Optimizing Peach Yields Through Training Systems[1]

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Currently the primary orchard system used in the southeast is trees trained to the open center and spaced 20' x 20', giving a tree density of 109 trees to the acre. Fruit are picked from the ground and the typical mid-season variety produces ca. 400 bu/acre at maturity. In the past, this level of production was sufficient for well managed operations to be profitable. But with the increased cost of new orchard chemistries and labor, increased fruit production per acre is critical to the success of peach fruit production. An intuitive method to increase production per acre is to increase the number of tree scaffolds per acre and extend the length of the scaffolds. The objective of this trial is to assess the efficiency of high-density orchard systems relative to conventional low-density plantings. Yield and quality assessments along with a cost analysis were conducted.

Three training systems and densities were chosen based upon their past or future potential for peach production in the southeast U.S. For each training system, the in-row spacing is different, however, the between-row spacing is constant at 18'. The purpose of maintaining constant between-row spacing is to allow commercial orchard equipment to pass through the orchard. The conventional 'open center' training system was spaced at 18' x18' with 134 trees/acre), one quarter more dense than our industry standard. The 'four scaffold vase' or 'quad V', developed in California has trees spaced 9' x 18' with 269 tree/acre. Finally, the 'perpendicular V' is a two scaffold vase tree developed by DeJong et al (1994) and trees are spaced 6' x 18' for 403 trees/acre. In both V-systems crotch angles were about 50-60 degrees.

All trees were budded in 1998 and planted at the Byron station in January of 1999 with a randomized complete block split-plot experimental design. The main plot was the training system (one of three noted above) and the split plot was the rootstock. Each experimental plot consisted of 30 trees - half on 'Lovell' rootstock and half on 'Guardian™'. Each plot was three rows wide by five trees long. There were three data trees for each rootstock per plot and they occurred in the center row. Each data tree has a guard tree on either side in the adjacent row that was the same treatment. There were a total of 360 trees in the experimental orchard. Trees were fertilized and sprayed according to the Southeastern Regional Peach Production Guide. Drip irrigation was used during the first two years of orchard growth. Microsprinkler irrigation was added fall 2000. Sod middles were established fall 1999 with weed management by a combination of Poast Plus, Fusilade, Surflan, simizine and Round-up (after careful sucker removal) treatments interspersed with tillage (during the first summer). The herbicide and tilled strip was maintained weed free down the orchard row and straw mulch was added after suckering in July 1999 and again in June 2000. The straw mulch suppressed weeds and reduced the affect of the summer drought, appearing to optimize our drip irrigation system. But we may have increased borer infestation by this method. Drip irrigation and careful weed suppression clearly improved

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the growth of the system trial trees compared to other trees planted at the same time at this station.

Trees were trained to the perpendicular V, Quad-V or open center system in the spring of 2000. At the same time all fruit was removed from the trees. The open center trees had reached a height of 9-11 feet by the time of bearing in the third leaf and the quad-V and perpendicular-V trees grew to a height of 12-14 feet. Trunk circumference data was collected during the

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winters of 1999 – 2002. Changes in trunk size reported as trunk cross sectional area (Table 1) since initial planting show that tree girth increased most with the open center training system, with the quad-V and perpendicular-V trees following in size. Possibly a look at total trunk cross-sectional area per acre for each system is more telling. The perpendicular-V and Quad-V systems provided 44% and 37.5% more trunk cross-sectional area per acre than the open center system.

Table 1. Growth measured as t**runk cross-sectional area/tree** diameter since planting in January 1999.

Treatments	**Trunk Cross-sectional Area/Tree (cm^2)/ 4 yrs**	**Total Trunk Cross-sectional Area/Acre (cm^2)**
Perpendicular-V		
Redglobe/Guardian	50.51 b48.66 b	20355.5 a
Redglobe/Lovell		19609.9 a
Open Center		
Redglobe/Guardian	120.9 a 90.1 a	16213.7 b
Redglobe/Lovell		12073.4 b
Quad-V		
Redglobe/Guardian	69.7 b 71.6 b	18749.3 a
Redglobe/Lovell		19260.4 a

