BLOOM AND POSTBLOOM PRUNE MANAGEMENT PRACTICES FOR MORE CONSISTENT PRODUCTION OF HIGH QUALITY PRUNES.

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PROBLEM AND ITS SIGNIFICANCE

Inconsistent cropping (yield/acre) is a major challenge facing the dried plum industry in California. This is a year to year phenomenon, linked, primarily, with weather conditions at bloom. Hot or cold weather (above 80^{o}F or below 60^{o}F) coincided with or caused state-wide crop failure in 2004 and 2016 and regional failures in 2005, 2007, 2014 and 2015. However, in most years, warm to moderate temperatures at bloom (daytime highs of 60-80^{o}F) produced excessive fruit set resulting in over production of small, lower quality fruit -- unless growers shaker-thin at reference date. Over cropping in one year will reduce bloom the next year, further reducing production the following year if poor bloom conditions exist. Prune growers are, literally, faced with boom or bust production every year (Figure 1).

There are few options for growers between bloom and reference date to manage cropload for more consistent production. Under tree sprinkler irrigation can decrease daytime orchard temperatures by 1-2^{o}F and so may help growers avoid losses under conditions just above the damage threshold (83-84^{o}F). However, no materials or practices have been proven to avoid crop loss at bloom when higher temperatures (>84^{o}F) or extended wet/cold conditions occur. Shaker thinning at reference date provides inexpensive and effective crop management, but this practice limits production potential in an orchard by disproportionately removing larger fruit, potentially damaging older trees and occurs after 4-6 weeks of fruit development. The earliest possible thinning – bloom thinning – has been shown, in peach, to deliver larger fruit size and total crop at harvest compared to later thinning. The same results should follow in prune. Field research with GA-3 showed some promise in reducing flower number the year after application, but research results are not consistent. This material is also not currently labeled for prunes for this purpose. Flower thinning by hand is not feasible and chemical blossom thinning with caustic materials remains largely untested in prunes. Prune production in California should benefit from cropload management practices that either improve or reduce fruit set at bloom and/or reduce excessive fruit set within 3-4 weeks of full bloom.

<u>Objectives:</u>

- Evaluate materials and practices intended to improve or reduce fruit set depending on the bloom temperature in the orchard to allow consistent production of large, high quality prunes.

PROCEDURES

Spray treatments were applied in a mature (12th leaf), high production (4-5 dry ton/acre, 32% PAR interception) site in south Sutter County – the same orchard used in 2015 and 2016. The orchard

is planted 16' x 20' on M29C rootstock and flood irrigated until the 2016 season, when microjet irrigation was installed. This orchard was not pruned following the 2016 season.

In March, 2017, a randomized complete block design experiment was established. Individual trees were blocked by trunk diameter -- measured at 12" above the soil. All trees in this orchard produced less than half of a crop in 2016, so return bloom was not an issue entering the 2017 season and cropping history was not considered when selecting trees for this study.

Eleven treatments in five blocks, one treatment rep per block, were applied between March 13 and May 12. Both thinning and "sticking" materials were applied. For "Sticking" – improving set – separate treatments of ReTain® (AVG, which inhibits for formation of a precursor of ethylene) were applied at a popcorn (Mar 13) or 25% bloom (Mar 16). Five treatments of a caustic fertilizer -- potassium thiosulfate (KTS) -- were applied at different concentrations (1, 1.5 or 2% v/v) at different timings (25% and 80% bloom or once at 25% or 80% bloom). One treatment of fish oil (2% v/v) and lime sulfur (2.5% v/v) was applied at 80% bloom. A shaker thinning treatment was applied just before reference date (May 2). Finally, a fruitlet thinning spray of 75 ppm ethephon plus 10 ppm NAA was applied on May 12.

Treatments were applied using a gas-powered, backpack sprayer (Stihl® SR420; Stihl USA, Virginia Beach, VA) at a volume equivalent to 200 gallons per acre. The first ReTain® treatment was applied just before sunset (7-8 PM) on March 13. The second ReTain® treatment and the 25% bloom thinning treatments were applied between 6:30 and 10:30 AM on March 13 under clear skies and temperatures in the upper 50's and lower 60's. The 80% bloom thinning sprays were applied between 7:15 and 10:30 AM on March 19. The PGR (ethephon+NAA) thinning spray was applied in the evening of May 12.

