Developing New Peach Tree Growth Habits for Higher Density Plantings

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Peach production worldwide relies on the use of vigorous, spreading scion cultivars grafted onto rootstocks of similar vigor. Regardless of the desired growing system, from low density to high density, from large open-center to closely spaced tree walls to "Y" trellis systems, the standard, vigorous tree type must be made to fit the system. For the development of high density peach production systems severe pruning is necessary. Pruning invigorates trees and leads to excessive vegetative growth which may adversely affect fruit quality and subsequent flower bud formation due to shading. Summer pruning of excess regrowth can help to alleviate the problem, but the economic benefits of this practice are still in question.

As currently grown, peaches produce rather poorly when compared with other tree fruits. The average production of peaches in the U.S. is only 9 to 10 MT/ha (4 to 4.5 tons/acre). Apples produce 18 to 22 MT/ha (8 to 10 tons/acre), and pears, 13 to 27 MT/ha (6 to 12 tons/acre). The advantages of high-density fruit production have been clearly demonstrated in improving apple yields. Apple systems rely on the use of dwarfing rootstocks. Spur-type scions are important for some cultivars. Commercially acceptable dwarfing rootstocks are not available for peach (Marangoni et al., 1984). While there are possibilities for the development of dwarfing rootstocks for peach, there clearly are opportunities for other approaches to growth habit manipulation in peach. These opportunities are based upon 1) the existence of a great variety of different growth habits, some of which will be discussed below, and 2) unlike apple, most commercial peach varieties have been developed by breeding programs. Therefore the development of new varieties with different growth habits is feasible within our current peach breeding structure.

PEACH GROWTH HABITS

Dwarf

Dwarf trees vary in size but rarely reach over 2.4 m (8 ft) in height. There are at least two types of dwarf trees. The "brachytic" dwarf is characterized by very short internodes, long leaves, and a dense canopy. The brachytic dwarf has received some attention in breeding programs and high fruit quality brachytic dwarf varieties have been released (Hansche, 1989). However, the dense canopy is a problem for this growth habit and its future is uncertain. Another dwarf type tree (A72) was reported by Monet and Salesses (1975) in France, but it has received little attention. Seedlings from open pollinations of these dwarf trees exhibit a wide range of sizes. Leaves are not "oversized" and overall the canopies are much more open than those of the brachytic dwarfs. At the USDA-ARS Appalachian Fruit Research Station in Kearneysville we are just beginning to analyze the potential for this dwarf type. Fruit quality at this time is poor and at least several generations of crossing to high fruit quality types will be necessary for variety development.

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Compact

The "classic" example of the compact growth habit is the variety Com-Pact Redhaven. Compact trees have shorter internodes than standard trees, wider branch angles, and a greater number of and longer laterals than produced on standard trees (Scorza, 1984). These characteristics make for a dense canopy and reduced light penetration (Scorza et al., 1984). Com-Pact Redhaven can be found in home garden nursery catalogs but is not, to our knowledge, grown for commercial fruit production. The attraction for home growers may be the reduced tree size but the dense canopy and excessive pruning necessary for adequate light penetration would be a disadvantage to commercial growers.

Spur-type

Many stone fruit species including plum, apricot, and cherry produce fruiting spurs. The first report of spur-type growth in peach was published by Scorza (1987). Spur growth type peaches were found in some exotic peach germplasm that had been imported into the U.S. Some were apparently peach-almond hybrids and their spurriness was most likely inherited from the almond parent. Yet, the trees that produced the greatest densities of spurs were peach x peach hybrids with dwarf and compact in their backgrounds. The spur-type trees were not dwarf or compact. So it appears that the spur character may be inherited from tree types such as dwarf and compact without inheriting other growth traits such as dwarfism. At the USDA Station in Kearneysville, we are continuing to develop and evaluate spur-type peach trees.

