Editorial

Stone Fruit Research in New York State

Both this, and the previous issue of the New York Fruit Quarterly feature collections of papers that were presented at the stone fruit symposium held this past spring in Geneva in honor of Dr. Robert Andersen’s contributions to the stone fruit industry. As you can see from the content and quality of these articles, there is a lot going on in stone fruit research in the Eastern United States. It is also evident that there is a great deal of work that still needs to be done.

Many growers that have the soils, micro-climates and markets to grow stone fruit and are seriously looking into the possibility of diversifying their operations or expanding their current acreage of stone fruits. This is evident by the recent expansion of acreage of peaches and sweet cherries in New York State. All growers need reliable, proven, and practical information on how to successfully and profitably grow stone fruits on their farms.

On behalf of the stone fruit growers of New York, I would like to thank Bob Andersen for the research he has done and guidance he has provided us over the years, and wish him well in retirement. To adequately express our appreciation for all he has done would probably take the rest of this page. Instead, let me outline Bob’s legacy – the continuing work being done at the Geneva Experiment Station.

- Dr. Susan Brown will continue to evaluate the sweet cherry selections that have been bred at Geneva with the hope some winners will be found in that group. It is unlikely that new crosses will be made in the future.

- Dr. Terence Robinson will continue to work on stone fruit planting systems and evaluate new rootstocks.

- Dr. Courtney Weber is evaluating the plum selections that are at Geneva and making some new crosses.

- Jay Freer, Bob’s longtime technician, is helping all three of with their stone fruit work.

These individuals are dedicated to, and very interested in the stone fruit work they are doing. How much research gets done in the future though, will be dictated by the amount of funding that can be found for the work. We, as growers, are going to have to work together to ask for, and help secure the funding for the needed research. The success or failure stone fruit industry’s future in New York depends on it.

Jim Bittner  
Fruit Grower, Singer Farms  
Appleton, NY
Should New York Growers Plant Higher Density Peach Orchards?

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²Department of Horticultural Sciences, NYSAES, Cornell University, Geneva, NY

New York State is on the northern limit of successful peach production areas. Peach trees in NY suffer from perennial cankers (Cytospora spp.) and winter cold damage in some years. This limits the useful life of a peach orchard to about 15 years. Traditionally, peach trees have been grown using the open center system at densities of 350-400 trees/ha. Mature tree height has been limited to 2.5m and tree spread has extended up to 5m in diameter. This results in rather short trees that can be harvested largely from the ground. However, the low tree density results in poor yield during the early years. In addition, the low tree stature of the NY open center system results in low mature yields that do not exceed 20 Mt/ha. Warmer peach producing areas have significantly higher yield than NY (DeJong, et al., 1994). The relatively cool summers of NY State result in moderate shoot growth and relatively slow tree development during the early years of a new orchard. Under these conditions of slow tree growth and short orchard life, high-density orchard systems have great potential to improve yield and profitability of peach orchards (Loreti and Massai, 2002).

Materials And Methods

In 1999, a replicated field trial comparing six peach orchard training systems (Open Center, Quad-V, Tri-V, Perpendicular-V, Central Leader and Slender Spindle) with three varieties [Allstar (yellow peach), Blushingstar (white peach) and Flavortop (nectarine)] all on Bailey rootstock was planted at Olcott, New York. Tree densities and spacings are given in Table 1.

The Open Center System was developed based on heading the leader at 40cm at planting. In the second year, four well-placed scaffold branches were selected and headed by one third and the leader was removed. Each of the four scaffolds was bifurcated at two-foot intervals by heading successively in the dormant seasons of the second through fourth years. The scaffolds were pruned to an angle of 50° above the horizontal. In the fifth year, tree height was limited to 2.5m by lowering the top branches down to a horizontal side branch.

The Quad-V system also was developed by heading the leader at 40cm at planting. In the second year, four well-placed scaffold branches were selected and headed by one third and the leader was removed. Two of the four scaffolds were oriented to each side of the row and oriented to opposite quadrants of the tree. In the dormant seasons of the second through fourth years, the four scaffolds were pruned to an angle of 65° above the horizontal and allowed to extend to a height of 3.25m. In the late dormant season of each year, all secondary branches that were not fruiting twigs were removed back to a side shoot or bud near the scaffold. This resulted in columnar scaffold branches with the fruiting twigs produced on or near the scaffolds.

The Tri-V system was developed in a manner similar to the Quad-V system except only three scaffold branches were allowed to develop. They were oriented perpendicular to the row with two on one...
side and one on the other, alternating down the row. In the dormant seasons of the second through fourth years, the scaffolds were headed each year by one third to a side branch that continued in the 65° upward direction. The scaffolds were allowed to extend to a height of 3.25m. In the late dormant season each year, all secondary branches that were not fruiting twigs were removed back to a side shoot or bud near the scaffold. This resulted in columnar scaffold branches with the fruiting twigs produced on or near the scaffolds.

The Perpendicular-V system was developed in a manner similar to the Quad-V system except only two scaffolds branches were allowed to develop. They were oriented perpendicular to the row. In the dormant seasons of the second through fourth years, the scaffolds were headed each year by one third to a side branch that continued in the 65° upward direction. The scaffolds were allowed to extend to a height of 3.25m. In the late dormant season each year, all secondary branches that were not fruiting twigs were removed back to a side shoot or bud near the scaffold. This resulted in columnar scaffold branches with the fruiting twigs produced on or near the scaffolds.

The Central Leader system was developed by heading the leader at 100cm at planting and removing large diameter feathers (larger than two thirds diameter of leader). During the second through the fourth years, the leader was headed by one third each year and a strong vertical shoot arising near the heading cut was trained as the leader. In the second year, a lower tier of four scaffolds was selected and pruned to horizontal by shortening each branch back to a horizontal side branch. Large diameter branches along the leader were renewed back to the trunk on an annual basis by cutting to a side shoot or bud near the trunk. Tree height was limited to 3.25m.

The Slender Spindle system was developed in a manner similar to the central leader except that no permanent lower tier scaffold branches were allowed. Large branches were renewed back to the trunk on an annual basis by stubbing back to a bud or side shoot near the leader. This created a columnar leader with fruiting twigs arising near the leader. Tree height was limited to 3.25m.

The Slender Spindle system was developed in a manner similar to the Central Leader except that no permanent lower tier scaffold branches were allowed. Large branches were renewed back to the trunk on an annual basis by cutting to a side shoot or bud near the trunk.

An economic analysis of profitability was done using actual yields, simulated packout, material costs and labor inputs through year six. We added projections of yield, packout and labor costs for years 7-15 based on average yield for years five and six. (Robinson and Hoying, 2004).

Results

Growth. After six years the largest trees (measured as trunk cross-sectional area) were from the traditional Open Center system (Figure 1). The smallest trees were from the highest density Slender Spindle system. There was a strong negative effect of tree density on tree size. The highest density system had a trunk cross-sectional area that was less than half the size of the lowest density system.

Yield. In the second year (2000) the trees had a very small crop followed by significant commercial crops in the third year and large commercial crops in the fourth-sixth years (Figure 2A). On a land area basis, the Central Leader and the Slender Spindle systems, which had the least pruning at planting, had the highest 2nd year yield/ha while all of the other four systems which required severe heading at planting, had very low 2nd year yield (Figure 2B). In the third year, the Slender Spindle and Perpendicular-V had the highest yield/ha followed by the Central Leader, Tri-V, Quad-V and Open Center, which had the lowest yield. In the fourth through sixth years, the Perpendicular-V had the highest yield followed by the Slender Spindle, Tri-V, Central

Figure 1. Effect of increasing planting density on peach tree size after 6 years in the orchard.

Figure 2. Annual yields per tree (A) and per hectare (B) of 6 peach orchard systems over the first 6 years of orchard development.
Leader, Quad-V and Open Center systems.

Cumulative yield per tree was negatively related to planting density in a curvilinear manner (Figure 3A). The highest density system had slightly less than one half the cumulative yield per tree as the lowest density system. The three V systems had greater than expected yield from the regression relationship, and the two pyramid shaped systems had lower than expected yield. Cumulative yield per ha was positively related to tree density; however, there was an interaction with variety (Figure 3B). The yellow peach (Allstar) and the white peach (Blushing Star) gave similar responses at each density, but the nectarine (Flavortop) had significantly lower yield at each density. For the two high yielding varieties, the Perpendicular-V had the highest cumulative yield (100 Mt/ha) followed by the Slender Spindle, Central Leader, Tri-V, Quad-V and the Open Center system (27 Mt/ha). The best system had approximately 3X the yield of the poorest system. With the nectarine, the Slender Spindle and the Perpendicular-V had the highest cumulative yield (37 Mt/ha) followed by the Central Leader, Tri-V, Quad-V and the Open Center System (15 Mt/ha). The best system had approximately 2.5X the yield of the poorest system.

**Fruit Quality.** Average fruit size in years three through six was greatest with the Open Center and Quad-V systems, intermediate with the Tri-V, the Central Leader and the Slender Spindle, and smallest with the Perpendicular-V system (Table 2, Figure 4). Fruit red color in 2004 was similar for all of the systems (approximately 60%) except the Open Center system, which had significantly poorer color (46%).

**Economics.** In year two, farm gate crop value was highest for the Slender Spindle, but by year three the Perpendicular-V had similar crop value as the Slender Spindle (Figure 5A). By year six the crop value of the Perpendicular-V system exceeded the returns of the Slender Spindle. The Open Center system had the lowest crop value in each of the years. Accumulated crop value over six years was highest for the Perpendicular-V system ($38,695/ha) followed by the Slender Spindle, Tri-V, Central Leader, Quad-V and was lowest for the Open Center system ($14,961/ha) (Table 2). Estimated profitability over a 15-year orchard life showed that all systems were profitable except the Open Center system with Flavortop (Figure 5B). The relationship between tree density and profitability was curvilinear; however, there was an interaction with

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**TABLE 2**

<table>
<thead>
<tr>
<th>System</th>
<th>Tree Density/ Ha</th>
<th>Av. Fruit Size (g)</th>
<th>Fruit Red Color (%) (2004)</th>
<th>Cumulative Farm Gate Crop Value/ Ha** ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Center</td>
<td>384</td>
<td>182.4 a*</td>
<td>46.3 b</td>
<td>14,961 d</td>
</tr>
<tr>
<td>Quad-V</td>
<td>538</td>
<td>179.7 a</td>
<td>61.5 a</td>
<td>24,668 c</td>
</tr>
<tr>
<td>Tri-V</td>
<td>905</td>
<td>172.0 b</td>
<td>56.7 a</td>
<td>28,583 b</td>
</tr>
<tr>
<td>Central Leader</td>
<td>1,098</td>
<td>170.1 b</td>
<td>61.9 a</td>
<td>28,573 b</td>
</tr>
<tr>
<td>Perpendicular-V</td>
<td>1,583</td>
<td>160.9 c</td>
<td>61.4 a</td>
<td>38,695 a</td>
</tr>
<tr>
<td>Slender Spindle</td>
<td>1,922</td>
<td>168.1 b</td>
<td>60.2 a</td>
<td>36,207 a</td>
</tr>
<tr>
<td>LSD ps0.05</td>
<td></td>
<td></td>
<td></td>
<td>3,539</td>
</tr>
</tbody>
</table>

*Means followed by the same letter are not significantly different. (ps≤0.05, n=9)

** Excludes picking, storage and packing costs.
variety. The yellow peach (Allstar) and the white peach (Blushing Star) generated similar shaped quadratic response curves. The optimum density was 1,329 trees/ha for Allstar (yellow peach), and 1,406 trees/ha for Blushing Star (white peach). The nectarine had significantly lower profitability at each density, and the curve increased with increasing density up to 1900 trees/ha (highest density of this experiment). For the two high yielding varieties, the Perpendicular-V system exceeded the profitability predicted from its density while the open center, the central leader and the slender spindle had lower than expected profitability.

Discussion

In this study, the wider plant spacings resulted in larger trees after six years than at the closer plant spacings. The strong effect of increasing tree density on limiting tree growth was likely due to two effects. 1) At the higher densities, the canopy of the tree was limited by pruning beginning in the third year, which likely reduced total carbohydrate supply and thus tree size. With the Slender Spindle and the Central Leader systems, the main pruning strategy was to remove large diameter limbs each year to limit trees to an allotted space. When this is repeated over several years, the size of the canopy remains small and presumably root system size is also limited. 2) Inter-tree root competition for water and nutrients may have also contributed to reduced tree size at the high planting densities. From a practical viewpoint this result indicates that even with peach trees on seedling rootstocks there is a large range of tree densities that are manageable.