Due to a miscommunication with the shaker operator, the entire orchard was shaker thinned on May 5. At least 3,000-4000 fruit were removed with a gentle 5 second shake using no throttle.

Fruit from control trees were at 4 lbs pressure and 22% sugar on August 24, and the trees were harvested on September 2. At commercial harvest, individual tree dry fruit yields were determined by shaking each tree on to a commercial harvester, clearing the belts into large plastic bins held by one or two men and weighing each bin on a scale. Following commercial drying of a four pound subsample, the fresh:dry weight ratio was used to calculate dry fruit yield per tree. Fruit in the subsample were screened using the UC Davis small scale fruit screen to determine fruit size distribution and percent A, B, C, and D screen as well as percent undersized fruit. Treatment differences in dry fruit yield per tree (multiplied by 136 trees per acre to provide yield in tons/acre) and percent screen sizes were tested using Statgraphics Centurion XVII (Statpoint Technologies, Inc., Warrenton, VA) software package using the General Linear Model procedure with mean separation tested by Duncan's MRT method. Where data did not meet requirements for parametric analysis, median values were compared using Mood's Median Test.

Table 1. Treatments and timing applied in 2017.

Treatment	Materials	Treatment timing(s)	1st spray	2nd Spray
1	1% KTS	25 & 80% bloom	16-Mar	19-Mar
2	1.5% KTS	25 & 80% bloom	16-Mar	19-Mar
3	2% KTS	25 & 80% bloom	16-Mar	19-Mar
4	1.5% KTS	25% bloom	16-Mar	X
5	1.5% KTS	80% bloom	X	19-Mar
6	ReTain® early (333 g/a)	popcorn	13-Mar	X
7	ReTain® later (333 g/a)	25% bloom	16-Mar	X
8	Unthinned control	None	X	X
9	Shaker thinned	Shaker thinned	Shaken 5/2	X
10	2% fishoil & 2.5% LS	80% bloom	X	19-Mar
11	75 ppm ethephon + 10 ppm NAA	1 week ARD*	12-May	X

*After Reference Date

RESULTS AND DISCUSSION

Weather during the 2017 prune bloom in the Sacramento Valley was good for prune fruit set – upper 60's to lower 70's (deg F) with rain. Subsequently, the control trees set heavy crops of small fruit, despite being shaker thinned in early May (Table 2).

Dry fruit weight per tree and per acre was correlated with block ($p=0.001$; $r^2=18.4$), with smaller trunk diameter trees generally yielding less dry weight per tree and per acre than larger diameter trees. These data support the use of blocking by trunk diameter in this experiment, although the correlations are not as strong as in 2015, when the crop was similar in size but not shaker thinned.

Dry fruit yield was not significantly affected by any treatment ($p=0.73$). However, caustic materials (1.5%KTS or FO+LS) applied 1x at full bloom significantly increased the yield of A&B sized fruit per acre and reduced dry away ratio (dry fruit weight:fresh fruit weight) compared to untreated control (Table 2 and 3). ReTain® treatments did not significant affect fruit number, large fruit yield/acre or dry away (Tables 2 and 3). Shaker thinning (May 2), early KTS (1.5% at 25% bloom), or ethephon+NAA did not significantly influence cropload (Tables 2 and 3). Applications of KTS at 25 and 80% bloom significantly reduced dry away ratio compared to untreated control (Table 3), but did not produce significantly more large (A's and B's) fruit (Table 2).

CONCLUSIONS

In this, the first year of comparison of timings, materials and rates with good bloom weather, better results were obtained with a single full bloom application (80%) compared to one early treatment, which produced no apparent impact, or two sprays (25 and 80% bloom) where variable results produced inconclusive comparison with untreated control (Tables 2 and 3, Figures 2 and 3) due, perhaps, to over thinning and under thinning in different replicates.

