Tree Height and Volume Studies For Fresh-Shipping Stone Fruits

1999 CTFA Research Report

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INTRODUCTION

Reducing overall production costs while maintaining fruit quality and yield is essential in today's tree fruit market. Dwarfing and semi-dwarfing rootstocks are one way to accomplish this. However, few if any commercially acceptable dwarfing rootstock are available for peaches and nectarines. Physically reducing tree height is another method. Shorter trees are generally less expensive to prune, thin, and harvest, but in general are considered to be less productive.

Previous research by the project leaders has shown that fruit yield and size is directly related to total crop load (expressed as number of fruit per acre), and not tree density, providing that orchard light interception is the same. In these studies, tree height was also investigated, and taller trees found to be more productive. However, because of similarities in tree architecture and branch angle, there were differences in light interception that favored the taller trees.

A better method would be to evaluate trees of differing heights, but within orchard systems with similar tree volume and light interception characteristics. This can be performed by moving the rows closer together. Another method would be to alter tree scaffold angle, in conjunction with varying tree height. This method would yield trees of different height, but similar overall volume, and would provide a basis for a better understanding of how tree structure, light environment, and fruit quality interrelate.

In order to investigate these relationships an experiment was begun at the Kearney Agricultural Center in 1998. The primary purposes of this study are to determine the effects of:

1. Tree height and volume on fruit yield and quality
2. Orchard light interception on fruit yield and quality
3. Tree height on labor costs

METHODS

A block of young, grafted, Summer Bright nectarines located at the Kearney Agricultural Center is being used in this study. Within the orchard there are two training systems: 1) Kearney Perpendicular V at 6'x18' (403 trees per acre), and 2) Quad V at 9'x18' (269 trees per acre).

The following treatments were imposed on these young trees in 1998 and were replicated six times in each tree training system:

1. **Standard sized trees**: These trees are being grown to an industry standard height of 12-13 feet. Branch angle is that typical of the species/variety and is approximately 65 degrees from horizontal. Total tree planar volume at maturity is estimated to be about 70 square feet. Current tree height is about 12 to 13 feet on average.

2. **Limited sized trees**: These trees are being limited to a height of 8-9 feet. Branch angle has been artificially established by tying scaffolds to an angle of about 50 degrees from horizontal. Total tree planar volume at maturity is estimated to be about 65 square feet. Current tree height is about 8 to 9 feet on average.

RESULTS

A primary focus in 1999 was on further establishing the treatments, i.e. scaffold number, angle, and height. In the case of the standard sized trees this was performed exclusively by dormant pruning. These trees are now about 12 to 13 feet tall and have branch angles typical of the common orchard in the southern San Joaquin Valley.

In the limited sized trees treatments were established by a combination of dormant pruning, limb tying (with the use of hop clips), and summer pruning. These additional manipulations cost about $350 to $400 per acre. These trees are now about 8 to 9 feet tall and have branch angles of about 45 degrees.

Yield

1999 was the first year in which yields were taken. All four systems had yields that were statistically similar with respect to the tree height between tree density comparison, (tables 1 and 2). The standard size Quad-V treatment had the greatest yield, but this was primarily a function of fruit number per tree. Note too that this treatment also had the smallest sized fruit and that is was 10% smaller than the fruit on the treatment with the

largest size – the Limited Size KAC-V. It appears at this point that all four systems were comparable in their ability to produce and carry a crop.

Table 1. Yield summary of Summer Bright Nectarine pruned and trained to different conformations.

Pruning Treatment	**Yield** (tons per acre)	**Fruit Weight *** (grams per fruit)	**Fruit Count** (fruit per tree)	**Fruit Count** (fruit per acr
Limited Size KAC-V	14.22	137[a]	235	94,700
Standard Size KAC-V	15.35	131[ab]	264	106,400
Limited Size Quad-V	14.57	133[ab]	370	99,500
Standard Size Quad-v	15.93	124[b]	434	116,750

*Numbers followed by different letters are significantly different.

Table 2. Per acre yield of Summer Bright Nectarine Trees pruned and trained to different conformations. Based on 25-lb volume fill cartons with 15% cullage.

Pruning Treatment	**1st harvest**	**2nd Harvest**	**Total ***
Limited Size KAC-V	633	356	989[a]
Standard Size KAC-V	547	521	1068[ab]
Limited Size Quad-V	585	428	1013[ab]
Standard Size Quad-V	650	458	1108[b]

*Numbers followed by different letters are significantly different.

Cost of Hand Labor Operations

Pruning

By the end of 1998 treatment effects were beginning to be discernable. In the limited size trees all pruning is performed from the ground without ladders. Ten-foot ladders are used in the standard size portion of the block. At pruning, the trees are pruned so that there is a similar number of fruit bearing shoots (expressed on a per acre basis) on the short and tall trees. This is done to try to equalize crop potential between the treatments.

The December 1999 dormant pruning costs were significantly cheaper for the limited size trees than the standard sized trees as a consequence (table 3). There was no significant difference in pruning costs for trees of the same height but different densities, i.e. KAC-V vs. Quad-V. Limited size trees had greater pruning weights than standard sized trees since more wood was removed when limiting tree height. As the trees mature these relationships may change as treatment effects on tree height become more apparent.