The strong positive relationship between tree density and cumulative yield/ha at the end of year six indicates that for New York conditions there is great benefit to high-density orchards. This is in contrast to results in warmer climates (e.g. California) which have shown that the yield benefits of high-density peach orchards are short lived and that the high density systems require more summer pruning to manage tree vigor at close plant spacings (DeJong et al. 1994; Loreti and Massai, 2002). In the New York climate, trees grow less vigorously than in California, so that the yield advantage of high plant densities in NY is much longer and the management of tree vigor at close plant spacings is not so problematic. In fact, in our study, fruit color was the poorest at the lowest plant spacings indicating that at the higher planting densities shoot growth was manageable and did not cause excessive shading and reduced fruit color.

Tree shape appeared to have an effect on yield performance independent of planting density with the V systems performing better than the pyramid shaped systems. Although the Slender Spindle system had the highest tree density, it had less cumulative yield than the slightly lower density Perpendicular-V system. This was likely due to excessive pruning of the Slender Spindle at the highest tree densities. The V shaped trees (Quad-V, Tri-V and Perpendicular-V) had higher yield than predicted from the common relationship of tree density and yield. In contrast, the pyramid shaped trees had lower yield than predicted. This is similar to results by Chalmers and Van den Ende (1989) and DeJong et al. (1999). It is likely this difference was due to higher light interception and distribution within the V canopy (Iannini, et al., 2002).

The curvilinear relationship of yield and tree density indicates that the optimum planting density depends on the influence of economic factors and the law of diminishing returns. Our preliminary economic analysis showing projected yields from year 6 to year 15 indicate that the optimum density is somewhat less than the maximum density that can be managed. Similar economic results were reported by DeJong et al., (1999), in the warmer climatic conditions of California. The optimum density in the present study is similar to that reported by Loreti and Massai (2002) and is very similar to the optimum planting density for dwarf apple trees (Robinson and Hoying, 2004). There appears to be a significant economic advantage to the V shape with peach (DeJong et al., 1999).

Conclusions

- Under the moderate growth conditions of New York State and the relatively short orchard lifespan, high-density orchard planting systems offer a significant early yield and mature yield advantages over the traditional open center system.
- Even the highest density systems (Slender Spindle and Perpendicular-V) were quite manageable in this climate and produced 2-3 times as much yield over the first six years as did the Open Center system.
• The more severe pruning required at maturity with the Slender Spindle made it inferior to the Perpendicular-V system in annual yield in the last year of the study indicating that at maturity the V systems would be superior.

• Farm gate crop value and long-term profitability were much higher for the high density systems than the Open Center system. The optimum density appears to be about 1,000 trees/ha.

References

Acknowledgement
We thank Dan Sievert of Niagara Orchards for hosting this experiment on his farm.

Steve Hoying is an Area extension educator in orchard management in the Lake Ontario region of New York State. Terence Robinson is a research and extension professor at Cornell’s Geneva Experiment Station who leads Cornell’s research and extension program in high-density orchard systems. Robert Andersen is a recently retired emeritus professor of Horticulture at Cornell’s Geneva Experiment Station who specializes in the breeding and culture of stone fruits.
New varieties are the lifeblood of a thriving peach industry, especially in those states with a sizeable wholesale fresh or processing side. In Michigan, we have seen over the last 15 years the rapid replacement of varieties such as ‘Cresthaven’, ‘Glohaven’, and ‘Redskin’ by newer varieties with greater appeal in the local and national fresh markets. ‘Red Haven’, still the largest acreage variety in Michigan, is losing dominance in the Michigan peach industry. With market demand switching from 2 1/4” to 2 1/2” diameter peaches with over 60% red skin, and tighter profit margins, Michigan growers are always looking for better alternatives.

In looking for better varieties, fruit bud hardiness is always a major concern in Michigan and other northern states. Over the last 30 years, there have been five years where January or February temperatures reached -16°C or lower in the peach growing region along the west side of Michigan. Such temperatures will kill most peach fruit buds. Cold-resistant varieties may have significant fruit bud survival in the -10°C to -12°C temperature range in mid-winter. We consider the Michigan climate to be somewhat harsher than Southern New Jersey where moderately cold-tender varieties such as ‘Sentry’, ‘Loring’, ‘Bellaire’, and ‘John Boy’ produce crops more reliably.

Good varietal resistance to bacterial spot, caused by Xanthomonas campestris pv. pruni is important for Michigan conditions, especially in those orchards with sandy soils, frequent rainfall, and considerable exposure to wind. Fruit marked by bacterial spot infections are more prone to fruit diseases such as brown rot and Rhizopus rot. Varietal resistance to bacterial spot (Table 1) is particularly important on disease-prone sites. Varieties with poorer resistance may escape the disease for the early years of an orchard if planted in well-protected, isolated sites with no older trees harboring the pathogen.

White peach and nectarine variety options for northern wet climates depend heavily on whether or not bacterial spot can be kept under control. Many of the newer white peach varieties such as ‘Snow King’, ‘Sugar Giant’, and ‘Yukon King’ and nectarines such as the Arctic series are popular in California and drier climates (Table 2) but have significant bacterial spot susceptibilities that make them a challenge to grow in Michigan. ‘Blushingstar’ has been the best new white peach for our area in recent years. ‘Southern Pearl’, from Byron, Georgia has been productive, relatively firm, and has medium eating quality. ‘China Pearl’ from North Carolina is very productive but medium firm. ‘Klondike’ is probably the best of the newer California white peaches from the standpoint of bacterial spot resistance in our early tests. ‘Saturn’ is a white doughnut peach that is productive, sweet, and is becoming popular for direct market sales. There is considerable room for hardy, new, firm, white peach varieties with better bacterial spot resistance.

Yellow Melting Flesh Peach Varieties

Many new yellow melting flesh peach varieties have been introduced over the past 10 years as possible substitutes to those currently being grown (Table 3). The newest varieties have not been tested long enough to determine their suitability to the wide range of soil types and growing seasons of the Great Lakes region.

For the early July window, ‘PF1’ has been seen as a less split-pit prone substitute for ‘Harbinger’. ‘Queencrest’ is a very new selection that looks promising at this time. For mid-July, ‘PF5B’ has much more red skin than ‘Harrow Diamond’ and appears to have a stronger

**TABLE 1**

Bacterial spot rating on leaves of yellow melting flesh type peaches
(4-year average at the SW Michigan Research and Extension Center, Benton Harbor, MI). W. Shane, Michigan State University.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Bacterial spot rating</th>
<th>Variety</th>
<th>Bacterial spot rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Allstar’</td>
<td>8.5</td>
<td>‘PF1’</td>
<td>8.9</td>
</tr>
<tr>
<td>‘Blazing Star’</td>
<td>9.0</td>
<td>‘PF12A’</td>
<td>8.9</td>
</tr>
<tr>
<td>‘Bountye’</td>
<td>7.7</td>
<td>‘PF15A’</td>
<td>7.7</td>
</tr>
<tr>
<td>‘Canadian Harmony’</td>
<td>8.3</td>
<td>‘PF17’</td>
<td>8.8</td>
</tr>
<tr>
<td>‘Coral Star’</td>
<td>8.3</td>
<td>‘PF20-007’</td>
<td>8.4</td>
</tr>
<tr>
<td>‘Cresthaven’</td>
<td>8.1</td>
<td>‘PF23’</td>
<td>8.6</td>
</tr>
<tr>
<td>‘Glowing Star’</td>
<td>8.6</td>
<td>‘PF24-007’</td>
<td>9.0</td>
</tr>
<tr>
<td>‘Harbinger’</td>
<td>8.1</td>
<td>‘PF27A’</td>
<td>9.0</td>
</tr>
<tr>
<td>‘Harrow Beauty’</td>
<td>8.9</td>
<td>‘Red Star’</td>
<td>8.2</td>
</tr>
<tr>
<td>‘Harrow Dawn’</td>
<td>8.0</td>
<td>‘Redhaven’</td>
<td>8.0</td>
</tr>
<tr>
<td>‘Harrow Diamond’</td>
<td>9.0</td>
<td>‘Rising Star’</td>
<td>8.1</td>
</tr>
<tr>
<td>‘Harrow Fair’</td>
<td>8.6</td>
<td>‘Starfire’</td>
<td>9.0</td>
</tr>
<tr>
<td>‘John Boy’</td>
<td>9.0</td>
<td>‘Suncrest’</td>
<td>7.1</td>
</tr>
<tr>
<td>‘Laural’</td>
<td>6.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bacterial spot rating scale range (3=severe to 9=none).
# Table 2

White peach and nectarine varieties for the Great Lakes growing region. W. Shane, Michigan State University – 2004

<table>
<thead>
<tr>
<th>Variety name</th>
<th>Alias</th>
<th>Harvest days before/after N = nectarine</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Spring Snow’</td>
<td>-20</td>
<td>P</td>
<td>Small to medium, good size for season with light load, round, firm, dark red skin, attractive, hangs well, sweet subacid, few split pits, light cropper, somewhat susceptible to bacterial spot</td>
</tr>
<tr>
<td>‘Sugar May’</td>
<td>-10</td>
<td>P</td>
<td>White-fleshed peach, early evaluation, lot of red in flesh, medium-sized fruit, significant bacterial spot, light crop 2001, dark red blush color, attractive, very firm, and texture, freestone when ripe, usually nice flavor</td>
</tr>
<tr>
<td>‘Saturn’</td>
<td>-5</td>
<td>P</td>
<td>White flesh ‘Peento’ (flat/doughnut-shaped fruit), freestone, sweet mild flavor, 40 to 70% pinkish skin, prone to brown rot, appears to be productive, 2 1/2” or more diameter, teors at petiole when ripe, softens quickly, small pit, some bacterial spot noted on fruit</td>
</tr>
<tr>
<td>‘Southern Pearl’</td>
<td>BY84P1807</td>
<td>2</td>
<td>White peach, relatively firm, generally okay bacterial spot resistance, acidic with moderate sweetness, good flavor, attractive 60% to 70% red skin on white, slight green background, red in flesh, productive, decent size, split pits some years if light crop</td>
</tr>
<tr>
<td>‘Snow Bride’</td>
<td>5</td>
<td>P</td>
<td>80% red/pink blush, round/oval, white flesh, freestone, significant bacterial spot on leaves and fruit, low fuzz, medium size, low acid, light crop 2000 &amp; 2004, nice flavor</td>
</tr>
<tr>
<td>‘Klondike’</td>
<td>6</td>
<td>P</td>
<td>Large to very large, 90% to 100% pink purplish red, round, attractive, very firm flesh, semi-freestone, sweet and subacid, productivity has been so-so, ripen 1 week after ‘Red Haven’, some bacterial spot noted</td>
</tr>
<tr>
<td>‘Crystal Red’</td>
<td>7</td>
<td>N</td>
<td>Early evaluation, 100% dark red skin, white flesh, round/oval, medium to large size, some bacterial spot on leaves and fruit, range of flavors</td>
</tr>
<tr>
<td>‘Carolina Belle’</td>
<td>8</td>
<td>P</td>
<td>White flesh, freestone, red skin on white slight green background with little fuzz, fairly resistant to bacterial spot, attractive, large size fruit, maybe not large cropper, flavorful generally most years, too soft for wholesale shipping</td>
</tr>
<tr>
<td>‘White Lady’</td>
<td>8</td>
<td>P</td>
<td>White-fleshed peach, medium-sized, rounded fruit, firm flesh, bacterial spot susceptible, 90%+ dark skin, many pickings as it ripens over long period, aromatic fruit on tree some years, split pits significant some years</td>
</tr>
<tr>
<td>Roseprincess</td>
<td>BYBON384</td>
<td>10</td>
<td>White-fleshed nectarine, candy red skin on pinless/white background, medium to large, essentially freestone, some white peach aroma, prone to surface marks, flavor variable from year to year, high acidity, juicy</td>
</tr>
<tr>
<td>‘Arctic Sweet’</td>
<td>10</td>
<td>N</td>
<td>Early evaluation, white nectarine, showy large bloom, round/oblong, bright cherry red on bright white background, attractive, sweet, freestone, 2.5”, significant bacterial spot on leaves and fruit</td>
</tr>
<tr>
<td>‘Arctic Jay’</td>
<td>10</td>
<td>N</td>
<td>Early evaluation, white flesh, severe bacterial spot on fruit, solid dark red skin, small fruit</td>
</tr>
<tr>
<td>‘Blushingstar’</td>
<td>12</td>
<td>P</td>
<td>White-fleshed, freestone, 80-90% red skin on white background, generally good resistance to bacterial spot, moderately sweet with significant acidity, somewhat tender skin, medium to large, productive, red around pit, hangs well for white peach</td>
</tr>
<tr>
<td>‘Arctic Rose’</td>
<td>12</td>
<td>N</td>
<td>White flesh nectarine, bright red skin with pink highlights, significant bacterial spot problems</td>
</tr>
<tr>
<td>‘Crimson Snow’</td>
<td>Bradcrim</td>
<td>12</td>
<td>White-fleshed nectarine, freestone, bright 90% red skin, attractive, round, some white speckle/rough texture, significant bacterial spot seen on leaves, mild, sweet, relatively firm flesh, melting, juicy, good taste, medium size</td>
</tr>
<tr>
<td>‘Red Rose’</td>
<td>15</td>
<td>P</td>
<td>40-60% red skin on green/yellow background, not really attractive, blush area soften earlier, white/slight-green flesh, uneven halves, okay flavor, medium-sized fruit, vigorous tree</td>
</tr>
<tr>
<td>‘Summer Pearl’</td>
<td>NJ 252</td>
<td>22</td>
<td>White-fleshed peach, medium to large fruit, 40-70% dull red skin on white/ light-green background, leaves and fruit are moderately susceptible to bacterial spot</td>
</tr>
<tr>
<td>‘Sugar Giant’</td>
<td>25</td>
<td>P</td>
<td>White-fleshed peach, early evaluation, okay in Washington, very large, round, subacidic sweet, medium sweetness, significant bacterial spot on leaves and fruit</td>
</tr>
</tbody>
</table>
### TABLE 2, continued.

