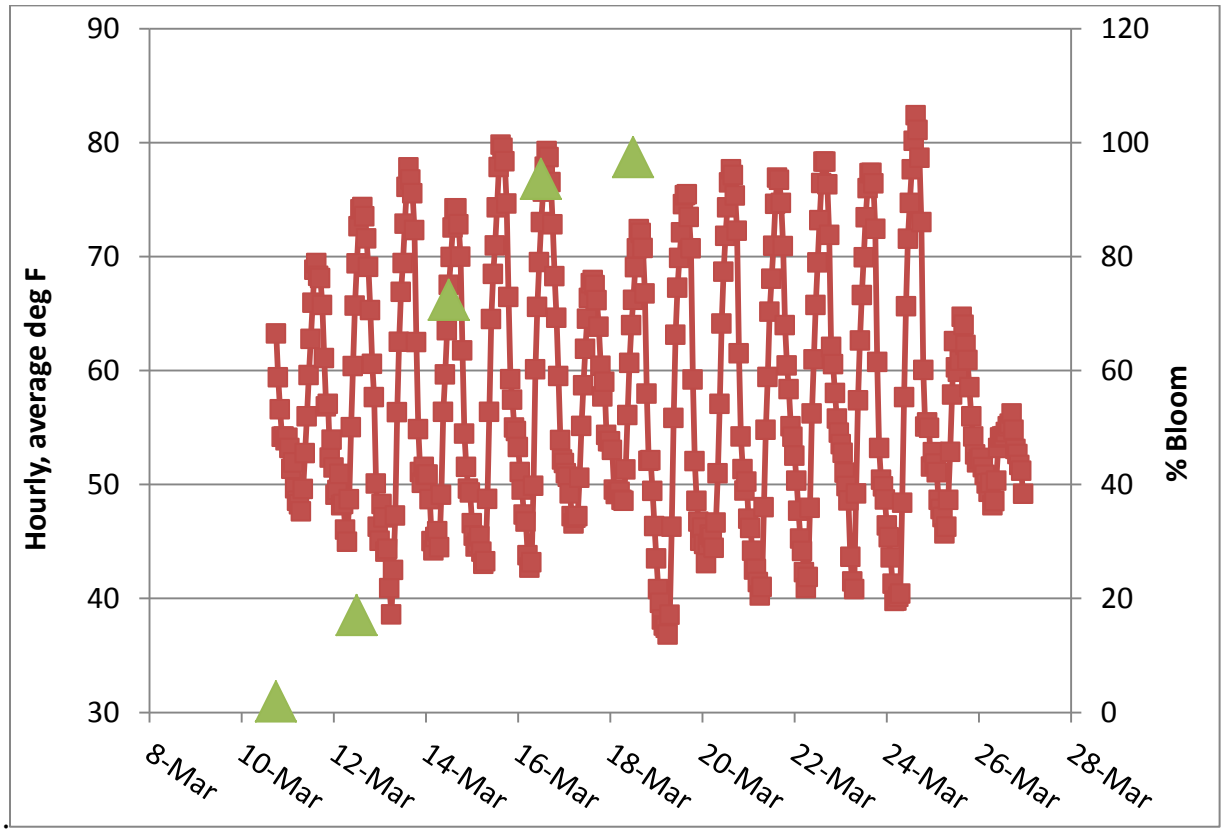

Figure 2. Comparison of fruit set in the same Tehama Co. orchards in 2009 through 2013

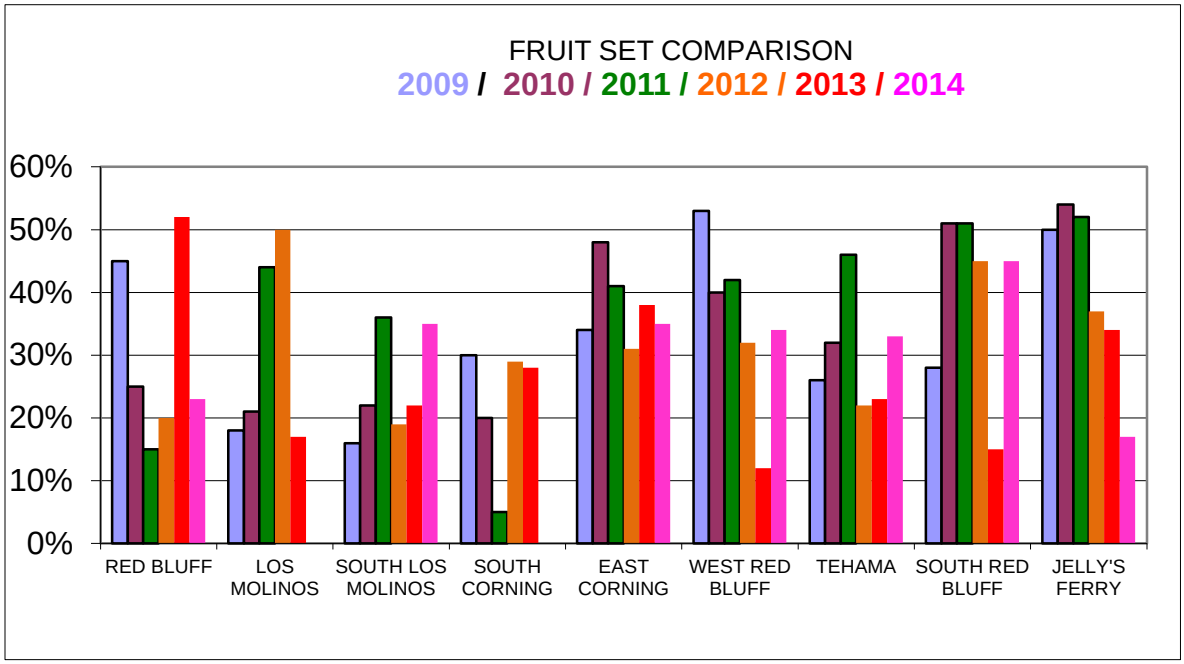

Figure 3. Weather conditions in Yolo County (Esparto, CA) vs Tehama County (Gerber, CA) in 2014.