Table 3. The effect of tree training system on dormant pruning of Summer Bright nectarine.

	Limited Size KAC-V	**Standard Size KAC-V**	**Limited Size Quad-V**	**Standard Size QUAD-V**
Pruning Time (Minutes/tree)	2.20	3.13	3.155	4.45
Pruning time (Hour/acre)	12.96	21.02	14.14	19.9
Pruning Cost ($/acre) *	$99.79 [a]	$161.85 [b]	$108.88 [a]	$153.23 [b]
Pruning Weight (Pounds/acre)	3964	3285	3432	2297

*Numbers followed by different letters are significantly different.

Thinning

On the limited size trees most of the thinning was done from the ground without ladders, occasionally, trees were thinned using a short 6-8 foot ladder. The standard size trees were hand thinned using 10-foot ladders.

Thinning costs and times are presented in Table 4. For trees of this age, these costs were too great. This is because the trees set much more heavily than anticipated. Also, fruit set on the limited size trees was much greater than on the standard size trees. This is

because the scaffolds on these trees are flatter, and consequently the fruit bearing shoots flower much more profusely. In 2000 this response will be more closely monitored.

There were no significant differences in thinning costs between treatments unless expressed as a function of yield ($/box.), in which case the standard sized KAC-V was the most expensive to thin.

Table 4. The effect of tree training system on thinning for Summer Bright nectarine.

	Limited Size KAC-V	**Standard Size KAC-V**	**Limited Size Quad-V**	**Standard Size QUAD-V**
Thinning Time (Minutes/tree)	7.3	8.2	11.2	10.8
Thinning Time (Hours/acre)	49.0	54.8	50.0	48.3
Thinning Cost ($/acre)	$377.54	$422.00	$384.99	$371.83
Thinning Cost* ($/box)	$0.60 [a]	$0.77 [b]	$0.66 [a b]	$0.57 [a]

*Numbers followed by different letters are significantly different.

Harvest Costs

Harvest costs were only calculated on the first of the two picks. Those results are presented in table 5. Harvest cost were significantly different and were lowest on the limited sized KAC-V trees. In 2000 these relationships will be further investigated.

Table 5. The effect of tree training system on harvest costs for Summer Bright nectarine.

	Limited Size KAC-V	**Standard Size KAC-V**	**Limited Size Quad-V**	**Standard Size QUAD-V**
Harvest Time (Minutes/tree)	4.4	6.2	8.3	10.3
Harvest Time (Hours/acre)	29.6	41.6	56.0	69.4
Harvest Cost* ($/acre)	$228.00 [a]	$320.08 [b]	$430.86 [c]	$534.53 [d]
Harvest Cost* ($/box)	$0.36 [a]	$0.58 [b]	$0.74 [c]	$0.82 [c]

*Numbers followed by different letters are significantly different.

Cost Summary

The major hand labor costs for each of the treatments is summarized in table 6. In 1999 an actual harvest labor cost was made for the first pick, but not the second. This figure was used as a basis to estimate the costs of the second harvest as well. While not an absolute figure, this method can be used as an approximation since roughly the same percentage of fruit was harvested from each treatment on each date. That said, the limited size KAC-V trees had the greatest labor efficiency during the 1999 season.

Table 6. The effect of tree training system on labor costs for Summer Bright nectarine.

	Limited Size KAC-V	**Standard Size KAC-V**	**Limited Size Quad-V**	**Standard Size QUAD-V**
Dormant Pruning ($/acre)	$99.79	$161.85	$108.88	$153.23
Thinning ($/acre)	$377.54	$422.00	$384.99	$371.83
Estimated Harvest Cost ($/acre)	$356.02	$619.30	$749.75	$908.77
Total Cost ($/acre)	$833.35	$1203.15	$1243.62	$1433.83
Total Yield (boxes/acre)	989	1068	1013	1108
Total Hand Labor Cost ($/box)	$0.84	$1.13	$1.23	$1.29

Conclusion

This is only the first year of what is anticipated to be a three-year trial, and as such it is too soon to reliably determine whether the limited height system will be viable on a whole orchard standpoint. These data do suggest that significant labor savings are possible with limited height trees. A key to overall acceptability will be to determine if trees of limited height but similar volume will be as productive as standard sized trees from a long-term perspective.

Project Abstract

The relationship between tree conformation and height, yield productivity, and labor costs are being investigated in this study. There are two tree heights, 8 to 9 feet tall and 12 to 13 feet tall; and two tree-training systems, two leader Kearney V trees at 6'x18' and four leader Quad-V trees at 9'x18'. The scaffolds of the short trees are tied to a flatter more horizontal orientation than normal (about 50 degrees), while the scaffold angles on the tall trees are allowed to develop naturally.

The trees first cropped in 1999. There were no significant yield differences between treatments. In general, hand labor operations were more inexpensive on the shorter trees. Total per box cost of production (with respect to pruning, thinning and harvest costs only) was significantly lower on short, limited-size two-leader KAC-V trees.