MANAGING HEAT AT BLOOM IN 'FRENCH' PRUNE, 2020

F. Niederholzer
L. Milliron
K. Jarvis-Shean
P. Gordon
M. Gillis

PROBLEM AND ITS SIGNIFICANCE

Excessive heat or extended wet, cool weather at bloom are linked to significantly reduced prune production in five of the last fifteen years (2004, 2005, 2007, 2014, and 2016) in key California growing regions. 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 2004, 2005, and 2007, based on county ag commissioners' data. Overall economic damage to the regional economy was probably 1.5x that loss -- $360 million.

Bloom weather crop disasters further destabilize the prune economic situation in California. Crop value rises in the years following "off years", encouraging growers to focus on increasing production. In addition, light cropping in the disaster year results in strong bloom the following year and high yield potential the following year. Consequently, the crop following weather impacted crop year(s) is usually very large with a significant volume of small, low value fruit that is slow to sell in a world market, impacting sales and pricing for that year and potentially subsequent years. Crop disasters impact prune growers and industry in California in the disaster year and for years afterwards.

As the probability of heat in March appears to be increasing (Rick Snyder, retired UCCE microclimate specialist, personal communication), California prune growers must develop management strategies to mitigate heat damage at bloom to remain economically viable, while remaining aware of crop risk due to unusually cool bloom weather,

Recent research results show that temperatures >75ºF begin to negatively affect pollen tube growth rate and viability, but research has not identified temperature thresholds for actual crop damage. Cool bloom periods slow pollen tube growth. Temperature effects on ovule longevity of 'French' prune flowers has not been successfully evaluated.

OBJECTIVES

- Determine bloom-time temperature thresholds above and below which crop damage occurs and bloom patterns that present crop risk.

PROCEDURES

Madera, Sutter, Solano/Yolo and Tehama Counties:

Bloom timing and temperature have been monitored since 2010 along most of the length of the major fruit growing regions of the Sacramento Valley, home to 85% of the bearing acres in California. In 2018, a study site in Madera County in the San Joaquin Valley was added. In 2020, orchards in Tehama County (3), Butte Co (2), Sutter County (3), Solano County (1) and Madera County (1) were monitored for bloom timing and orchard weather (temperature and percent relative humidity).

Combined temperature and relative humidity sensors housed in radiation shields were placed in between trees down the tree row at 6-8' above the orchard floor within the study orchard. Sensors were not placed in tree canopies. Temperatures and relative humidity in each block were continually recorded during bloom at all sites. Average hourly temperatures are reported, not maximum temperature for the day.

Bloom progression was measured by counting open flowers on 2-5 short branches (roughly 100 flowers, each) at approximately 6' height around 3 trees in each orchard. Initial set was measured in late April/May by counting fruit on the length of branch were flower number and bloom timing were measured.

RESULTS AND DISCUSSION

Bloom, 2020, was early compared with the late bloom of 2019, with flowers out in early blooming blocks the first week of March. Very similar temperatures were recorded in Butte, Glenn, Sutter, and Tehama Counties for the same time period (Table 1), while Madera County temperatures were cooler though out the study period. Bloom lasted for 10-18 days, depending on location. Fruit set ranged from good (32%) to very poor (≤5%) and averaged 17% across all 10 orchards where flowers were tracked. Only one study block, in the Vina/Corning area of Tehema County, was shaker thinned.

CONCLUSIONS

Moderate to very poor fruit set occurred in a year with all of the following conditions:

- adequate chilling as of February 1
- a warm, dry February
- early and rapid bloom development (average full bloom date of study orchards = March 9-11)
- extreme weather (maximum daily temperature ≥ 80^{o}F or ≤ 60oF) at or around bloom in orchards with the worst fruit set (<15%). The warmest recorded temperatures two days after full bloom (Sutter Co; Table 1) coincided with the poorest fruit set.

What was the role of drying winds at bloom in poor crop? Dry north winds occurred in the Sacramento Valley on or around full bloom (March 10-12) and may have contributed to the generally lower fruit set. However, against the relatively uniform background of dry winds, where the temperature increased to 82-83^{o}F shortly after bloom (Sutter County) severe crop damage occurred, while better fruit set was measured with slightly less heat (Solano, Butte and Tehama Counties; Table 1). Note: It is hard to determine the relative influence of bloom timing (a day after full bloom vs 2 days after full bloom) on fruit set under these windy, low relative humidity conditions.

Note for future consideration: Over the last 7 years, with adequate chilling by February 1, warm February weather has led to earlier bloom and higher risk for damage (Table 2).

Financial value of this research: Prune crop loss in the Sacramento Valley in 2016 was estimated to be at least 1.5 dry tons/acre across 90% of the acres in the region (37,000 acres using 2015 crop report data). At $1800/dried ton, that loss = $100M in farm gate value before the multiplier effect on local economies. This research, developing information to allow growers to more accurately predict crop risk at bloom, will help growers use management tools to minimize damage from unseasonable weather at bloom.

Table 1. Prune bloom timing, 2020. Length of bloom, full bloom (80% open flowers) date and average prune fruit set (late April or May) for individual orchards with maximum daily temperatures during bloom in Tehama, Butte, Sutter, Solano, and Madera Counties. Maximum orchard temperatures on the day of full bloom in each orchard appear in BOLD font. Shaded cells indicates dates with open flowers before bloom (and after in orchards where bloom was tracked after full bloom).

		------------------------------March------------------------------																				
County	Location	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**% set**
Tehama	Red Bluff--East					63	56	58	66	77	74	81	**72**	60	**52**	54	45	52	63	67	71	25
Tehama	Red Bluff -- West					64	56	58	67	76	**73**	80	72	58	54	56	45	54				15
Tehama	Vina/Corning*					66	57	59	67	76	74	81	**74**	61	54	55	46	54	64	67	72	17
Butte	N. Chico					66	56	60	68	77	74	82	73	60	56	**57**	47	51	65	67	72	17
Butte	West Chico	*73*	*81*	*76*	*75*	66	60	61	67	77	75	**81**	73	59	54	55	49	51	63	67	71	32
Sutter	W Yuba City	*73*	*81*	77	76	**65**	58	59	69	79	75	82	71	55	54	49	52	52	64	66	69	23
Sutter	SW Yuba City	*73*	*81*	77	76	66	58	60	69	**79**	76	82	72	56	53	49	53	52	64	65	69	5
Sutter	Dingville	*73*	*81*	76	75	65	57	59	68	**77**	73	82	70	54	52	48	54	52	62	65	67	4
Solano	Wolfskill	72	81	77	74	63	60	58	**66**	76	73	81	68	55	55	49	55	53	61	64	66	19
Madera	S Madera					69	66	65	65	68	73	70	57	54	**47**	53	58	60	65	58	60	12

*Block was shaker thinned

Table 2. Weather conditions prior to bloom, bloom date and fruit set (in May) in one orchard in south Sutter County over seven years. Growing Degree Hours were calculated from the Verona CIMIS station.

Year	Chilling portion accumulation Feb 1	Total precipitation (inches) February	Total precipitation (inches) in March by FB +2 days	Growing Degree Hours (February)	Full bloom date	% set
2014	53	2.74	0.36	ND	Mar 15	33
2015	53	1.96	0.11	5,180	Mar 14	35
2016	62	0.61	8.05	5,194	Mar 9	3
2017	56	5.18	0.24	4,490	Mar 17	28
2018	56	0.56	4.82	3,863	Mar 28	41
2019	55	12.03	4.35	2,456	Mar 30	31
2020	54	0.02	1.11	4,913	Mar 10	4