White peach and nectarine varieties for the Great Lakes growing region. W. Shane, Michigan State University – 2004

<table>
<thead>
<tr>
<th>Variety name</th>
<th>Alias</th>
<th>Harvest days before/ after 'Red Haven'</th>
<th>N = nectarine</th>
<th>P = peach</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>'China Pearl'</td>
<td></td>
<td>28</td>
<td>P</td>
<td></td>
<td>Round/oblate, medium to decent size, somewhat fuzzy, attractive, ripens early on blush, sweet, moderate acidity, 50% red/pink on white/slight-green back, good bacterial spot resistance, softens quickly, productive</td>
</tr>
<tr>
<td>'Lady Nancy'</td>
<td></td>
<td>31</td>
<td>P</td>
<td></td>
<td>White peach, ripening with 'Encore', good firmness, very firm, large, round/oval, with 80% red over yellow/white ground, bad bacterial spot, yellow suture line in flesh, poor winter fruit bud hardness</td>
</tr>
<tr>
<td>'Snow Giant'</td>
<td></td>
<td>35</td>
<td>P</td>
<td></td>
<td>Very large fruit, 60 to 70% pinkish purple-red skinned over cream green, very firm, significant, bacterial spot on leaves in 2002 and 2003</td>
</tr>
<tr>
<td>'Snow King'</td>
<td></td>
<td>35</td>
<td>P</td>
<td></td>
<td>Medium-large peach, very firm, partially dark pinkish-red over cream green, flesh is crunchy, subacid, significant susceptibility to bacterial spot, initial evaluation indicates fruit bud hardness may be poor</td>
</tr>
<tr>
<td>'Yukon King'</td>
<td></td>
<td>35</td>
<td>P</td>
<td></td>
<td>Early evaluation, bad bacterial spot on leaves and fruit in 2004</td>
</tr>
</tbody>
</table>

For the late July window, ‘Garnet Beauty’ and its slightly redder-coloring counterpart ‘Summer Serenade’ are productive and have good quality flesh but still insufficient skin color. ‘Rising Star’ is medium-red colored with a pretty background and good flavor, but it softens quicker than desired at times. ‘Glenglo’ has good reports from Pennsylvania, has looked good on the few trial trees on the Michigan State University research farm, but we have no other experience with it in Michigan. ‘PF7’ has been not been tested much in Michigan, and there are three brand new Flamin’ Fury selections (‘PF7A’, ‘PF8A’, and ‘PF9A-007’) aimed at approximately the same window. So far, there are no clear winners in this time frame.

### TABLE 3


*Note: These are not necessarily recommended varieties. The purpose is to indicate best-guess harvest season.*

<table>
<thead>
<tr>
<th>Ripening order (Southern MI)*</th>
<th>Traditional</th>
<th>Newer</th>
<th>Very New</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early July</td>
<td>‘Harbinger’ -33</td>
<td>‘PF1’ -30</td>
<td>‘Queencrest’ -34</td>
</tr>
<tr>
<td>Mid July</td>
<td>‘Harrow Diamond’ -20’</td>
<td>‘PF5B’ -25’</td>
<td>‘PF5D Big’ -25’</td>
</tr>
<tr>
<td>Late July</td>
<td>‘Garnet Beauty’ -6</td>
<td>‘Rising Star’ -8</td>
<td>‘Early Star’ -12</td>
</tr>
<tr>
<td>Late July to Early August</td>
<td>‘Red Haven’ +0</td>
<td>‘Vivid’ +2</td>
<td>‘PF11’ +0</td>
</tr>
<tr>
<td>Early August</td>
<td>‘Starfire’ +5</td>
<td>‘Blazingstar’ +5</td>
<td>‘PF Lucky 13’ +8</td>
</tr>
<tr>
<td>Mid August</td>
<td>‘Glohaven’ +10</td>
<td>‘Loring’ +12</td>
<td>‘PF17A’ +12</td>
</tr>
<tr>
<td>Late August to Early September</td>
<td>‘Contender’ +18</td>
<td>‘Allstar’ +18</td>
<td>‘PF Lucky 21’ +15</td>
</tr>
<tr>
<td>Early to mid September</td>
<td>‘Harrest’ +28</td>
<td>‘PF27A’ +30</td>
<td>‘PF80-007’ +33</td>
</tr>
</tbody>
</table>

*Note: Estimated harvest dates for typical year. Cooler year will delay harvest dates. Sites in more northern areas are generally later.*
relatively new varieties. ‘Starfire’ seems to be emerging as the favorite of the three Stellar varieties and ‘PF-15A’ is the most widely planted ‘Flamer’ in that season, although ‘PF Lucky 13’ looks really nice in early tests.

For mid August, ‘PF17’ is probably the leader, based on total fruit quality, productivity, and better skin color than the older ‘Glohaven’, ‘Loring’, ‘Suncrest’, and ‘Canadian Harmony’. ‘Coralstar’ has very nice size and flavor but medium coloring.

Late August to early September has many options in the old ‘Cresthaven’ and ‘Redskin’ windows. ‘Glowingstar’ and ‘PF25’ are attractive, hardy, and nice quality and are my choices over ‘Allstar’, ‘PF24-007’, and ‘PF20-007’ for various reasons. ‘PF23’ is also very attractive with great shelf life but not as large as some of the other options. There are four very new options in this window; ‘PF Lucky 21’, ‘PF22-007’, ‘PF Lucky 24B’, and ‘PF-24C’ plus a Michigan State University release ‘Beaumont’ that are being tested by growers, nurseries, and universities.

Finally, in the early to mid-September window, ‘PF27A’ is an attractive alternative to ‘Fayette’ and ‘Encore’, but seems to struggle a bit with size at times. Three new varieties ‘PF30-007’, ‘PF35-007’, and ‘Autumnstar’ are being tested in the field as possible replacements with better color and nice fruit size.

Bill Shane is an Extension Specialist in South West Michigan who leads Michigan State University’s peach breeding and evaluation program.
Peach And Nectarine Cultivars: A New Jersey Perspective

Jerome L. Frecon
Rutgers Cooperative Research and Extension
1200 North Delsea Drive, Clayton, NJ

The testing and evaluation of peach and nectarine cultivars has been an ongoing research project in New Jersey since 1983. The New Jersey Agricultural Experiment Station has had a fruit breeding program since 1907 developing hundreds of cultivars, some having wide scale impact in peach producing areas outside of the region. The Babygold series developed in New Jersey have been planted and used throughout Michigan, Ontario, and Western New York. Blake was a major variety in the southeastern United States. Encore, a very productive late variety has been popular in Washington State and the Midwestern United States. Saturn for many years was the first and only peento or flat peach marketing in the United States and is widely grown in California. Jerseyqueen, Sun high, and Western New York. Blake was a major variety in the southeastern United States. A similar situation occurred with Easternglo nectarine. Many other private and public breeding programs are not listed or described because they have not been named or introduced.

New Jersey has a large peach and nectarine evaluation project that has had success in evaluating peach varieties for Mid Atlantic conditions. This article presents comprehensive results from New Jersey evaluations on numerous varieties with suggestions for varieties that may be adapted for production areas of New York. However there is no substitute for doing local evaluations of adaptability.

Numerous Varieties of Flat Peaches Introduced. The Fruit Growers News. Vol 43(2) 23;
Frecon, J. L. 2004. What are Flat Peaches? Horticultural News 84(1) 22-24;
The balance of this report is broken into four sections. First is Table 1 which lists recommended, or suggested varieties for planting in New Jersey. Note the varieties marked with an asterisk have a high bud density and with their record of productivity may be better adapted to production areas of New York and Ontario. However there is no substitute like local research. The second section describes in order of ripening, varieties that may be recommended or show promise for trial plantings. The third section describes varieties under test that appear to have no special characteristics that would warrant further testing or planting. Both of these sections include varieties that are currently planted in test blocks. The last section lists a group of varieties that have been tested since the inception of the project but are not recommended or suggested for commercial planting. Many selections from the New Jersey Agricultural Experiment Station program or from other private and public breeding programs are not listed or described because they have not been named or introduced.

Some Interesting Varieties in 2003-2004 (In Order of Ripening)

Queencrest - A very early yellow-fleshed clingstone peach ripening most years in late June in southern New Jersey. While the fruit size is only medium it has been productive with few split pits. It is also attractive with a scarlet red overcolor over 70-80% of the surface.

Spring Snow - A firm, medium sized, white-fleshed peach ripening in late July but will hang for a week. A pinkish, purple red skin color covers 80-90% of the surface making it attractive. The flavor is sub-acid and good for this early in the season. It will produce split pits. The tree is vigorous, moderately productive, and slightly susceptible to bacterial spot.

Sunbrite - It ripens just after Queencrest but may have better size. While the skin color is only slightly less complete, the fruit seems more uniform with firmer yellow-flesh. Sunbrite is a pretty peach with tolerance to bacterial spot.

Flamin Fury PF 5B - An attractive, firm, medium sized, yellow-fleshed clingstone peach ripening on July 7. The tree is vigorous, very productive, and tolerant to bacterial spot. Size is the main problem with this attractive cultivar.

Empress – This attractive bright red-skinned, clingstone variety ripens with, or just after Sunbrite. Empress has very firm yellow flesh. The tree has not been consistently productive but it is sitting in
a lower area of our variety block in Richwood, which increases its exposure to lower temperature.

**SpringFlame** - This early season variety previously identified as Burchell D2. 102 ripens with Empress and Sunbrite. It has and attractive scarlet red overcolor completely covering the skin. Pubescence is light, fruit size is very good for this season with mostly 2 1/2 inch fruit. The flavor is good, the flesh is very firm and semi clingstone. Developed by Burchell Nurseries in Oakland California the tree is vigorous, moderately productive, and susceptible to bacterial spot. I notice in their catalog SpringFlame is a trademarked name that is used for a number of generic varieties.

**Arctic Star** – This is the standard for an early white-fleshed nectarine ripening on July 10. The size is medium large with all of the fruit between 2 1/2 to 2 3/4 inches in diameter. It has a beautiful pink red skin color over 70-90% of the surface with a cream white undercolor. It has a semi clingstone, firm, white-flesh. The flavor is low acid and very good. It is moderately susceptible to bacterial spot and will crack under conditions of excessive moisture rendering it very susceptible to bacterial spot. The tree is upright-spreading, vigorous, and moderately productive. Developed by Zaiger Genetics in Modesto, California.

**Harrow Dawn** – A yellow-fleshed peach with large size ripens on July 10. It however lacks the color and firmness of other varieties in this season. Harrow Diamond, an older variety, ripens just before Harrow Dawn and seem to have better color and flavor. Both varieties have vigorous, productive spreading trees tolerant to bacterial spot.

**NJ D88-147** – An early season, yellow-fleshed clingstone peach with low acid flavor ripening on July 11. The flavor is low acid but very good. The tree is vigorous, productive and susceptible to bacterial spot. Developed by Zaiger Genetics in Modesto, California.

**Snow Prince** – A very firm, dull complete red skinned, white-fleshed clingstone peach ripening on July 12. It has a low acid flavor with clearer flesh color and larger fruit size than Spring Snow, which ripens about 4-5 days earlier. Both Spring Snow and Snow Prince hang on the tree well and have few split pits. Developed by Zaiger Genetics in Modesto, California.