The first two harvests were made in 2001 and 2002. Fruit yield results suggest that production was highest with the two V systems (Table 2). If one simply looks at the yield per tree, production of open center and quad-V training systems would appear to give greater yield, but if tree density is accounted for, the perpendicular-V and quad-V systems produced 126% and 95% more fruit, respectively, in the first year and 39% and 65% more fruit, respectively, than the open center system. A look at the yield efficiency data (Table 3) for the three systems demonstrated in the first year of production, that the open center trees did not produce fruit as efficiently as the two V-systems. In the second year of production, the three systems generally produce fruit at similar efficiency. However, the V-systems are numerically somewhat more efficient in that second year of production. Although the production efficiency gap is narrowing in fourth leaf trees, we might expect that in the third production year (fifth leaf tree) the production efficiencies will still be separated. As the trees age, this efficiency will first become equivalent and finally that of the open center trees will surpass that of the V-systems. At that time decisions about orchard management will need to be made. Work in California suggests that this may occur in the 6th leaf. With cloudier skies and shorter growing seasons of the east, we might anticipate that this will occur somewhat later in this climate.

Peel color (Table 4), harvest date, size, firmness and soluble solids (Table 5) were not altered by the orchard system. The fruit were picked at commercial maturity, with background color breaking from green to yellow (Clemson color chip no. 4.6-4.9). Generally the peel had about a 62-75% overblush. Not significantly different was the one-day delaying effect of the more upright, vigorous V-systems, with a mean harvest date of June 30 and July 1 for open center trained trees and V-systems trees, respectively. The fruit were generally 2.5" in diameter and very firm at ~7 kg. The soluble solids were similar at ca. 11%. Less than 20% (ratio 0.11- 0.18) of the fruit we harvested had insect damage. This appeared to be a particularly bad year for plum curculio damage throughout the area.

Table 2. Yield for 3rd and 4th leaf trees.

Treatment	**Per tree Yield (lbs) 2001**	**2002**	**Yield/Acre (bu)2001 2002**	
Perpendicular-V				
Redglobe/Guardian	27.93c	30.93 c	234.6	259.6
Redglobe/Lovell	27.84c	24.24 c	a233.8 a	a203.3 ab
Open Center				
Redglobe/Guardian	40.4 a	61.82 a	112.9 c95 c	172.5
Redglobe/Lovell	34.09bc	57.24 a		b159.6 b
Quad-V				
Redglobe/Guardian	42.19b	43.45 bc	236.3	243.3
Redglobe/Lovell	30.8 b	53.88 ab	a172.4 b	a302.1 a

Table 3. Yield efficiency for 3rd and 4th leaf trees.

Treatment	**Yield Efficiency Kg/cm²2001 2002**	
Perpendicular-V		
Redglobe/Guardian	1.21 a1.25 a	1.34 a1.10 ab
Redglobe/Lovell		
Open Center		
Redglobe/Guardian	0.74 c0.83 c	1.12 ab
Redglobe/Lovell		1.4 a
Quad-V		
Redglobe/Guardian	1.33 a0.94 b	1.37 a1.66 a
Redglobe/Lovell		

Table 4. Effect of orchard systems on fruit color

Treatment	Background Color	% Red
Perpendicular-V		
Redglobe/Guardian	4.6	61.5
Redglobe/Lovell	4.9	74.1
Open Center		
Redglobe/Guardian	4.7	71.5
Redglobe/Lovell	4.8	75.2
Quad-V		
Redglobe/Guardian	4.9	73.1
Redglobe/Lovell	4.9	63.4

Training and pruning operations were monitored for the time required per tree so that a cost analysis could be conducted for the study. Clearly, training of the perpendicular-V trees was the simplest, while training trees to the Quad-V system was most difficult, requiring two trips to the tree to complete the initial training (Table 6). Initial analysis certainly indicates that although training trees to the perpendicular-V required less time per tree, the initial cost per acre is higher, while training the quad-V system had the greatest cost per acre.Table 5. Effect of orchard systems on harvest date, size, firmness and soluble solids.