More consistent results with 2x KTS at bloom were obtained in 2015, when 1) sprays were applied in the evening compared to the morning sprays in 2017, possibly slowing drying time of sprays on the target flowers and 2) flood irrigation may have reduced the fruiting size potential of the heavily cropped control trees.

ReTain®, shaker thinning and ethephon+NAA a week after reference date did not significantly influence yield, fruit per tree or fruit size compared to control in this year of study. No gumming was observed on the treated trees.

Finally, since all trees were accidently shaker thinned in early May and bloom thinned treatments with fewer fruit at harvest (Table 2) very probably had fewer, larger fruit at reference date when shaker thinning occurred, the bloom thinned treatments may have lost more large fruit at shaker thinning compared to other treatments.

These treatments will be repeated in 2018, with the ethephon/NAA treatment moved closer to bloom.

Figure 1. Average fruit set (± 1 standard error) in selected Tehama and Sutter/Yuba county prune orchards (n=4) from 2009-2017.

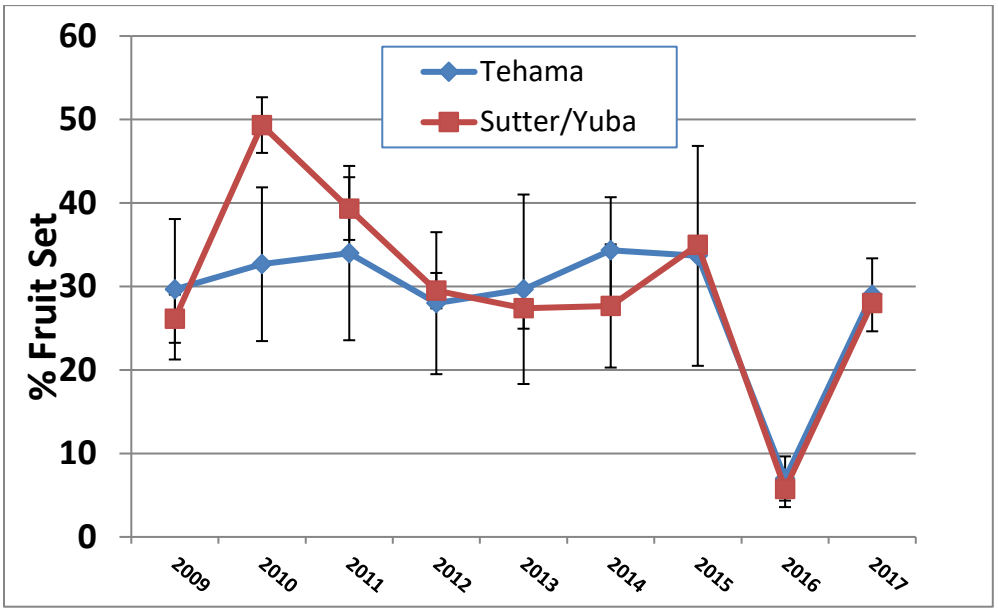

Table 2. Median dry fruit yield/acre, mean fruit count per tree, and mean yield of A&B sized dry fruit yield/acre by treatment. 2017. Values in columns followed by the same letter are not statistically different with 95% confidence using 1) Mood's Median Test or 2) Duncan's RMT.

Treatment (with spray timing)	Dry fruit (tons/acre)[1]	Fruit/tree[2]	A&B screen fruit (tons/acre)[2]
Lime Sulfur + Fish Oil (80% bloom)	4.33 a	4924 a	3.25 a
1.5% KTS (80% bloom)	4.62 a	6229 abcd	2.91 ab
2% KTS (25 & 80% bloom)	4.28 a	5174 ab	2.80 abc
1% KTS (25 & 80% bloom)	4.54 a	6043 abc	2.71 abcd
1.5% KTS (25 & 80% bloom)	4.49 a	6221 abcd	2.23 abcd
ReTain® (25% bloom)	5.42 a	8192 abcd	2.01 abcd
Shaker thinned (May 2)	5.44 a	8800 bcd	1.43 bcd
Ethephon+NAA (May 12)	5.65 a	10128 d	1.28 bcd
1.5% KTS (25% bloom)	5.73 a	9638 cd	1.26 bcd
Untreated control	5.40 a	9334 cd	0.99 cd
ReTain® (popcorn)	5.58 a	9286 cd	0.95 d

Table 3. Mean dry away ratio (weight dry fruit/weight fresh fruit) by treatment. 2017. Values in columns followed by the same letter are not statistically different with 95% confidence using the Duncan's RMT method of means separation.