**NJK56-4** – A beautiful bright red, firm, white-fleshed semi-clingstone nectarine ripening just before EasternGlo and about two weeks before Redhaven. It has an 80 to 100% bright pinkish red skin color, good firmness, and very good eating quality. It is resistant to bacterial spot as EasternGlo and has better flavor. It however may be about the same size or 2 3/4 inches. The finish was excellent in 2004. Fruit harvested on July 10 at the RAREC yielded 35. 5% 2 1/4 to 2 1/2 inches and 64. 5% 2 1/2 to 2 3/4 inches. Fruit harvested on July 14, 2004 at RAREC yielded 30. 7% 2 1/4 to 2 1/2 inches. Fruit size is very good for this season it should be considered for planting. Developed by the Riviera Breeding Program in the Provence Region of southeastern France.

**Manon** – A firm, complete red-skinned, white-fleshed, clingstone peach ripening on July 12. Manon has an excellent low acid flavor while not as firm as Snow Prince is larger and has less bacterial spot. Because of its size this early in the season it should be considered for planting. Developed by the Riviera Breeding Program in the Provence Region of southeastern France.

**Sugar May** – A firm, dark pink, purplish red, white-fleshed, clingstone peach ripening on July 12. The flavor is good but acidic. The tree is vigorous, productive and susceptible to bacterial spot. Developed by Zaiger Genetics in Modesto, California.

<table>
<thead>
<tr>
<th>Ripening Date in Southern NJ</th>
<th>Best Peach Varieties</th>
<th>Best Nectarine Varieties</th>
<th>Promising Peach Varieties for Trial</th>
<th>Promising Nectarine Varieties for Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 30 to Jul 5</td>
<td>Sunbrite</td>
<td>Queencrest</td>
<td>Spring Snow (W)</td>
<td>Nustar Jade (W)</td>
</tr>
<tr>
<td>July 6 to 12</td>
<td>Flamin’Fury PF #58</td>
<td>ArcticStar (W)</td>
<td>Harrow Beauty*</td>
<td>Redstar* Blazing Star</td>
</tr>
<tr>
<td>Arctic Star*</td>
<td>Flamin’Fury PF 15A*</td>
<td>Redhaven*</td>
<td>Sugar Lady (W)</td>
<td>Emeraude (W)</td>
</tr>
<tr>
<td>Flamin’Fury PF 24-007</td>
<td>Flamin’Fury PF 20-007</td>
<td>Redgold</td>
<td>Allstar* (W)</td>
<td>Artic Gold (W)</td>
</tr>
<tr>
<td>July 18 to 26</td>
<td>Flamin’Fury PF 23*</td>
<td>Fantasia</td>
<td>Blushingstar* (W)</td>
<td>Sugar Giant (W)</td>
</tr>
<tr>
<td>Aug 27 to September 3</td>
<td>Cresthaven</td>
<td>Lady Nancy (W)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug 27 to September 10</td>
<td>Autumnglo</td>
<td>Snow Giant (W)</td>
<td>Autumn Star</td>
<td>Arctic Pride (W)</td>
</tr>
<tr>
<td>Sept 3 to September 10</td>
<td>Autumnglo Encore*</td>
<td>Yukon King (W)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Indicates variety is the most productive or winter hardy in its season of ripening. (W) Indicates White-Fleshed. See FS687 Yellow-Fleshed Peach Varieties for New Jersey, FS686 White-Fleshed Peach Varieties for New Jersey, and FS642 Nectarine Varieties for New Jersey for complete descriptions of all varieties listed in this chart.
Zaiger Genetics in Modesto, California.

A sub acid variety and getting medium ripe. This nectarine was spectacular in 2004. It has medium flesh, semi-clingstone peach ripening on July 14. The skin is covered with a 60-80% crimson red overcolor. The flesh is firm with good flavor. The tree is very good. Developed by Zaiger Genetics in Modesto, California.

Sentry - Sentry is the standard yellow-fleshed variety in New Jersey ripening on July 13. It is an attractive variety with 60-70% scarlet red overcolor and red wash yellow undercolor. It is medium large, and the semi-clingstone flesh is moderately firm and of good quality. The tree is moderately productive, spreading, and tolerant to bacterial spot. Glenglo is an alternative where Sentry is not productive.

Glenglo - A medium large, yellow-fleshed, semi-clingstone peach ripening on July 14. The skin is covered with a 60-80% crimson red overcolor. The flesh is firm with good flavor. The tree is very good. The size is slightly smaller than Arctic Star but matures later. Arctic Sweet is moderately susceptible to bacterial spot. It will crack under conditions of heavy moisture, which will render it more susceptible to bacterial spot. The tree is spreading, vigorous and productive. Developed by Zaiger Genetics in Modesto, California.

Jade - A medium large, flavorful, bright complete purplish red-skinned, semi-freestone, white-fleshed nectarine ripening before Redhaven. The ripening season is July 20. Fifty percent of the fruit is 2 3/4 inches in diameter. Fruit at nine pounds pressure was 9.5% SSC in 2004. Developed by the Riviera Breeding Program in the Provence Region of Southeastern France.

Nustar - A firm, complete bright scarlet red-skinned yellow-fleshed freestone nectarine ripening on July 20. The size has been medium large but the tree has never set up heavily. It is moderately vigorous, spreading, and susceptible to bacterial spot.

NJK54-17 - A very early yellow-fleshed semi-clingstone nectarine ripening on July 24. The fruit is only medium size but this nectarine is in a season where there are no other varieties with its combination of red color, attractiveness, productivity, and tolerance to bacterial spot. Virus indexed at NRSP-5 project and ready for introduction.

USDA BY 87P994 - An attractive, semi-freestone yellow-fleshed peach ripening on July 24. The skin is covered with 80-90% scarlet red over color. The flesh is firm and the flavor very good. The tree is large, vigorous, spreading, productive, and tolerant to bacterial spot.

Flavorcrest - A firm, yellow-fleshed semi-freestone peach ripening on July 24 that holds its firmness well. The flavor is very good. Flavorcrest is a challenge to size and is susceptible to bacterial spot. The freestone is spreading, vigorous but only moderately productive.

Harblaze - An attractive, medium large 70-90% scarlet red skinned, yellow fleshed, semi-freestone nectarine ripening on July 25. It has a moderately firm acidic flesh with very good flavor. The tree is moderately vigorous, productive, spreading and slightly susceptible to bacterial spot.

Virgil - An early season, orange-yellow fleshed non-melting clingstone ripening on July 25. It has very good, sweet, spicy flavor, and medium large size. The trees are very vigorous but young.

Gala - An early midseason, firm, yellow-fleshed semi freestone. Gala ripens in a season between Sentry and Redhaven where a good peach is needed. It has medium large size averaging mostly 2.59" in diameter. Flavor is good with 9.7% SSC at 10 lbs pressure in 2004. Gala has a crimson red color over 70-80% of surface with low pubescence. The tree is spreading upright, tolerant to bacterial spot, productive, and vigorous. Size is a borderline issue with this variety.

Snow Bride - A large, very firm, attractive, white-fleshed, semi-freestone peach ripening on July 23. The skin is covered with a purple to pinkish red over 80-90% of the surface. The flavor is low acid and very good. The tree is vigorous, moderately productive and susceptible to bacterial spot. Developed by Zaiger Genetics in Modesto, California.

Very acidic and fewer problems with brown rot and bacterial spot. Arctic Sweet white nectarine ripening at the same time is sub acid and slightly larger but is more susceptible to bacterial spot and brown rot, and less productive. Virus indexed at NRSP-5 project and propagated for introduction.

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ening because it hangs on the tree so well. The variety is very susceptible to bacterial spot and not consistently productive. Developed by Zaiger Genetics in Modesto, California.

**Honeyblaze** – A medium large ovate shaped yellow-fleshed nectarine with a sub acid flavor, ripening July 23. It has a complete scarlet red skin color, and is very attractive and very firm. The tree is vigorous, spreading, moderately productive and susceptible to bacterial spot. Developed by Zaiger Genetics in Modesto, California.

**Saturn** – The standard in a flat peach had 10.9% SSC in 2003 and 13.5% in 2004. This peach is usually a standard for flavor often measured by soluble solids concentration (SSC). Saturn is attractive but has a number of problems. It is not firm, and the skins tear at harvest. It is very susceptible to brown rot because of a scar on the dorsal end. Saturn developed at the New Jersey Agricultural Experiment Station, is the most important flat or peento peach cultivar and commonly marketed under the name donut peach.

**USDA BY 96P2531** – A very firm, large, yellow-fleshed semi-freestone peach ripening on July 26. The skin is covered with a 70-90% crimson red overcolor. The tree is vigorous, spreading, productive and tolerant to bacterial spot. The flavor is excellent. This is a nice all around peach.

**Redhaven** – Ripening on August 6 in 2003 and July 20 in 2004. The normal ripening date is usually July 26. This is the standard for rating all varieties for season of ripening.

**Redstar** – This attractive yellow-fleshed freestone peach ripens on July 28. It has 70-90% of the surface with a bright scarlet red color. Being of medium large size, it can be a challenge, during some years, to get fruit size over 2 1/2 inches. The tree is very productive, vigorous, spreading and tolerant to bacterial spot. Redstar, and Flamin Fury 15A are beautiful peaches but a challenge to size.

**Flamin Fury PF 15A** – An attractive, yellow-fleshed semi-freestone peach ripening on July 28. The skin is covered with a 70-90 scarlet red skin color. The fruit size is medium large. The tree is productive, vigorous, spreading and tolerant to bacterial spot.

**NJD91-134** – A medium large, firm, clear golden yellow skinned, clingstone peach with an orange yellow, aromatic and spicy non-melting flesh. Normally this variety has exquisite flavor but was disappointing in 2003 with only 11% SSC. It increased to 14.2% in 2004. This peento or flat peach has a prominent suture and a small to medium scar. It ripens near Saturn (NJ F-2). It does get some skin browning from abrasion when ripening and from being handled but otherwise quite distinctive. The tree has been productive, vigorous, and tolerant to bacterial spot. Fruit harvested at the RAREC on July 19, 2004 yielded 80% 2 1/4 to 2 1/2 inches and 20% 2 1/2 to 2 3/4 inches. This variety has been virus indexed and propagated for introduction.

**Harflame** – An attractive, moderately firm, 80-90% scarlet red skinned, yellow fleshed, semi freestone nectarine ripening on July 31. The fruit size is larger than Harblaze and similar in firmness. The tree is vigorous, productive, spreading, and tolerant to bacterial spot.

**NJD91-120** – A cream colored fleshed clingstone flat or peento peach ripening about a week after Redhaven and 10 days after Saturn. The skin is clear or a washed-out greenish white. If the fruit hangs too long, the skin might get brown flecks or streaks. The flavor is excellent. The major advantage of this variety is the unique skin color. The surface has a prominent suture and the scar on the apex is medium sized and will crack if the fruit is large. The fruit is a moderate in production. The tree is spreading and vigorous with slight susceptibility to bacterial spot. The first harvest on July 28, 2004 at the RAREC yielded 33.9% 2 1/2 to 2 3/4 and 66.1% were 2 3/4 inches to three inches. The second harvest on August 3, 2004 at the RAREC yielded 40.5% 2 1/2 to 2 3/4 inch fruit and 59.5% 2 3/4 to 3-inch fruit. The average SSC on these samples were 14.4%. Fruit of this cultivar was also grown at Circle M block in Mullica Hill and rated excellent in 2004 with great size and 13.9% SSC. This cultivar has been virus indexed and propagated for introduction.

**White Lady** – This white-fleshed variety is a standard in New Jersey ripening on August 1. The flesh is very firm, low acid and semi freestone. The skin is attractive with a pinkish red skin color over 70-80% of the surface. The fruit hangs on the tree very well. The tree is upright, moderately productive, vigorous, and slightly susceptible to bacterial spot. Developed by Zaiger Genetics in Modesto, California.

**Snow Beauty** – A medium sized, dark purplish pink skinned, white fleshed, semi freestone peach ripening on August 2 just after White Lady. This variety definitely has darker skin but is not as large fruited as White Lady. The tree is very susceptible to bacterial spot. Developed by Zaiger Genetics in Modesto, California.

**Emeraude** – A firm, medium-large, pink to purplish red, white-fleshed, semi-freestone nectarine ripening on August 3 in 2004. Emeraude had an aromatic, excellent flavor and had few blemishes in 2004. The tree is very vigorous and had no bacterial spot. Fruit harvested on August 1 was 100% 2 1/2 to 2 3/4 inches in diameter. Fruit at nine pounds, with 10.5% SSC. Developed by the Riviera Breeding Program in the Provence Region of Southeastern France.