Treatment	Harvest Date (Julian Date)	Size (inches)	Firmness (kg)	Soluble Solids (%)
Perpendicular-V Redglobe/Guardian Redglobe/Lovell	182.7182.9	2.542.50	7.257.14	10.910.8
Open Center Redglobe/Guardian Redglobe/Lovell	181.3181.9	2.582.53	7.567.66	11.511.3
Quad-V Redglobe/Guardian Redglobe/Lovell	182.4181.6	2.552.44	6.986.89	11.111.1

Table 6. Time and cost analysis of pruning in the 2nd, 3rd and 4th leaf peach trees.

Training System	Time/tree (min)			Average total cost/tree	Projected total cost/acre/year
	2000	2001	2002		
Perpendicular-V	5.4 c	5.7 b	1.5 b	1.47	$176 (360 trees/A)
Open Center	8.2 b	9.2 a	3.2 a	2.41	$96 (120 trees/A)
Quad-V[z]	14.5 a	9.9 a	2.9 a	3.21	$257 (240 trees/A)

[z] To initially establish the Quad-V system, two trips to train the trees were necessary relative to the other two training systems.

Thinning (Table 7) was more costly in the perpendicular-V and quad-V systems. Tree height and orchard density were factors in creating the additional cost. Yield analysis of this study should show whether the two new systems yield highly enough to warrant the additional pruning and thinning expense.

The per acre costs of shield budded trees were $228, $457 and $685 on Lovell rootstock and were $328, $659 and $987 on Guardian for open center, quad-V and perpendicular-V trained trees, respectively. The average cost for each orchard system was used in the economic analysis covered by Table 8. The total pruning and thinning costs as determined

Table 7. Time and cost analysis of thinning in the 3rd and 4th leaf peach trees.

Training System	**Time/tree**		**Average cost/tree**	**Projected cost/acre/year**
	2001	**2002**		
Perpendicular-V	11.2 b	5.7 b	1.98	$356 (360 trees/A)
Open Center	19.8 a	11.3 a	3.64	$218 (120 trees/A)
Quad-V	19.5 a	10.8 a	3.55	$425 (240 trees/A)

by timing each operation in the trial was much greater in the quad-V system than the open centered system but also greater than the more dense perpendicular-V system. The major reason for this increased cost was the fact that it was necessary to go back to the orchard a second time to set-up the quad-V trees. Despite this increased cost, the quad-V system was more profitable than the low density, open center system and the higher density perpendicular-V system. With greater training experience, the quad-V system would likely be even more profitable. Some may feel that a vase shaped tree spaced as densely as the quad-V would be more profitable. While this may be the case, the time required for orchard operations is theoretically reduced because of the control of scaffold orientation along the row, and might cancel out the ease of tree form establishment that the vase-shape poses.

Table 8. Average trees cost/acre with pruning and thinning costs for each orchard system.

Treatment	Average Tree Costs	**Total Pruning and Thinning Costs/Acre (3 years)**	**Gross Income (2 years)**	**Net Income (2 years)**
Perpendicular-V				
Redglobe/Guardian	$836	$1405	$9488	$7247 a
Redglobe/Lovell			$8392	$6151 a
Open Center				
Redglobe/Guardian	$278	$825	$5480	$4377 b
Redglobe/Lovell			$4526	$3425 b
Quad-V				
Redglobe/Guardian	$558	$1815	$9208	$6835 a
Redglobe/Lovell			$9112	$6699 a

The perpendicular-V combines high density and simplicity of tree architecture. I must say however, that the increased cost of the training trees to the quad-V system may be avoided with more experience. I think that we could have done a better job with that system, had we simply trained them to a vase tree attempting when possible to place the four scaffolds in two "V" formations perpendicular to tree row, in one trip to the orchard. The two trips occurred due to an attempt to "force" all trees into the quad-V rather than occasionally allowing the tree to become a vase tree.

Conclusions and Comments: Early indications suggest that the Perpendicular-V and Quad-V systems provide superior productivity relative to the additional costs of establishment and production. Although early data indicate that the new orchard systems will increase profit, additional years of assessment are necessary to base a final set of conclusions. The Quad-V system holds great potential.

References

DeJong, T.M., K.R. Day, J.F. Doyle, R.S. Johnson. 1994. The Kearney Agricultural Center Perpendicular V Orchard System for Peaches and Nectarines. In: Technology and Product Reports. HortTechnology. 4:362-367.