Treatment (with spray timing)	Dry away ratio
Lime Sulfur + Fish Oil (80% bloom)	2.52 a
2% KTS (25 & 80% bloom)	2.59 a
1% KTS (25 & 80% bloom)	2.65 a
1.5% KTS (25 & 80% bloom)	2.64 a
1.5% KTS (80% bloom)	2.67 ab
ReTain® (25% bloom)	2.72 ab
ReTain® (popcorn)	2.74 abc
Shaker thinned (May 2)	2.75 abc
1.5% KTS (25% bloom)	2.86 bc
Untreated control	2.87 bc
Ethephon+NAA (May 12)	2.94 c

Figure 2. Dry fruit yield per acre for each replicate per treatment (n=5) except for ReTain® at popcorn bloom stage (n=4). 2017.

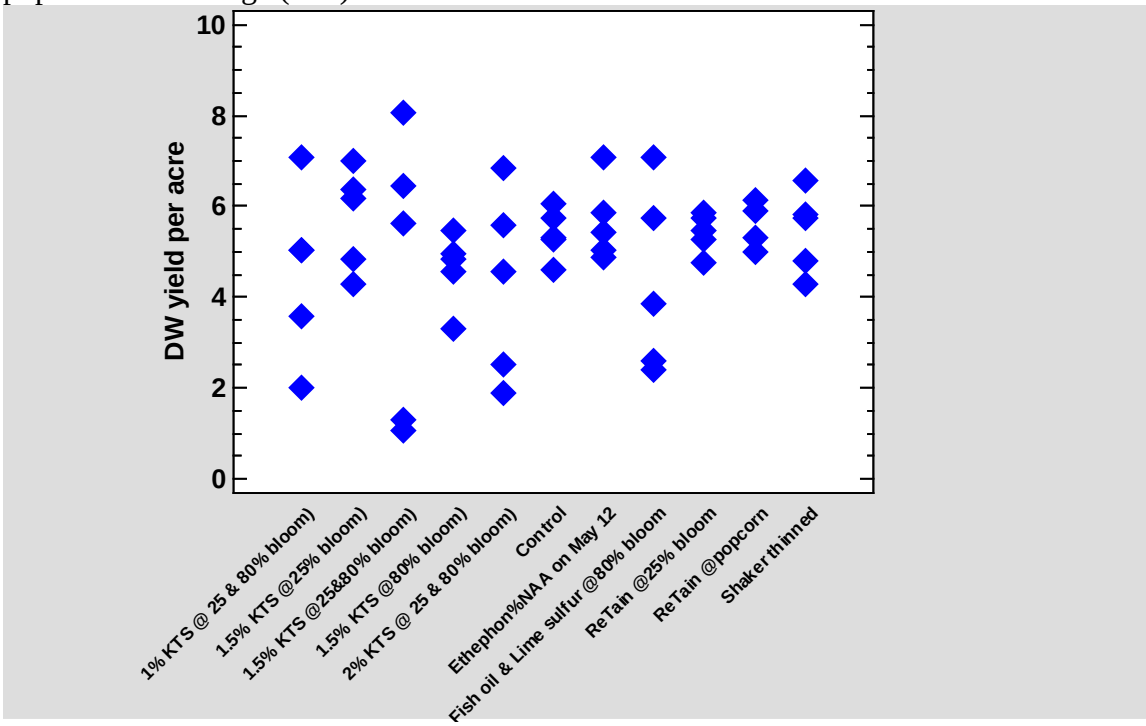

Figure 3. A and B sized dry fruit per acre yield for each replicate per treatment (n=5) except for ReTain® at popcorn bloom stage (n=4). 2017.