**Sugar Lady** – A firm white-fleshed peach ripening on August 9. It looks very much like White Lady.

**John Boy** – A medium large to large, yellow-fleshed, semi-freestone peach ripening on August 4. This attractive red skinned variety is a major variety in New
The tree is very vigorous, productive, and tolerant to bacterial spot.

**Starfire** – A 60-70% light scarlet red skinned, yellow-fleshed, semi-freestone peach ripening on August 4 after Redhaven. Starfire is a firm, medium sized peach. The tree is vigorous, spreading and tolerant to bacterial spot.

**Coral Star** – A firm yellow-fleshed freestone peach ripening on August 6. This very attractive peach has 60-70% of the surface covered with a brilliant scarlet red overcolor and an orange-red undercolor. The tree is vigorous, productive and tolerant to bacterial spot.

**Klondike** – A white-fleshed variety with normal ripening on August 6. It is large, very attractive, with a pinkish purple skin color over 80-90% of the surface. The flesh is very firm and semi-freestone. The flavor is very good and sub acid. The tree is upright, moderately productive, and susceptible to bacterial spot. Klondike is a replacement for Sugar Lady because of its good size and firmness retention. Developed by Zaiger Genetics in Modesto, California

**Flamin Fury PF 20-007** – A firm yellow-fleshed freestone peach ripening on August 9. This peach has 60-70% of the surface covered with a crimson red skin color. The size was excellent with 100% of the fruit over 2 3/4 inches. The tree is vigorous, productive, and tolerant to bacterial spot.

**July Flame** – A brilliant and complete bright red, very firm, yellow fleshed peach from Burchell Nurseries in California. This attractive peach has a beautiful scarlet orange skin color over 90% of the surface. The tree is upright spreading, moderately productive and very susceptible to bacterial spot. Ripens on August 10 with Bounty.

**Arctic Jay** – This nectarine was spectacular in 2004. The beautiful pinkish red skin color covers 80-90% of the surface. The skin had no blemishes in 2004 and generally is low in blemishes with good nitrogen management. It has large size with 65 % 2 1/2 to 2 3/4 inches and 35% 23/4 inches up in 2004. The flesh is white, very firm, crisp, and freestone ripening on August 10. The flavor is very good, low acid with 13.7% SSC at 11 pounds in 2004. The tree is vigorous, upright spreading and moderately productive. Arctic Jay is susceptible to bacterial spot and brown rot. Developed by Zaiger Genetics in Modesto, California.

**USDA BY93P4046** – A partially red skinned with a cream green undercolor, white-fleshed, firm, freestone flat peach ripening on August 11, 2003. Flavor was good and SSC averaged 10.5% in 2003 and much better in 2004.

**USDA BY93P3562** – Similar to BY93P4046, but with more red skin color and brighter and more attractive. A flat peach with white, firm freestone flesh, ripening at the same time. Average SSC in 2003 was 10.5% and higher in 2004.

**USDA BY93P4065** – A partially red skinned with yellow green undercolor, yellow-fleshed, firm, freestone flat peach ripening on August 13 in 2003. Flavor was not as good as white varieties and averaged 8.4% SSC. SSC was 11.2% in 2004.

**USDA BY93P4062** – A small to medium sized, white fleshed, freestone flat nectarine, with good red skin color very good firmness. This sub acid peach has very good flavor ripening on August 15, 2003.

**USDA BY96P2531** – A large, very firm, attractive, full red skinned semi freestone, yellow-fleshed peach ripening on August 3. The fruit has excellent flavor like many of the USDA selections. This variety has better size that SurePrince, ripening before it and Summer Prince.

**EW 170** – A large yellow-fleshed, moderately firm, freestone peach ripening on August 9. The flesh is very good and sweet. The surface is covered with 60-70% scarlet red color. The tree is productive, vigorous and has not had bacterial spot.

**Heavenly White** – A large to very large, freestone, white-fleshed nectarine ripening on August 10. The skin is only covered on 30-50 % with a pinkish red color and will show blemishes and cracks although it was smooth in 2004. It is susceptible to brown rot and very susceptible to bacterial spot. The flesh has a sweet, aromatic sub-acid excellent flavor. The tree is only moderately vigorous and moderately productive.

**Paul Friday 15B** – A yellow-fleshed firm, freestone, peach ripening with Bounty and Flamin Fury 17. This beautiful crimson red skinned variety has more overcolor than these two varieties but is not any larger. It has been consistently productive in the many years we have tested it, and never had bacterial spot. Supposedly will be introduced in 2004-2005.

**USDA BY 87P994** – A large, attractive, firm yellow-fleshed freestone peach ripening on August 10. It hung on the tree until August 25. The skin is covered with an 80-90% yellowish red overcolor. Flavor is very good. The tree is vigorous, spreading, productive and tolerant to bacterial spot. This peach was named **Scarlet Prince** in 2004.

**Bounty** – It is one of our standards in the season, ripening on August 10. Bounty was very large with an average of 9.2% SSC in 2003 and 11.5% SSC in 2004. There are definitely two different varieties marketed as Bounty trees. Bounty is a large firm, globose peach with red color over 60-70% of the surface.

**Sweet Dream** – One of the newer low acid yellow-fleshed peaches. Sweet Dream is very firm with a beautiful dark red overcolor on 90% of the surface. Like most California yellow-fleshed peaches it if highly susceptible to bacterial spot, and on these young trees fruit size was compromised from lack of B5 infected leaves. It hangs on the tree very well but peaks in maturity about August 11. Developed by Zaiger Genetics in Modesto, California

**Blazeprince** – A medium large, attractive, with a crimson red overcolor on 80-90 % of the surface ripening on August 11. I have only seen this peach two years and it appears to be a promising variety. The tree is vigorous, spreading, and productive with no bacterial spot.

**Flamin Fury PF 17** – This is one of the standard varieties in this season ripening on August 11. It has many good characteristics and can only be improved by more firmness and better color. The tree is vigorous, productive, spreading and slightly susceptible to bacterial spot.

**Intrepid** – A firm, yellow-fleshed peach, ripening about August 12. The fruit is cover with a 60-70% crimson red color and a greenish yellow undercolor. The fruit is medium to medium large. The tree is vigorous, spreading, productive and tolerant to bacterial spot.

**Harrow Beauty** – A very attractive, yellow-fleshed freestone peach ripening on August 12. Harrow Beauty is the peach with the highest pack outs. It has light pubescence, a 60-80% scarlet red overcolor with an orange yellow undercolor. The tree is spreading, vigorous and very productive. Size is the major problem with Harrow Beauty as most of the fruit is medium large about 2 1/2 inches.

**Allstar** – A large, yellow-fleshed free- stone ripening on August 13. It is moderately firm. The color is brighter and the fruit more uniform than FF23. The fruit sized is similar but it is not as firm and does not hang on the tree as well as FF23. The tree is vigorous upright-spreading
and productive. It is tolerant of bacterial spot.

**USDA BY 93P4055** – A medium-large, white-fleshed, freestone, flat peach with more red color than 4062. Flavor was also excellent. In 2003 the SSC was 11.9 to 12% for both sub-acid selections. Ripened on August 18.

**USDA BY 93P4053** – medium-sized, yellow-fleshed, freestone, flat, peach similar 4055 but ripens a few days later.

**NJ40-34** – A medium-large, very firm, yellow-fleshed, low-acid, freestone peach. This peach is attractive, with a scarlet red skin color with 60–70% of the surface having a bright orange red undercolor. The tree is productive, vigorous, spreading, and tolerant of bacterial spot. This variety has been virus indexed and was propagated for introduction.

**Arctic Gold** – A medium large, white-fleshed nectarine ripening on August 15. It has a 40-60% pinkish red skin color over a cream undercolor. The flesh is firm, freestone and very good, one of the best testing varieties. The tree is of medium vigor, moderately productive, and spreading. While the size is acceptable and the flavor outstanding it is very susceptible to bacterial spot.

**Johanna Sweet** – A very firm, medium large, deep red skinned, freestone, yellow-fleshed peach ripening on August 15. It has a low acid flavor and is very susceptible to bacterial spot. Fruit had some spot in 2003. Trees are young with their first good crop in 2003 and had a moderate crop in 2004. Developed by Zaiger Genetics in Modesto, California.

**Flamin Fury PF 23** – A large yellow-fleshed freestone peach, Flamin Fury PF 23 is often picked too early because it gets a deep red color and when it is mature on August 16 it will have large to very large size. It is still one of my favorite Flamin Fury varieties.

**Beaumont (MSU 11-7)** – A firm yellow-fleshed freestone peach ripening on August 17. The fruit size is medium to large on young trees. The tree is vigorous, spreading, early bearing with no bacterial spot on young trees.

**Flamin Fury PF 24-007** – A very large yellow-fleshed freestone peach ripening on August 18 just after Bounty. Many growers have planted this variety. I have always been concerned about its low bud density and lack of color. The lack of color may come from the light crop although with a full crop and good light exposure scarlet red color may cover 50-70% of the skin surface. It has a nice bright undercolor. It also hangs on the tree very well and retains its firmness like FF 23. It is always one of the largest varieties.

**Blushing Star** – A medium large, white-fleshed peach ripening on August 19. The flavor is very good, aromatic, and acidic. The flesh is firm and skin covered with 60-80% pinkish red overcolor. The tree is vigorous, spreading, productive, and tolerant to bacterial spot.

**NJ D101-162** – A very attractive, yellow-fleshed, firm, freestone peach with a complete crimson red overcolor and a beautiful golden yellow-orange undercolor. It ripens in Cresthaven season. It has an excellent flavor. Fruit harvested on August 19, 2004 at the RAREC was 30.6% 2 1/2 to 2 3/4 inches; 57% 2 3/4 to 3 inches; 12.4% 3 to 3 1/4 inches. This fruit averaged 12.5% SSC. This variety is a possible replacement for Cresthaven. This variety is virus indexed and propagated for introduction.

**Redgold** – This is still one of the best yellow-fleshed freestone nectarines ripening on August 20. The tree is of low vigor and susceptible to bacterial spot, but the fruit is large and of excellent quality.

**Flamin Fury P. F. Lucky 24 B** – This variety has been tested for many years as Paul Friday 219. It ripens about August 20 with or just before Cresthaven. The skin color is 60-80% scarlet red over a reddish yellow undercolor. Fruit size is excellent with 86% 2 3/4" and 14% 3" in 2004. The flesh is yellow, firm, melting, and freestone. Flavor is good, acid with 10.5% SSC at 12 pounds in 2004. The tree is always very productive, vigorous, spreading and never has had bacterial spot. The fruit hangs on the tree very well and may have a tendency to be picked too early before it reaches it full color and size.

**Fantasia** – This is the number one yellow-fleshed nectarine, and the standard for other varieties. It ripens on August 25. The fruit is medium large to large and the tree is of medium vigor and has low susceptibility to bacterial spot.

**Lady Nancy** – A large to very large, white-fleshed nectarine ripening on August 25 a day or two ahead of its parent Jerseyqueen. It has a 50-60% pinkish red overcolor with a cream undercolor. It can always be identified by the yellow suture line. The flavor is excellent, aromatic sweet acidic. The tree is just like Jerseyqueen.

**Flamin Fury PF 27A** – A firm, yellow-fleshed, large sized peach which ripens on August 27 with Jerseyqueen. This variety ripens close to FF PF 25 but has better size but a less vigorous tree more susceptible to bacterial spot.

**Jerseyqueen** – A very large yellow-fleshed peach that is a standard in season with Elberta on August 27. It has a vigorous, spreading and moderately productive tree that is slightly susceptible to bacterial spot.

**USDA BY 88 P4040** – A very firm yellow-fleshed variety ripening on August 28 with crimson red skin color over 70-80% of the surface with a yellowish red undercolor. The tree is very productive and tolerant to bacterial spot. The size was medium but the tree was not thinned properly in 2004.

**Opale** – A large globose, dark red skinned, very firm white-fleshed, freestone peach ripening in August 28, in 2003 and August 31 in 2004. It has a sub acid flavor. The variety does not get bacterial spot like other late white sub acid peaches. Developed by the Riviera Breeding Program in the Provence Region of Southeastern France.

**Zephyr** – A white-fleshed freestone nectarine ripening on August 30 or about seven days after Fantasia. The flesh is firm, and the flavor very good sweet and sub acid. The SSC was 14.7% at eight pounds in 2004. The skin was covered with faint pinkish red color over 50% of the surface speckles and spots in both 2003 and 2004. The tree is vigorous, spreading, and susceptible to bacterial spot. Developed by the Riviera Breeding Program in the Provence Region of southeastern France.