Weeping

Weeping peaches have been released as ornamentals. There are at least two programs in Europe, including one in Bologna, Italy, and one in Bordeaux, France, that are developing commercial fruit quality weeping peach varieties. Bassi et al. (1994) suggested that the weeping peach may be of interest for new training systems, similar to the Lepage system in pear with a zigzag stem made from the scaffold branches alternately radiating from the trunk one above the other.

Columnar

Columnar trees were first reported from Japan where they have been developed as ornamentals (Yamazaki et al., 1987). Left to grow naturally, they will attain a height of 4.9 m (14 ft) and a crown diameter of about 1.5 m (5 ft). The most striking feature of the columnar tree is its narrow branch angles (Scorza et al., 1989) (Figure 1). Fruit quality of the original columnar (also known as "pillar") tree is very poor and yields are low. The breeding program at USDA-Kearneysville and at several locations in Italy (Bologna and Forlì) has significantly improved the fruit quality and productivity of columnar trees. The fact that columnar trees have a naturally narrow canopy appears to make them ideally suited to high-density spindle tree or "wall" systems.

"Mixed" Growth Types

Beyond the naturally occurring peach growth habits, we have found that through intercrossing of the different growth habits we can produce new tree types, including columnar dwarfs, columnar compacts, trees with ball-shaped canopies, and others. One of the potentially more useful of these mixed types is the upright tree (Bassi et al., 1994) which is a combination of the columnar and standard tree types. Upright trees are more spreading than columnar trees but retain the upright growth habit suitable for high-density production systems. Upright trees with high fruit quality are being developed both at USDA-Kearneysville and in Italy (Bologna and Forlì).

EVALUATION OF COLUMNAR TREES

Tree performance of dwarf, compact and other peach tree growth habits has been published previously (Hansche and Beres, 1980; Scorza et al., 1984, 1986; Bassi et al., 1994). Here we present an initial evaluation of the original, unimproved columnar tree in terms of pruning and fruit production at several planting densities.

Tree Density Trial

A columnar genotype from the University of Florence peach collection named Pillar was budded in September 1987 to peach seedling PS A5, a rootstock selected by the University of Pisa that induces a slight reduction of vigor, high yields and ripening uniformity. The 1-year-old trees were planted in November 1988 at the University of Bologna's Cadriano Experimental Station. At budbreak in the following spring, their leaders were headed back to about 20 cm (8 inches) from the graft union to promote uniform canopy growth.

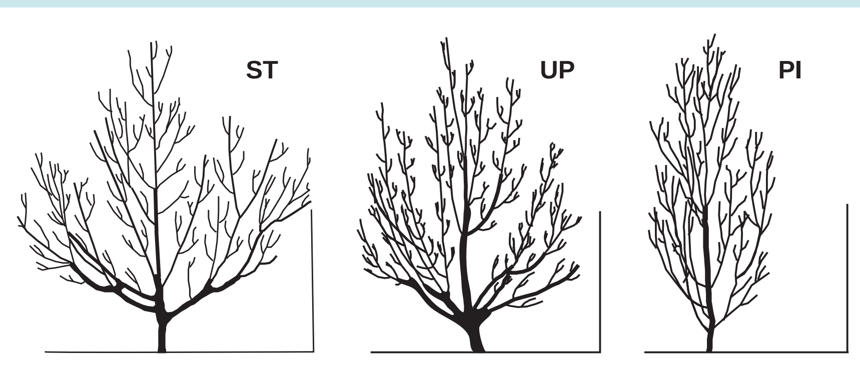
Three planting densities with three replications of five trees each were tested: 1) medium density (MD), 3 x 4.3 m (9 x 13 ft), 775 trees/ha (314 trees/acre); 2) high density (HD), 1.5 x 4.30 m (4.7 x 13 ft), 1550 trees/ha (627 trees/acre) and 3) ultra high density (UHD), .75 x 4.30 m (2.3 x 13 ft), 3100 trees/ha (1255 trees/acre). Pruning consisted of thinning cuts to remove branches that were intercrossed or otherwise obviously competing for light. Some thinning and heading cuts were made on 2- to 3-year-old wood to reduce branch density. Trunk diameter 20 cm (8 inches) from the ground (always above the graft union) and canopy height and diameter were recorded at the end of each season on the three central trees in each replication. The weight of dormant season prunings per tree was recorded from 1989 to 1993, total yield per tree and average fruit weight were recorded from 1990 to 1993 and in 1993, 5 years after planting, the fruits were graded by size. The data were statistically analyzed by analysis of variance, LSD and chi-square tests to verify differences.

