Investigation of Pruning Strategies for Prunes Including Hand, Mechanical and Combinations

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Introduction:

Prune trees are pruned to thin fruitwood, improve fruit size, reduce alternate bearing and control tree size and shape. Hand pruning with ladders and loppers has long been thought to be the best alternative for pruning because of the selective nature of the pruning which can not be matched by mechanical pruning. Previous studies of mechanical pruning have shown the limitations of mechanical pruning. In a study conducted in Glenn County during the 1990's, pruning severely enough mechanically to achieve equal fruit size and value per ton compared to hand pruning resulted in reduced yield that was not completely compensated for by increased fruit value. New developments in mechanical pruning equipment have made different types of mechanical pruning possible. Because of the cost and availability of labor, growers have been continued to look for strategies to reduce pruning costs while maintaining yield and quality. These have included held pneumatic pruners, and different types and timings of mechanical pruning and combinations of different pruning strategies.

Objectives:

The objectives of this study were to compare different pruning strategies including hand and mechanical at different times and in various combinations to see if these strategies can be incorporated into prune production with out reducing returns to a greater extent than the potential cost savings. We realize that the results will be affected by growing conditions during the season and that what is the best treatment one year may not be the best in a different year. Our plan was to initially select a pruning strategy and then use the available tools such as mechanical thinning to optimize that treatment.

Methods:

During the winter of 2005-2006 a mature highly productive block of French Prunes was selected. The block was a north-south planting with a spacing of 14 X 17 ft. or 183 trees per acre. In the winter, 2006, prior to the beginning of the trial the trees were 17-18 ft. tall. A total of 9 different pruning strategies were selected and applied in a randomized complete block design with 3 replicates. Each replicate consisted of an entire row of 33 trees. The plots were harvested and green weights were determined using a load cell attached to the forks of the receiver. Two samples (approximately 100 fruit each) were collected from each plot. Sample weights were obtained before and after commercial drying (courtesy of Sunsweet Dryers, Hamilton City). And drying ratio, dry count per pound and dry yield per acre was determined.

Treatments in 2007 were adjusted from 2006 based results and observations from 2006 and are described below. Two treatments, 3. "Ladders and loppers" and 9. "Mowhawk"

were the same as 2006. All of the treatments were pruned by polesaws from the ground to thin the upper tree canopy. Reference date was estimated to be 5/2/07. All of the treatments were mechanically thinned to about 6000 fruit per tree between 4/27 and 5/7. All of the treatments were thinned as needed by striking clusters with PVC poles on 6/4 and again on 7/12. On 7/19 a small alley way of 1 to 2 ft. wide was cut between all of the rows by orienting the star cutting bar vertically and then angling the head slightly so that one side of the row was cut as the circular saws on the star moved down and the other side of the row middle was cut as they moved up.

Treatments for 2007:

1. Dormant lopper work from the ground to remove hangers.
2. Dormant pole saw work on tops, skirt 4/23, roof top 6/2, 15'center, 12' on outside.
3. Dormant hand pruning- Ladders and loppers.
4. Dormant lopper and chainsaw thinning, skirt 4/23, V cut 6/2, 14'at bottom, 17' outside.,.
5. Dormant polesaw, skirt 4/23, roof top post harvest 9/17, 12' at bottom 15' at top.
6. Dormant polesaw, Three to four cuts from ground with loppers 4/23, post harvest 9/17 topped at 15' .
7. Dormant polesaw, skirt 4/23, post harvest V cut, 14' in middle 17' on outside 9/17.
8. Dormant polesaw, skirt 4/23, V cut 6/2, 14' middle, 17' outside..
9. Dormant polesaw (leave center), skirt 6/23, mowhawk 6/2 (V notches in the shoulder of the canopy on both sides.).

Specific leaf weight (leaf weight per leaf area) is highly correlated with light interception in prunes. To test if our pruning treatments produced differences in light exposure in different parts of the canopy, leaves were sampled and processed to evaluate specific leaf weight (SLW) and direct light measurements were taken on August 14, 2007.

Twenty leaves were sampled from each of three locations in the canopies of four replicate trees from each of three treatments: 1) Treatment 3: dormant ladders and lopers pruning, 2) Treatment 7: Minimal dormant thinning cuts (3-4/tree), and 3) Treatment 8: Dormant thinning cuts with pole saws and summer (June 2) V-pruning. Sampling locations were 1) Exposed leaves high (10-14' off the orchard floor)in the canopy, 2) mid-level in the canopy at 7'-9', and 3) heavily shaded leaves at 5'-7' off the orchard floor. The locations 1 and 3 were expected to be significantly different, but location 3 was included to test whether pruning differences influenced light interception by leaves in the mid-canopy area.