**NJ G48-133** – A large, firm, ovate to mostly globose, 50-80% scarlet to crimson red over a yellow orange-red, undercolor freestone, peach ripening from August 28 to September 7 just a little before Encore. The flavor is sweet,
acidic and good. The tree is vigorous, spreading and productive. No bacterial spot has been observed. On August 23 picking 91% of Fruit in RAREC block was to 3 to 1 4/4 inches and 9% was 3 1/4 to 3 1/2 inches. This fruit averaged 11 % SSC. The August 26 harvest at Richwood was 37.5 % 2 3/4 to 3 inches and 62.5% 3 to 3 1/4. This fruit averaged 11% SSC. Fruit harvested on September 2, 2004 in Richwood was 100% 3 to 3 1/4 inches with 10. 9% SSC. Fruit harvested on September 2, 2004 at the RAREC was 45% 2 3/4 to 3 inches and 55% 3 to 3 1/4.

**Topaze** – A white-fleshed, freestone nectarine similar to Zephyr except it ripens one week later about September 3. It has a bout 60% pinkish red color with slightly and less speckling than Zephyr and a cream greenish ground color. Both Zephyr and Topaze have good size 2 1/2 to 3” on diameter. Topaze has a mild sweet flavor with 14. 5% SSC in 2004. The tree is moderately vigorous, productive, with slight susceptibility to bacterial spot. Developed by the Riviera Breeding Program in the Provence Region of southeastern France.

**Encore** – Ripened about August 31 in 2004 and normally September 2. This variety characterized many late season peaches in 2003. Quality was disappointing with the rainy and cloudy weather. Fruit drop was heavy and definitely related to two severe windstorms. Encore is normally our standard for a variety in this season with large size and good color. The tree is very productive, upright, and vigorous.

**Valley Sweet** – A medium sized, very red, very firm, yellow fleshed freestone peach ripening on September 3 in 2004. Valley Sweet has a low acid flavor but the tree is very susceptible to bacterial spot. Fruit size was smaller because trees were young. Developed by Zaiger Genetics in Modesto, California.

**Laurol** – This large firm yellow-fleshed ripened about September 4, in 2004. Laurol is susceptible to bacterial spot. It is one of the most important varieties in New Jersey.

**NJ 47-104** – This attractive yellow-fleshed freestone peach ripened on September 5 in 2004. It has been regularly productive and tolerant to bacterial spot. The flesh is firm and of very good quality. It has been virus indexed.

**Flameprince** – A very attractive, firm, yellow-fleshed, freestone peach ripening about September 6. This southern variety may be a replacement for Encore as it hangs on the tree better. When Flameprince trees were younger it was always a challenge to size the variety. Size is much better on fully mature trees. In 2004 it was later than Encore and size was not as good.

**August Flame** – A very large, very firm, dark crimson red skinned, attractive, yellow-fleshed, freestone peach ripening about September 6. This peach has absolutely no undercolor but is quite susceptible to brown rot and bacterial spot. The tree is vigorous, moderately productive and upright spreading. September Flame is similar but probably too late for New Jersey. Developed by Burchell Nurseries in Oakdale, California.

**Arctic Pride** – A medium large, 50-70% pinkish red-skinned nectarine September 7. Size in 2004 was 44% 2 1/2”, 27% 2 3/4”, and 29% 3”. It has very firm, almost crisp white-freestone flesh and an excellent low acid flavor. At 11 pounds pressure it had 14% SSC in 2004. This year the finish was very good but some years it can have many blemishes and speckling. The tree is vigorous, spreading, moderately productive, and susceptible to bacterial spot. Brown rot can also be a problem. Developed by Zaiger Genetics in Modesto, California.

**Autumn Star** – A larger 50-60% crimson red-skinned yellow-fleshed freestone peach ripening about September 10. The color is variable from year to year. The tree is tolerant to bacterial spot and regularly productive. This variety performs irregularly but keeps evaluating it because it looks so nice some years like 2004.

**Fruit Acres 45** – A large, firm, scarlet red skinned, yellow-fleshed, freestone peach ripening about September 14. Autumn Star has no bacterial spot in this planting and always crops well.

**Yukon King** – An attractive, firm, white-fleshed sub acid freestone peach. Yukon King ripens just after Snow Giant on about September 13. It has an excellent sub acid flavor and average 13.4% SSC in 2003. While Snow Giant is freestone Yukon King and Snowfire two other white fleshed low acid peaches slightly earlier are clingstone. Developed by Zaiger Genetics in Modesto, California.

**NJ G47-122** – An ovate to globose, large, 40-80% crimson red color overcolor and yellow orange undercolor, freestone ripening, September 13. The amount of red color and the brightness of the undercolor will vary from year to year.

Optimum ripening date in 2004 was September 9. Most fruit had 30-60% red skin color, ripening on September 15 in 2003. The red overcolor and brightness of undercolor will vary depending on temperatures this late in the season. The flesh is melting but firm to very firm and holds it firmness well. Flavor is acidic, and sweet, but very good. The tree is vigorous, spreading and productive. One year it had bacterial spot but is generally tolerant. The first harvest of fruit samples in Richwood on September 7, 2004 yielded 81% 2 3/4 to 3 inches and 19% 3 to 3 1/4 inches. SSC on this fruit averaged 12.75, the first harvest of fruit at RAREC on September 7 yielded 35% 23/4 to 3 inches and 65% 3 to 31/4. SSC on these samples was 11.9%.

**Big Red** – A very large 20 to 50% crimson red-skinned variety ripening about September 18. The color on this variety is quite variable from year to year because of the late season and crop load. There are many years when Big Red does not have a full crop. Some growers have moderate success with it. It is susceptible to bacterial spot.

**Other Peaches with Limited Interest in Order of Ripening**

**Raycrest** – A yellow-fleshed clingstone peach ripening on June 21. This is not much of a peach but then what do we expect this early in the season.

**Harbinger** – A yellow-fleshed peach ripening on June 25. Again, not much of a peach.

**Flamin Fury PF 1** – A yellow-fleshed peach ripening on June 30. There are two cultivars with this name, one is small and soft and one is larger and brighter. I’d rather grow FF PF5.

**Crimson Lady** – An attractive yellow-fleshed variety that never produces a crop of fruit. It ripens on June 30. Interesting because of it excellent size for this season. Seldom sets a full crop of peaches.

**Spring Lady** – A firm yellow-fleshed attractive peach ripening on July 2. Tree is week, not productive and very susceptible to bacterial spot.

**May Sun** – A very firm yellow-fleshed peach ripening on July 3. Tree is not productive and very susceptible to bacterial spot.

**David Sun** – A very firm yellow-fleshed peach ripening on July 3. Tree is not productive and is very susceptible to bacterial spot.
Valley Fire – A yellow-fleshed peach ripening on July 7. Fruit was small and variable. Lots of split pits.

USDA BY 87P285 – A small to medium size, attractive, firm yellow-fleshed clingstone peach ripening on July 7. Size is always a challenge with this variety.

Candor – At one time an important commercial variety ripening on July 7. No longer planted because of split pit problem.

Royal May – An attractive yellow-fleshed peach ripening on July 8. This is a very nice peach but trees are not available so few can plant it.

Derby – A yellow-fleshed peach ripening on July 9. Selected as a replacement for Candor with better size but too many split pits.

D Zee III – A firm yellow-fleshed clingstone peach ripening on July 10. It never sets a full crop.

Kern Sun – A very firm yellow-fleshed variety ripening on July 12. Tree was not productive and very susceptible to bacterial spot.


Flamin Fury PF 7 – A yellow-fleshed semi-clingstone peach with 50-70% complete crimson red color but a challenge to size. Ripens on July 13. Glen Glo and Sentry better varieties in this season.

Brittany Lane – An attractive yellow-fleshed, clingstone peach with 70-80% scarlet red overcolor. Ripens on July 13. The flesh is very firm and of good quality. Size is good but trees are only moderately productive and susceptible to bacterial spot. This is one of my earliest blooming varieties and because of this characteristic and its susceptibility to bacterial spot does not do well.

Golden Monarch – A semi-freestone, yellow-fleshed peach ripening on July 17. The peach is large but not firm or highly colored.

Sure Prince – A medium sized, rim, dark-crimson red-skinned yellow-fleshed peach ripening on July 19. This is a nice peach but too small.

Paul Friday 088 – A yellow-fleshed semi-freestone peach ripening on July 20. The fruit is medium large, firm and covered with a 60-80% scarlet red skin. The tree is vigorous, upright spreading and productive. It is tolerant to bacterial spot. This is a nice peach.

LM 131 – A moderately firm to soft, yellow-fleshed semi-clingstone peach ripening on July 20. This variety is too soft.

Honeykist – A very firm yellow-fleshed nectarine with a crimson red color covering 100% of the surface. The fruit ripens on July 20. The flesh clings to the stone and has excellent sub acid flavor. The tree is upright and vigorous but very susceptible to bacterial spot. The fruit is generally from 2 1/8” to 2 1/4” in diameter too small for the wholesale market.

General – A large moderately firm yellow-fleshed peach ripening on July 21. General lacks red skin color and is not firm. It does have good flavor.

Fruit Acres 35 – A yellow-fleshed semi-freestone peach that has only medium size ripening on July 22.

Paul Friday BAC – A yellow-fleshed, medium large, medium firm peach ripening near Redhaven on July 22, 2004. The tree is vigorous, upright-spreading, productive, and tolerant to bacterial spot.

Summer Prince – A firm, yellow-fleshed, semi-freestone peach ripening on July 23. It has an attractive crimson red skin color over 80-90% of the surface. It is attractive but does not have acceptable size.

Red Fremont – A large sized yellow-fleshed freestone peach ripening on July 25. While it has good color, it is probably not firm enough for most peach markets.

USDA BY 78N993 – A yellow-fleshed clingstone nectarine ripening on July 25. The fruit size is regular and small.

USDA BY 97F1006 – A yellow fleshed semi-freestone peach. It has an 80-90% crimson red overcolor and is very firm. The tree is not regularly productive and fruit is a challenge to size.

USDA BY 89P2800 – A yellow-fleshed semi-clingstone peach ripening on July 27. This tree is vigorous, upright but only moderately productive.

June Princess – A small to medium yellow-fleshed semi-clingstone nectarine ripening on July 27. The tree is vigorous, upright, moderately productive and slightly susceptible to bacterial spot. June Princess produces too many split pits and is variable in shape and size.

Paul Friday CBA – A medium sized, firm, yellow-fleshed peach ripening near Redhaven on July 28. The skin has a 60-70% scarlet red overcolor. The tree is vigorous, spreading, productive, and tolerant to bacterial spot.

Flamin Fury PF 14 Jersey – A medium yellow-fleshed freestone peach ripening with FF 15A. Originally was PF 15 but number changed based on evaluation in Swedesboro, New Jersey. However this selection does not look like the PF 15 tested in Swedesboro. It is not as large or with as much skin color. Until I can get this sorted out it stays on this list.

Raritan Rose – A soft, white-fleshed semi-freestone peach ripening on July 29. The skin is covered with 30-50 pinkish red skin color and a cream green undercolor. This old variety is vigorous, spreading, and productive tree is tolerant to bacterial spot.

Burchell B16. 091 – A very firm, large, yellow-fleshed clingstone nectarine ripening on July 30. The skin is covered with 80-100% scarlet red overcolor and a yellowish red undercolor. The flavor is good but astringent. The tree is vigorous, upright, moderately productive, and susceptible to bacterial spot, brown rot and peach scab. This variety has been patented and will be introduced by Burchell Nurseries.

Summer Beaut – A yellow-fleshed nectarine ripening on July 30. This old variety is still one of the best, but it gets many split pits and is only moderately productive.

Firebrite – A yellow-fleshed freestone nectarine ripening on July 31. This is an old variety and is still one of the best. It has very good flavor and is attractive, but is moderately productive and does produce split pits. The tree is spreading, has medium vigor and is susceptible to bacterial spot.

Challenger – A yellow-fleshed semi-freestone peach ripening on August 1. The tree is vigorous, very productive, spreading and tolerant to bacterial spot. Nothing special.

Rose Princess – A semi-freestone white-fleshed moderately firm nectarine ripening on August 1. This nectarine has a 40-60% pinkish red overcolor with a cream green undercolor. The skin can crack and has blemishes. It is susceptible to bacterial spot.

Scarlet Sun – A firm, yellow-fleshed clingstone nectarine ripening on August 2. This nectarine was very attractive with large size. The tree is only moderately productive and susceptible to bacterial spot.

WH 124 – A firm attractive yellow-fleshed semi-freestone peach ripening on August 3. Fruit size is only medium.

