TREE HEIGHT AND VOLUME STUDIES FOR FRESH-SHIPPING STONE FRUITS

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ABSTRACT

The main goal of this trial has been the study of tree height and volume on fruit yield, quality and labor cost. We compared 12-13 feet tall Summer Bright nectarine trees to trees limited to a height of 8 feet. Trees of each height were planted as 2-leader or 4-leader trees at 6' x 18' and 9' x 18' respectively. In 2002 trees were thinned to differential crop loads. Regression analysis and mathematical correction of crop load indicated that short trees had at least as great a yield and size potential as that of tall trees. Labor costs were not studied in 2002 due to the differential thinning treatments, but in past years labor was reduced in the short trees by as much as 30% depending on the operation.

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 was 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 AND DISCUSSION

Orchard Establishment

In 1999 the primary focus was on 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/density comparison, (data not

presented). The standard size Quad-V treatment had the greatest yield, but this was primarily a function of fruit number per tree. It appeared at that point that all four systems were comparable in their ability to produce and carry a crop.

In the 2000 and 2001 seasons, the two leader Kearney V trees had the greatest yields, and tall trees yielded more than short trees. Both of the shorter systems had reduced yields, but average fruit size was greater than that of tall trees.

The difficultly in this was in determining if these yield differences were the result of a system effect or merely a crop load effect. To address that issue with greater precision, we differentially thinned the trees in 2002 (light, standard, and heavy crop loads) so that we could better compare yield and fruit size potential between the height/system treatments. Those results are presented in figures 1 and 2 for 2-Leader and 4-Leader trees respectively.

Figure 1. The relationship between fruit size and crop load for Limited Height (red) vs Standard Height (blue) trees pruned to a 2-leader conformation.

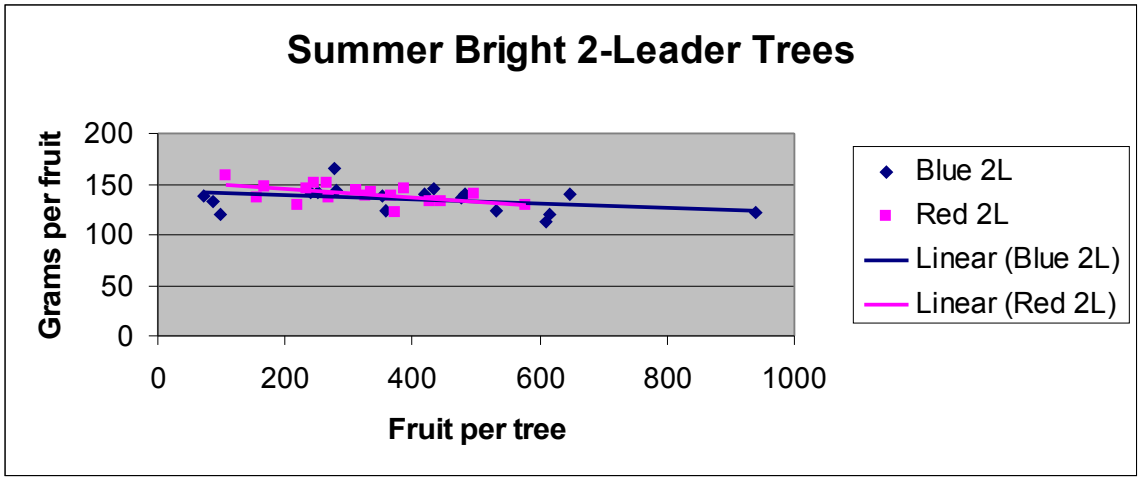
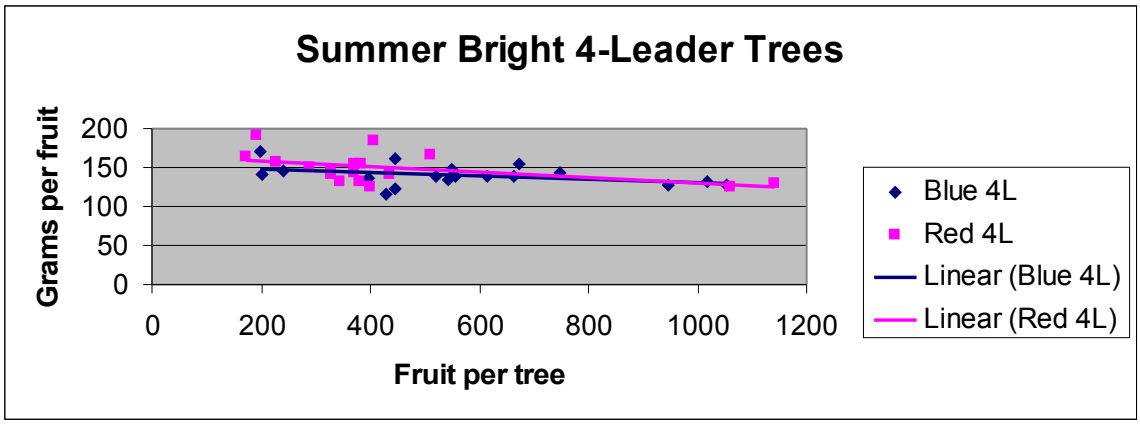