RESULTS

The MD trees had grown the most and the UHD the least 5 years after the orchard was planted, an effect of tree-to-tree competition (Table 1). Trees at the highest density required less pruning (40%) in terms of weight of wood removed than the trees at the lowest density, but the yield/tree at the lowest density was almost twice that of the highest density. While yields were low in this trial due to the shy bearing nature of the unimproved pillar trees that were used, the relative yields under the different tree densities offer some insights as to the spacing and training that will be useful for the columnar tree type. On a per-acre basis, the UHD trees produced 40% more fruit than HD trees and at least twice as much as MD trees. These values can be attributed to the fact that, by the second year after planting, the UHD trees had already occupied all

FIGURE 1

Schematic representation of standard (ß†), upright (UP), whichis a ST x PI hybrid, and pillar (PI), or columnar, peach trees.



of the allotted in-row space. In the fifth year the yield/acre was similar for the two higher densities, confirming that the yield efficiency of columnar trees did not decline at HD. Fruit size was adversely affected in the higher densities, especially at the UHD.

These findings indicate that columnar trees are promising for high-density peach production systems. They also suggest that, at increasing density, tree management practices such as nutrient and water inputs must be carefully calibrated to maintain fruit size.

CONCLUSIONS

The peach is a species rich in diversity for plant growth habit. Most of the growth habits are the result of single gene changes and are readily manipulated by breeders. In spite of this fact, there has been relatively little effort to genetically alter peach tree growth habit. The peach industry suffers from low productivity and lacks efficient high-density production systems similar to apple. Over the years we have demonstrated the performance of various novel peach tree growth habits. The columnar tree is a particularly promising growth type for high-density production systems. This is the first report that demonstrates the performance of the columnar peach. We have developed high fruit quality and higher yielding columnar and upright selections. They will be tested at several locations in the U.S., including the USDA Kearneysville Station, and at several locations in Italy, including Bologna. These trials will provide critical information on the practical utility of the columnar and upright trees for growing peaches at high densities.

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TABLE 1

Growth and yield of columnar peach trees 5 years after planting.

Trees/haz	Tree spacing (m)	Tree height (m)	Canopy diameter (m)	Cumulative pruning weight (kg/tree)	Cumulative yield (kg/tree)	Cumulative yield (MT/ha)	Fruit with diameter >2.5 inches (%)
Ultra high density							
3100	.75 x 4.3	2.47by	.67c	1.8c	9.9b	28.2	
(1255)	(2.3 x 13 ft)	(8.1 ft)	(2.2 ft)	(4.0 lb)	(21.8 lb)	(12.6 tons/acre)	47.4
High density							
1550	1.5 x 4.3	2.65ab	.88b	3.4b	13.7b	19.5	
(627)	(4.7 x 13 ft)	(8.7 ft)	(2.9 ft)	(7.5 lb)	(30.2 lb)	(8.7 tons/acre)	77.3
Medium density							
775	3 x 4.3	2.83a	1.0a	4.8a	19.2a	13.7	
(314)	(9 x 13 ft)	(9.3 ft)	(3.4 ft)	(10.6 lb)	(42.2 lb)	(6.1 tons/acre)	70.6

ZEnglish units (acre, ft, lbs, tons, inches) in brackets.
yValues within columns followed by the same letter are not statistically different.