Fruit Acres 53 – A firm, yellow-fleshed, freestone peach ripening on August 3. The tree is productive, vigorous, spreading and tolerant to bacterial spot.

Flamin Fury PF Lucky 13 – A medium large, firm, yellow-fleshed peach ripening after Redhaven or on August 3. The skin is covered with a 70-80% crim-
son red overcolor and a greenish red yellow undercolor. The tree is vigorous, spreading, productive and tolerant to bacterial spot.

USDA BY 87 P1006 – A very firm, yellow-fleshed freestone peach ripening on August 5. This peach is very attractive but lacks good fruit size.

Paul Friday ABC – A firm, medium large, yellow-fleshed peach ripening near Redhaven on August 4. The tree is vigorous, spreading, productive and tolerant to bacterial spot.

Summer Zee – A very firm, attractive, yellow-fleshed, semi freestone peach ripening on August 4. It has 80-90% of the skin surface covered with a crimson red color. The tree is not regularly productive and is very susceptible to bacterial spot.

Burchell A38, 039 - A medium, firm, yellow-fleshed, clingstone nectarine ripening on August 4. The skin is covered with 70-80% scarlet red overcolor and a yellow red undercolor. The tree is vigorous, spreading, moderately productive and very susceptible to bacterial spot, peach scab and brown rot.

Blazing Star – An attractive yellow-fleshed freestone peach ripening on August 5 a few days after Redhaven. The medium size is a concern on this variety. The tree is productive, vigorous, and spreading. It is tolerant to bacterial spot.

Crimson Snow – A medium firm, white-fleshed freestone nectarine susceptible to bacterial spot. It has excellent flavor but small size ripening on August 5.

John Boy II Peach – A medium, firm, yellow-fleshed peach ripening just after John Boy. The fruit, although pretty, was only of medium size.

Paul Friday 303 – A medium large, medium firm, yellow-fleshed semi-freestone peach ripening on August 6. The tree is covered with 70-80% scarlet red overcolor and an attractive reddish yellow undercolor. The tree is vigorous, spreading, productive, and tolerant to bacterial spot.

Ernie’s Choice – A large, yellow-fleshed freestone peach ripening on August 7. This was heavily planted in New Jersey but did not hold up well for wholesale marketing. It is still an attractive, large variety for local sales.

Fruit Acres 63 – A yellow-fleshed freestone peach ripening on August 7. The tree is productive, vigorous, and tolerant to bacterial spot.

Carogem – A moderately firm, yellow-fleshed freestone peach ripening on August 7. Carogem just doesn’t have the color or firmness of other varieties in this season.

Tristar – A yellow fleshed freestone peach ripening on August 8. Nothing special as far as size and red color go.

Harrow Fair – A yellow fleshed freestone peach with decent color that ripens near Harrow Beauty on August 8. The fruit size is much better that Harrow Beauty but not as attractive or as firm.

Paul Friday 214 – A yellow fleshed freestone peach with 60-80% crimson red color but variable size, ripening on August 10.

Flameglo – A medium large, very firm, yellow-fleshed, clingstone nectarine ripening on August 10.

Burchell A300 - A medium large, very firm, yellow-fleshed, clingstone nectarine ripening on August 10. The skin is covered with 70-80% scarlet red overcolor and a yellow undercolor. The tree is vigorous, spreading, moderately productive and very susceptible to bacterial spot, peach scab and brown rot.

Beekman Flavorcrest – A yellow-fleshed freestone peach ripening on August 12. This attractive variety has 70-80% of the skin covered with a bright crimson red overcolor. Getting large fruit is a challenge because it is susceptible to bacterial spot.

Pammy Bear – A firm yellow-fleshed variety ripening on August 12 just after Bounty. Pammy Bear is attractive but lacks good size and has a prominent raised suture.

Jolly Red Giant – A very large, yellow-fleshed clingstone nectarine ripening on August 13. The flesh is very firm and cracks, making it quite susceptible to brown rot. The tree is vigorous, spreading, moderately productive, and susceptible to bacterial spot.

Paul Friday 215 – A yellow-fleshed freestone peach with 70-80% crimson red color but lacks good size. Ripens on August 14.

Paul Friday 18B – A yellow-fleshed freestone peach ripening about August 14. This cultivar doesn’t have the firmness, red color or attractiveness of other cultivars in this season.

Benedicte – A firm white fleshed peach ripening on August 14. It is not as large as Sugar Giant nor does it have the skin color of Blushing Star or Sugar Giant.

USDA BY 88P2251 – A firm yellow fleshed freestone peach ripening on August 15.

Burchell A16, 083 – A large, very firm, yellow-fleshed clingstone nectarine ripening on August 15. The skin is covered with an 80-90% scarlet red overcolor. The tree is vigorous, spreading, moderately productive, and susceptible to bacterial spot, peach scab and brown rot. This nectarine has been patented and introduced by Burchell Nurseries.

Arctic Belle – A very firm white-fleshed low-acid nectarine ripening about August 16. The flavor is excellent and low acid. The fruit on young trees was small and very susceptible to bacterial spot.

Ruston Red – A medium large, yellow-fleshed, freestone peach ripening on August 20. This variety does not retain firmness in the wholesale market.

Fruit Acres 66 – A medium-large sized, medium-firm yellow-fleshed freestone ripening on August 20. The skin is covered with a 70-80% crimson red skin color and a red yellow undercolor the tree is vigorous, spreading, productive, and susceptible to bacterial spot.

Glacier – A very firm, white-fleshed freestone peach ripening on August 22. The trees are young and must be further evaluated.

Buddie’s Pride – A yellow-fleshed freestone peach ripening on August 22. The tree is vigorous, spreading and productive.

O’Henry II – A very firm yellow-fleshed freestone peach ripening on August 22. This peach is oblate and only medium large with a dark crimson red skin color over 80-90% of the surface. It is very susceptible to bacterial spot.

Stark Ovation – A firm, large, complete scarlet-red-skinned, yellow-fleshed freestone nectarine. The tree is of medium vigor, productive and tolerant to bacterial spot. Ovation was very smooth and attractive in 2004 but because it ripens with Fantasia and generally is not as uniform and productive is not suggested for planting.

Flamin Fury PF 25 – A medium large, 60-80 crimson-red-skinned, yellow-fleshed freestone nectarine. The tree is of medium vigor, productive and tolerant to bacterial spot. Ovation was very smooth and attractive in 2004 but because it ripens with Fantasia and generally is not as uniform and productive is not suggested for planting.

Jerseystar – A medium large to large yellow-fleshed freestone peach ripening on August 26. The tree and fruit looks like Redskin.

Harcrest – A large, yellow-fleshed freestone peach with a crimson-red skin color on 40-60% of the surface. The tree is spreading, vigorous, productive and tolerant to bacterial spot. This variety has had disappointing color and firmness.
Fruit Acres 120 – A medium-large sized, medium firm yellow-fleshed freestone ripening on August 25. The tree is vigorous, spreading, productive, and tolerant to bacterial spot.

Fruit Acres 136 – A large yellow-fleshed freestone peach ripening on August 26 in 2004. The tree is productive and had no bacterial spot.

Pretty Lady – This very firm yellow-fleshed peach ripens about August 27. It is very productive and seldom sets a full crop of peaches.

Paul Friday 301 – A medium large, medium firm yellow-fleshed freestone ripening on August 27. The tree is vigorous, spreading, productive, and tolerant to bacterial spot.

Sparkling Red – A medium-sized yellow-fleshed nectarine. This nectarine is pretty but does not size. As the trees have gotten older they are weak with leaf curling that continues to reduce the fruit size.

Fruit Acres 138 – A large to very large, yellow-fleshed freestone peach ripening on August 28, 2004. The tree is productive and had no bacterial spot.

Fruit Acres 144 – A large yellow-fleshed freestone ripening on August 28, 2004. The trees are productive and had no bacterial spot.

August Lady – This large very firm yellow-fleshed peach ripens about August 30. It never sets a full crop of peaches and is very susceptible to bacterial spot.

Fruit Acres 146 – A large, yellow-fleshed freestone peach ripening on August 30, 2004. The tree is productive and did not have any bacterial spot.

Snow King – A large to very large, white-fleshed, freestone peach with a dark purplish pink red color over 70-90% of the surface. The flesh is low acid and of very good quality. Fruit ripens on August 30. The tree is moderately productive and very susceptible to bacterial spot and susceptible to brown rot.

Fruit Acres 141 – A large, yellow-fleshed, freestone peach ripening on September 1, 2004. The tree is productive and had no bacterial spot.

Snowfire – A large to very large, white-fleshed, freestone peach ripening on September 2. Snowfire has the same problems as Snow, with low productivity and high susceptibility to bacterial spot.

Autumn Glo – A standard yellow-fleshed variety ripening with Encore on September 2. The tree while productive is susceptible to bacterial spot.

Fruit Acres 148 – A large, yellow-fleshed, freestone peach ripening on September 3 in 2004. The tree is productive and had no bacterial spot.

NJG47-99 – A late yellow-fleshed variety ripening on September 4. The color and medium large size limit the potential for this variety.

Zee Jr – A yellow-fleshed variety ripening on September 4. Nothing special but very large size.

Burchell D2. 093 – A very firm, yellow-fleshed clingstone nectarine ripening on September 6. The skin is covered with a 60-70% scarlet red skin color. The tree is vigorous, upright spreading and produces light crops. It is very susceptible to bacterial spot and scab.

Maccherone Red – A yellow-fleshed selection of Encore ripening on September 7. Not really any different except a few days later.

Fruit Acres 149 – A yellow-fleshed freestone peach ripening on September 7 in 2004. The tree is productive and had no bacterial spot.

USDA BY 86P2184 – A firm yellow-fleshed freestone peach ripening on September 8.

Fruit Acres 130 – A medium firm, yellow-fleshed freestone nectarine ripening on September 10. The skin is covered with 60-70% scarlet red skin color. The tree is vigorous, spreading, productive and tolerant to bacterial spot.

USDA BY 85P8522- A firm yellow-fleshed freestone peach ripening on September 12.

Agate – A white-fleshed, freestone peach ripening on September 15-17. The skin is covered with a 50-70%. Developed by the Riviera Breeding Program in the Provence Region of southeastern France.

USDA BY 85P2609 – A yellow-fleshed freestone peach ripening on September 20. This peach is very late making it hard to evaluate.

September Flame – A very firm yellow-fleshed peach ripening in late September. Because of its late season and its susceptibility to bacterial spot it has little value.

Peaches that have been tested but are no longer suggested for planting and trees have been removed from test blocks. (YP = yellow fleshed peach, WP = white fleshed peach)

Goldprince (YP), Dixeried (YP), Garnet Beauty (YP), LaWhite (WP) Sentinel (YP), Southern Pearl (WP), Riponette (YP) Juneprince(YP), Snowqueen (WN) Karlarose (WN), Flamin Fury 12-B(YP), Sureprince (YP), June Lady (YP), Rich Lady (YP), Snowbirte (WP), Fancy Lady(YP), Amaro (YP) Norman (YP), Sugar Sweet(YP) Late Sunhaven (YP), White Rose (WP), Red Sun (YP), Arctic Rose (WN), June Pride (YP) Harvester (YP), Hawthorne (YP), Topaz (YP), Cullinan (YP) Denmen (YP), Redrose (WP), Fireprince (YP), Finnicum’s Red (YP) Majestic (YP), Jayhaven (YP) La Premier (YP), Arctic Gem (WP), Beekman (YP), Summer Sweet (WP), Tasty Zee (WP), Berenda Sun (YP), Summer Pearl (WP), Elegant Lady (YP), Cassie(YP),July Sun (YP), Zee Lady(YP), Sierra Lady (YP)Ouchita Gold, (YP) Bobeva (YP), Somore (YP), Ryun Sun (YP), RedCal (YP), O’Henry (YP), Legend (YP), Kearney (YP), Lajewell (YP), White Star (WP) August Sun (YP), Snow Gem (WP), Calred (YP), TraZee (YP), Lategold (YP), Fairtime (YP), September Sun(YP), Autumn Prince(YP), Carnival (YP) Autumn Lady(YP), Autumn Gem (YP).