Leaves were placed in paper bags and transported to the lab on ice. Total leaf area for each sample was determined using a leaf area meter (LI-3000, LICOR BioSciences, Lincoln, NE), and total leaf dry weight was determined following oven drying of the leaves at 55^{o}C. Specfic leaf weights were calculated, and data statistically analyzed using GLM in Statgraphics XV (Statpoint, Inc., ; Herndon, VA.).

Canopy light interception under the same treatments was also evaluated by measuring light levels present below the canopy at a height of approximately 3.5' above the orchard floor using a device (AccuPAR LP-80, Decagon Devices, Pullman, WA). These samples

were also taken on August 14, 2007, between 12:30 and 13:30 hours. For each recorded measurement, sixteen measurements were taken at equal intervals along either side of the tree row under two trees – eight measurements each under each tree with the pointer of the device even with the outside of the trunk. All eight measurements were averaged to provide a recorded measure for each side (east or west) under the tree. All 32 measurements per sampling site were averaged to provide a single value. Data were power (0.532) transformed to create a normally distributed data set and then statistically analyzed using GLM in Statgraphics XV (Statpoint, Inc., ; Herndon, VA.). . Non-transformed results are presented.

Results:

Crop Yield: Crop set in 2007 was much heavier than 2006 and mechanical thinning was necessary in all of the treatments. Yields were very good for all of the treatments with reasonable fruit size and drying ratios (Table 1). No significant differences were seen between any of the treatments for drying ratio or dry count/lb. Treatments 5 and 7 , post harvest roof topped and V cut significantly out yielded treatments 3,8 and 1, ladders and loppers, summer V and dormant lopper pruning from the ground. The hand pruning treatment was the lowest yielding treatment in 2006, but in 2007 it's yield fell in the middle grouping of treatments.

Specific Leaf Weight: Although SLW was significantly affected by sampling location in the canopy (Figure 1), pruning treatment did not significantly ($p=0.47$) affect SLW (data not presented).

Light Interception by the canopy: Pruning treatments significantly ($p<0.05$) affected canopy light interception. Untopped (tall) trees with only a few dormant thinning cuts (Treatment 7) intercepting more light in August than summer V-cut trees with similar dormant thinning cuts (Treatment 8) . Canopy light interception under traditional ladder and loper pruned trees was not statistically different from either of the other treatments sampled for light interception on August 14 (Figure 2.)

Discussion:

Our intent has been to start with specific pruning strategies and then manage them using the available tools to maintain adequate light penetration with in the tree canopy to achieve high yields of high quality fruit while maintaining healthy fruit wood. The heavy crop in 2007 required several interventions after the initial pruning treatment was selected to achieve this goal and prevent tree damage from excessive crop load. These included mechanical thinning, selected limb thinning,mechanically skirting the trees in April at about 2ft near the trunk to about 7 ft height on the outside of the canopy, mechanically pruning a narrow alley way to keep the fruit laden limbs from coming down and propping heavy limbs near harvest to reduce limb breakage.

Observations from last year's treatments indicated that trees mechanically pruned during the dormant season had extremely vigorous growth which regrew everything that was removed and then some by the end of the growing season. Observations of summer

mechanically pruned treatments indicated much less regrowth. With summer pruning there is the concern that some of the current years crop is removed. Other researchers have reported less vigorous regrowth from post harvest topping than dormant season topping. In 2007 we discontinued dormant mechanical pruning and shifted our emphasis to summer and post harvest mechanical treatments. In 2007 the two highest yielding treatments were treatments that were scheduled for post harvest mechanical pruning so they were not mechanically pruned prior to the 2007 harvest.

In 2006 the hand pruned treatment had the lowest production and value of any of the treatments. This was due to a moderate crop in all of the treatments so that the pruning reduced cropping with out improving fruit size or crop value. In 2006 the hand pruning treatment which is a more detailed selective type of pruning appeared to have larger more deep green leaves. However fruit size and drying ratio was no better than any of the other treatments. The yield for the hand pruned treatment fell in the middle grouping for yield.

The estimated cost for the hand pruning was $3.25/tree or $594/acre with overhead included. The dormant polesaw pruning is estimated to cost about $200/ acre. The mechanical pruning is estimated to cost about $40/acre. So, the mechanical plus dormant pole saw pruning would cost about $240/acre.