Figure 2. The relationship between fruit size and crop load for Limited Height (red) vs Standard Height (blue) trees pruned to a 4-leader conformation.



In general, there were few if any differences in yield or fruit size potential between the two systems. Presumably this is a consequence of the similar light interception characteristics of these systems.

COST OF HAND LABOR OPERATIONS

Pruning and thinning costs

We were unable to study the hand-labor cost components of short vs. tall trees in 2002 because we instead chose to investigate differential thinning treatments. However, because of the interest in this subject the following comments are presented:

In the limited size trees all pruning has been 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 January 2001 dormant pruning costs were about 15% less expensive for the limited size trees than the standard sized trees (table 1). This is not as dramatic a difference as we have seen in the past, and was somewhat unexpected. In 1999 limited size trees had greater pruning weights than standard sized trees since more wood was removed when limiting tree height. However, in 2001 the pruning weights were similar for both short and tall trees. This tends to confirm that it is possible to contain the vigor of short trees by pruning and careful management of tree nutrition.

Fruit thinning costs were significantly reduced (37.5%) in the short trees (table 2). Combined labor savings are presented in table 3, indicating that the overall labor reduction for short trees was 27.4 % for these two hand operations. It was not possible to calculate labor costs at harvest, although observations indicate that a labor savings figure of 20 to 30% for short trees is at least likely.

Table 1. 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)	2.97	3.53	4.39	5.29
Pruning time (Hour/acre)	19.9	22.5	19.7	23.7
Pruning Cost @$6.75/hr + 33% fees ($/acre)	$178.70	$202.05	$176.91	$212.83
Pruning Weight (Pounds/acre)	3103	3023	2367	2313

Table 2. The effect of tree training system on fruit thinning times and costs of Summer Bright nectarine.

	Limited Size KAC-V	**Standard Size KAC-V**	**Limited Size Quad-V**	**Standard Size QUAD-V**
Thinning Time (Minutes/tree)	2.52	4.60	4.63	6.55
Thinning Time (Hour/acre)	16.93	30.90	20.75	29.36
Thinning Cost @$6.75/hr + 33% fees ($/acre)	$152.00	$277.48	$186.33	$263.67

Table 3. Combined cost averages for short and tall Summer Bright trees.

	Tall Trees	Short Trees	% Difference from tall to short
Dormant Pruning	$207.44	$177.81	-14.3
Fruit Thinning	$270.58	$169.17	-37.5
Total	$478.02	$346.98	-27.4

CONCLUSIONS/COMMENTS

After four years of yield study it is still difficult to reliably determine whether the limited height system will be viable on a whole orchard/industry standpoint – or whether some sort of intermediate tree height and/or dwarfing rootstock will be more suitable. However, we can confidently state the following:

- Light interception potential of the four systems is similar. This demonstrates that it is possible to design orchard systems in which short trees can intercept light as efficiently as tall trees.
- Vigor management of short trees is possible as short trees begin to mature and settle down. This is demonstrated by the similar dormant pruning weights between systems. A key to this is to not over-fertilize trees. Additionally, we have not been working with an overly vigorous variety.
- Significant labor savings are possible with limited height trees. It seems likely that a 25 to 35% reduction in labor is possible when ladders are eliminated from an orchard operation.
- Yield/fruit size potential remains the biggest question. Despite the fact that we have had impressive results with limited height trees, this flies in the face of many years of experience and conventional wisdom. However, given similar light interception characteristics, tree vigor, and crop load it is reasonable to assume that yields should be similar as well. Additional research to explore the role of these factors in other locations and with different varieties is necessary.