Yield, Fruit Size, and Leaf Nutrient Content of Three Peach Tree Growth Habits Grown at Four Spacings and With Two Training Systems [1]

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In the United States, peach production per hectare (National Peach Council, 2003) is significantly below that for apple (Belrose, 2003). Apple production is higher and has increased significantly in the past several decades mostly through the use of dwarfing rootstocks, spur growth habit trees, and high-density planting systems. Acceptable dwarfing rootstocks for commercial peach production have not been identified at this time, so the techniques which have supported high-density plantings in apple are not available for peach. Attempts to apply specialized training and pruning techniques to standard growth habit peach trees and adapt these standard trees to high density systems has found little success. An alternative approach to training and pruning systems that rely on standard growth habit trees is the development of growth habits suited to high-density systems (Scorza,1984). Scorza identified two growth habits with the potential for high density planting, the pillar (or columnar) (P) and the upright (UP) form tree (Scorza, 1988). Because of their vigorous vertical growth and compact type canopies (Miller and Scorza, 2002; Scorza, 1988), these trees will likely require specialized training and management systems for efficient production.

Previous reports (Miller and Scorza, 2002, 2003) have described the performance for P ('Crimson Rocket') and UP ('Sweet-N-UP') trees compared to a standard (S) ('Harrow Beauty') growth habit peach tree in terms of initial training and pruning, growth, yield, fruit size, and dormant and summer pruning times. This report provides an update on the yields and fruit size in the sixth leaf (2004), and leaf nutrient levels in the third (2001) and fifth (2003) leaf.

Details concerning the design, planting, pruning, cultural management, harvest, and data collection for trees in this study have been previously published (Miller and Scorza, 2002, 2003). Dormant pruning following the 2003 growing season was considered more severe than in previous years and was employed as a means of reducing crop load and with the desire to improve fruit size compared to previous years. Only S trees were fertilized in 2004 (28 Apr.) using 0.91 kg/tree 10N-4.4P-8.3K. The first picking for P, S, and UP trees was on 30 July, 2 Aug., and 12 Aug., respectively. The second picking for the P, S, and UP trees was on 5 Aug., 9 Aug., and 17 Aug., respectively. Leaves were collected between 15 July and 1 Aug. in 2001 and again in 2003 from the mid-terminal portion of current year shoots from each tree in the planting, washed in distilled, deionized water, dried in a forced-air oven at 80°C and ground to pass a 40-mesh sieve. Dried leaf tissue was analyzed at the Pennsylvania State University Soil and Tissue Analysis Lab by plasma emission spectroscopy. Data were analyzed by ANOVA as a factorial and means separated by Duncan's new multiple range test at $P = 0.05$.

Yields (kg/tree) for UP trees in 2004 were significantly greater than for P or S trees. Annual yields per tree in each year from 2000 (the first bearing year) through 2004 have been greater for UP trees than for P trees. P growth habit trees have had the lowest cumulative yield (82 kg/tree) during the first five bearing years followed by S trees (143 kg/tree) with UP trees showing the highest cumulative yield (173 kg/tree). When actual yields per tree and in-row spacing in the fifth and sixth leaf were used with a projected between-row spacing to calculate potential yield per ha, P trees spaced 1.5 x 4.9 m showed an average yield of 28.6 MT/ha. If between-row spacing was reduced to 4.3 m, potential yield increased to 32.6 MT/ha. Applying a similar approach with UP trees spaced 3.0 x 5.5 m, potential yield averaged over the fifth and sixth leaf was calculated to be 32.5 MT/ha. Reducing the in-row spacing of UP trees to 2.0 m would increase mean yields to 35.6 MT/ha. These yields compare with S trees planted at a more traditional spacing of 6.0 x 6.0 m where the calculated potential yield would be 20.4 MT/ha. If in-row spacing is reduced to 4.0 m, mean yields only increased to 21.0 MT/ha.

In this study, as in-row spacing increased from 1.5 m to 6.0 m, yields per tree increased. In 2004 (sixth leaf), trees spaced 6.0 m apart in the row produced greater yields per tree than the other three in-row spacings (1.5, 2.0, and 4.0 m). Training system [central leader (CL) or multiple leader (ML)] or summer pruning (SP) had no effect on yields in the 2000 and 2001 growing seasons, but trees trained to the ML system did produce significantly more fruit per tree in 2003 and 2004. Similarly, SP reduced yield per tree each year between 2002 and 2004. CL training reduced the 5-year cumulative yield per tree about 8% compared to ML trained trees. Summer pruning reduced the 5-year cumulative yield per tree about 7% compared to trees that received no SP.

The largest peaches were produced by the UP growth habit trees. Peaches from P trees were significantly smaller than UP fruit, but larger than fruit from S trees. These results agree with those obtained in the 2001 through 2003 growing seasons. Additionally, as in-row spacing increased fruit size (diameter) increased, which agrees with earlier findings (Miller and Scorza, 2003). Despite a more severe dormant pruning regime and a reduced crop load (mean reduction of 23.7%) for all growth habits in 2004, mean fruit diameter was slightly less than that recorded in 2003 for P (6.50 cm vs 6.90 cm, respectively) and UP (6.72 cm vs 7.32 cm, respectively) trees. For S trees fruit diameter was slightly greater in 2004 (6.30 cm) compared to 2003 (6.10 cm). A clear explanation for this fruit size response is not obvious. Moisture was not a limiting factor in either 2003 or 2004. P and UP trees had no supplemental N fertilizer applied after the 2000 growing season, which may be a contributing factor to reduced fruit size. Temperatures during the critical cell division period (late Apr. through early May) averaged 2.4°C below normal in 2003, but 2.3°C above normal in 2004. These elevated temperatures may have had a negative impact on cell division and/or the distribution of carbohydrates between fruit and vegetative shoots ultimately reducing fruit size. Since no data was collected on fruit size during the growing season, changes in fruit size during Stage III cannot be compared between 2003 and 2004. However, mean temperatures and moisture levels were very similar during this period for the two years.

As in previous years (Miller and Scorza, 2003, 2004) fruit size was reduced slightly by SP. This response was exhibited in fruit at the first picking, but not for fruit harvested at the second picking. A similar response in fruit size has been observed when trees were trained to the ML system compared to trees trained to the CL system.

Foliar analysis revealed a significant difference in leaf N levels between all three growth habits in both 2001 and 2003. Leaf N levels were highest in S trees and lowest in UP trees. Average leaf N levels decreased slightly for all three growth habits between 2001 and 2003. S growth habit trees also had higher levels of K and B than P or UP trees in both years sampled. In contrast P and UP trees had higher levels of foliar Ca, Mg (2001 only), and P (2001 only) than S trees. Mean leaf nutrient levels for N, P, K, Ca, Mg, and B fell within an accepted range (Pa Tree Fruit Production Guide, 2002-2003) for peach in both years sampled. Analysis for the coefficient of correlation (r) between leaf nutrient levels and yield revealed no relationships for N, P, K, Ca, or Mg. In-row spacing had little or no effect on leaf nutrient levels except for Mn where trees at 2.0, 4.0 and 6.0 m spacing had lower Mn levels than trees planted at the closets spacing (1.5 m). Training system had no effect on leaf nutrient levels. SP tended to increase leaf nutrient levels for most elements measured except for K where SP decreased the mean K levels.

This research project continues to demonstrate the yield benefits of P and UP peach growth habit trees planted at high density (610 to 1551 trees/ha) compared to S habit trees planted at conventional tree densities (274 to 410 trees/ha). The only concern has been fruit size, especially for the 'Crimson Rocket' P trees.

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