Through the two years of the study, the mechanically pruned treatments combined with ground pruning strategies (pneumatic pole pruners or pole saws) have maintained yield and fruit quality equal to or better than the more expensive hand pruned treatments. To date it would appear that these strategies can be used along with best management practices to reduce pruning costs while maintaining yield and fruit quality.

In 2008 we will continue with different mechanically pruned treatments combined with ground pruning. We will continue to compare this to the standard hand pruned treatment. The post harvest mechanical pruning treatments were applied for the first time in September of 2007. We will be collecting data from these pruning treatments for the first time in 2008.

We will continue light measurements, with a particular focus on canopy light interception as it is correlated with crop yield.

Table1. Pruning Trial Results 2007

2007 Treatment (preharvest)	Drying Ratio	Dry Ct/lb	Dry T/Ac	
5. Dormant pole saw; Skirt 4/23	3.13	67.41	8.18	A
7. Dormant pole saw; Skirt 4/23	3.11	72.30	8.09	A
9. Dormant pole saw; Skirt 4/23; Mohawk 6/2	3.12	70.35	7.98	AB
4. Dormant pole saw; Skirt 4/23; V cut 6/2	3.10	67.51	7.97	ABC
6. Dormant pole saw; 3-4 lopper cuts from ground 4/23,	3.19	74.63	7.96	ABC
2. Dormant pole saw; 4/23 skirt, roof top, 6/2	3.28	72.14	7.67	ABCD
3. Ladder and loppers, dormant	3.25	69.34	6.97	BCD
8. Dormant pole saw; Skirt 4/23, V cut 6/2	3.24	71.94	6.94	CD
1. Dormant pole saw w/ dormant lopper work from ground	3.21	70.24	6.76	CD
	NS	NS		

Numbers followed by different letters are significantly different at the 5% level using Fischer's test.

Figure 1. Mean (n=13) specific leaf weight (mg/cm^2) at three sample locations within 'French' prune canopies, immediately preharvest (August 14, 2007). "High" samples were taken from exposed leaves 10'-14' above the ground. "Medium" samples were taken from 7'-9' above the orchard floor from the interior of the canopy. "Low" samples were taken from shaded sites at 5'-7' above the orchard floor. Different letters indicate significant differences ($p<0.05$) between means determined using Bonferroni mean separation test.

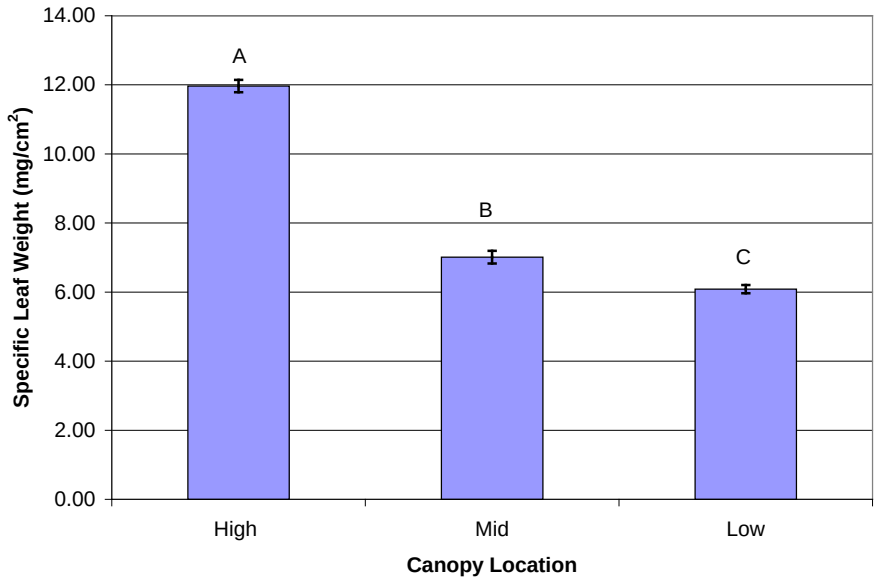

Figure 2. Mean (n=12) mid-day (12:30-13:30) light levels (µE m^{-2} s^{-1}) beneath the canopies of three different pruning treatments: 1) traditional dormant "ladder and lopers" pruning and dormant pole saw thinned pruning with either 2) no topping or 3) summer V-cut. Bars with the same letters are not significantly different ($p<0.05$) following Bonferroni mean separation test.