Nectarines that have been tested but are no longer suggested for planting and trees have been removed from test blocks. (YN=yellow fleshed nectarine, WN = white fleshed nectarine) Grand Sun (YN), Mayfire(YP), Snow flame (WN), Crimson Gold (YN), Juneglo (YN), Zeegrand (YN), Earlsicaret (YN), Crystal Red (WN), Earlibird (YN), Red Delight (YN), Sparkling June (YN), Durbin (YN), May Grand (YN), Tastygold (YN), Crystal (WN), Rose (WN), Red Diamond (YN), Diamond Ray (YN), Supreme Red (YN), Ruby Grand (YN), Summer Grand(YN), Midglo (YN), Summer Fire(YN), Zeeglo (YN), Royal Giant (YN), Stark Encore (YN), Flaming Red(YN), Flamekist(YN), Tastyfree(YN), Fairlane(YN)

Jerry Frecon is an extension specialist in the New Jersey Extension System. He leads New Jersey’s peach and nectarine variety evaluation program.
New rootstocks for peaches, plums and apricots are now being introduced into the United States through commercial nurseries for future sales to stone fruit growers. Almost all of these rootstocks are complex Prunus L. hybrids that are propagated asexually. Past experience with newly introduced Prunus rootstocks has shown that extensive testing is critical to avoid potential commercial problems due to non-adaptation of some rootstocks to North American climatic and edaphic conditions. In addition, putative resistance of introduced rootstocks to common soil diseases and other pathogens has not always carried over to orchard sites in the United States. To ensure widespread horticultural testing of new rootstocks, the NC-140 national rootstock testing group continues to serve as an unbiased tester in many different geographic and production areas of the United States and Canada.

Economic viability of a fruit production enterprise is linked directly to orchard productivity and management efficiency. Increased productivity and efficiency require tree survival, managed vigor, and increased marketable yields over the expected life span of the orchard. The growers’ choice of rootstock is often as important, if not more so, than the choice of scion variety whenever peaches, plums and apricots are grown in soils having high bulk density, parasitic nematodes, root rot fungal pathogens, or other edaphic or replant problems. If one or more of these conditions are present, fruit tree survival and growth can be improved significantly by selecting the appropriate rootstock for each soil or site situation. Stone fruit production has been limited in the past by the absence of rootstocks that moderate vigor or are tolerant to undesirable soil properties, site characteristics, and soil-borne pathogens. As good orchard sites become scarce and chemical control practices become cost-prohibitive or unavailable, new rootstocks are needed to overcome soil and site problems, which were corrected in the past by orchard relocation or chemical fumigation.

Many new rootstocks for stone fruits have been developed in the past 20 years (Loreti, 1994; Loreti, 1997; Moreno, 2004; Reighard, 2000), since those listed by Layne (1987) and Okie (1987). Moreover, many of these are now available for testing in North America. This paper discusses some of the recent rootstock releases and their potential for solving some of the specific soil and site problems that stone fruit growers currently face.

Parasitic Nematodes

Many nematode species successfully parasitize peach, plum and apricot roots and frequently cause a reduction in tree growth and survival. Four types of nematodes are recognized as injurious to peach trees in North America (Nyczepir and Becker, 1998). They are the ring (Criconemella xenoplax (Raski) Luc & Raski); root-knot (Meloidogyne incognita (Kofoid & White) Chitwood, M. javanica (Treub) Chitwood, M. arenaria (Neal) Chitwood, and M. hapla Chitwood); lesion (Pratylenchus vulnus (Allen & Jensen) and P. penetrans (Cobb) Chitwood & Oteifa) and dagger (Xiphenema americanum Cobb) nematodes. Rootstocks susceptible to a specific nematode are good hosts for nematode reproduction and are impacted negatively by nematode feeding in areas such as tree survival, growth and fruiting.

Ring nematode has been linked directly to the onset of peach tree short life (PTSL) syndrome in the Southeast (Nyczepir et al., 1983). Most new rootstocks have not been tested for reaction to ring nematode; however, older (1980s) rootstock introductions – such as the French peach seedling rootstocks ‘Montclar’, ‘Rubira’, ‘GF 305’, and

Many new rootstocks for peaches, plums and apricots are now being introduced into the United States through commercial nurseries for future sales to stone fruit growers. Some may have increased hardiness, tolerance to nematodes and or dwarfing. Past experience has shown that extensive testing is critical to avoid potential commercial problems due to non-adaptation to North American climatic and edaphic conditions. Testing through the national NC-140 rootstock-testing project should help shorten the timeframe for picking the best new rootstocks.
‘Higama’, and the plum hybrids ‘Isthera’ and ‘Myran’—were good hosts for ring nematode (Westcott et al., 1994) and were susceptible to PTSL (Reighard, unpublished data). In addition, commercial rootstocks such as ‘Lovell’, ‘Halford’, ‘Bailey’ and ‘Nemaguard’ are also moderately to highly susceptible. Thus far, no rootstock has survived better in field tests in South Carolina and Georgia than the regionally developed ‘BY250-9’ (now ‘Guardian™’) (Okie et al., 1994; Reighard et al., 1997).

Root-knot nematodes cause serious growth reduction in peach trees grown in warmer regions. There are at least four species of root-knot nematode (Meloidogyne arenaria, M. incognita, M. javanica, M. hapla) as well as a number of races within each species that feed on stone fruits. M. incognita and M. javanica are the most common in the southern United States; whereas, M. hapla is found in northern areas. Many peach rootstocks were introduced for root-knot nematode resistance in the United States in the 20th century (Day, 1953). These included ‘Shalil’, ‘Yunnan’, ‘Okinawa’, and later ‘Higama’. All of these rootstocks either were not resistant to M. javanica or had other problems and eventually were replaced by domestically developed rootstocks such as ‘Nemaguard’, ‘Nemared’, ‘Flordaguard’, and ‘Guardian™’. Hybrid rootstocks, such as ‘Atlas’ and ‘Viking’ from Zaiger’s Genetics, are also reported to be root-knot resistant. Traditional plum rootstocks such as ‘M Marianna GF 8-1’ are also resistant or immune to most root-knot nematodes.

Recent introductions having root-knot resistance include peach hybrids ‘Barrier 1’ and ‘Cadaman™’ (both P. persica x P. davidiana), ‘Krymsk™ 86’ or ‘Kuban 86’ (P. cerasifera x P. persica), plum species ‘Torinel™’, ‘Penta’ or ‘Empyrean™ 2’ and ‘Tetra’ or ‘Empyrean™ 3’ (both P. domestica), ‘Adeso 101’ (P. insititia) and ‘Ademir’ (P. cerasifera), plum hybrids ‘Myran’ (P. cerasifera x P. salicina), ‘Isthera’ (P. cerasifera x P. persica x P. cerasifera), ‘Julior’ (P. insititia x P. domestica), ‘Krymsk™ 1’ or ‘VVA-1’ (P. cerasifera x P. tomentosa), ‘Hiawatha’ (P. besseyi x P. salicina), peach-almond hybrids (P. dulcis x P. persica) ‘Garnem’ (GXN15) and ‘Felinem’ (GXN22), and ‘PumiSelect’ (P. pumila) (Esmaejand et al., 1997; Fernandez et al., 1994; Pinochet et al., 2002; A. Nicotra, personal comm.). Most of these rootstocks are compatible with peach and plum, but ‘Torinel™’ is not recommended for peaches, though it is compatible with some apricots and plums. ‘Cadaman™’ is not recommended for apricots.

Lesion (Pratylenchus vulnus and P. penetrans) and dagger (Xiphinema americanum) nematodes are two other problem nematodes in the northern and mid-Atlantic U.S. peach production areas. Lesion nematodes can significantly reduce tree growth and fruit production if not controlled. P. vulnus is a problem in the southern United States and California, while P. penetrans occurs in northern areas. ‘Rubira’, ‘GF 305’, ‘Penta’ (‘Empyrean™ 2’), ‘Tetra’ (‘Empyrean™ 3’), and ‘Torinel™’ are listed as having tolerance to P. vulnus in Europe (Alcaniz et al., 1996), with ‘Torinel™’ being the only one to show tolerance in multiple greenhouse screenings (Pinochet et al., 2002). Pinochet et al., 2002 showed that some were quite susceptible to P. penetrans and that the Canadian peach ‘H7338013’ were more tolerant in greenhouse studies. ‘Bailey’ and ‘Guardian™’ were less susceptible than many of the European rootstocks tested. Thus, multiple nematode species and races create a significant obstacle to finding a broadly adapted, lesion nematode resistant rootstock.

The dagger nematode can be a severe problem in the mid-Atlantic states. The major damage to peach trees from dagger nematode feeding is its vectoring of tomato ringspot virus (TomRSV), which causes stem pitting. Since many weed species, such as dandelions (Taraxacum officinale), are hosts for this virus, dagger nematode resistance in rootstocks is the only way to prevent infection. Dagger nematode species are also vectors for nepoviruses in other regions of the world. Peach seedling rootstocks are not resistant to dagger nematodes, and therefore, non-peach rootstocks need to be evaluated for resistance to the nematode or the virus. In contrast, ‘Marianna 2624’ was reported in Michigan to have some field resistance (Kommineni et al., 1998). Also, some cherry plum (P. cerasifera) genotypes appear to be less sensitive to tomato ringspot virus (Hoy and Mircetich, 1984; Halbrendt et al., 1994). Thus, rootstocks such as ‘Mr.S. 2/5’ (P. cerasifera), ‘Krymsk™ 1’, ‘Krymsk™ 2’ or ‘VSV-1’ (P. incana x P. cerasifera), and ‘Ademir’ (P. cerasifera) may offer some tolerance. However, these have not been tested in the United States for TomRSV resistance.

**Soil Texture, pH and Fungal Pathogens**

Peach and apricot rootstocks are well adapted to sandy, gravelly or loamy soils. Therefore, peach (e.g., ‘Lovell’, ‘Nemaguard ‘Guardian™’) and apricot (e.g., ‘Canino’, ‘Manchurian’, ‘Blenheim’, ‘Haggith’, ‘Manicot’) seedling rootstocks are often the choice for peaches (only peach rootstocks) and apricots (both species) on well-drained, non-calcareous soils.

In contrast, peach and apricot seedling rootstocks are generally not adapted to poorly drained, heavy clay soils or to calcareous soils where pH is above 7.5. Poorly drained soils result in tree decline or death. Weak, unproductive, chlorotic trees are typical when grown on peach or apricot roots in high pH soils. Alkaline soils are uncommon in North America and are only important in stone fruit production areas in Texas, Colorado, and a few other western locations. Therefore, few rootstocks have been developed for these regions, except for peach x almond rootstocks such as ‘Titan’ and ‘Hansen 536’ and from Zaiger’s Genetics, ‘Atlas’ and ‘Viking’, which are interspecific hybrids tolerant of saline and alkaline soils.

Many new rootstocks introduced from Europe were developed for calcareous soils. These include ‘Jaspi’ ((P. domestica x P. salicina) x P. spinosa L.), ‘Pollizzo’ (P. insititia), ‘Julior’, ‘Torinel™’, ‘Paramount™’ (formerly ‘GF 677’, a natural peach-almond hybrid), ‘Cadaman™’, ‘Barrier 1’ (’Empyrean™ 1’ or ‘Primo’), ‘Mr.S. 2/5’, ‘Adeso 101’, ‘Adara’, ‘Garnem’, ‘Felinem’ and ‘Sirio’, ‘Castore’ and ‘Polluce’ (all P. persica x P. dulcis). Of these new rootstocks, ‘Paramount™’ grows well on alkaline soils but it is very vigorous and was not as yield-efficient as other rootstocks on acid soils (Perry et al., 2000). Peach on ‘Jaspi’ has been very susceptible to bacterial canker on acid soils in the southeastern United States. ‘Adeso 101’ root suckers and may have some incompatibility with peach. ‘Jaspi’, ‘Julior’, ‘Cadaman™’, ‘Mr.S. 2/5’ and ‘Adeso 101’ are in current NC-140 field trials.

On heavy or poorly drained soils, peach seedling rootstocks, and to a lesser degree apricot seedling rootstocks, are at risk of becoming infected with Phytophthora or crown rot. Similarly, almost all stone fruit rootstocks are susceptible to the oak root rot fungus (Armillaria mellea and A. tabescens), regardless of soil
texture or drainage. Both of these root rot fungi are difficult to control or eradicate; therefore, genetic resistance to them is highly desirable. ‘Mariana 2624’ has some tolerance to Armillaria but is incompatible with peaches. Moreover, Armillaria resistance reported for ‘Isthar’ and ‘Myran’ in France has not held up in Georgia and South Carolina field tests.

Many European rootstocks recently introduced to the United States are listed as tolerant of waterlogging (Moreno, 2004). Rootstocks labeled as tolerant to waterlogged soils include ‘Jaspí’, ‘Julior’, ‘Pollizo’, ‘Torinel™’, ‘Penta’, ‘Tetra’, ‘Mr.S. 2/5’, ‘Barrier 1’, ‘Adesoto 101’, ‘Adara’, ‘Krymsk™ 1’, and ‘Krymsk™ 2’. The season of waterlogging usually is not specified in rootstock release notices, and thus, it is not known whether these rootstocks are tolerant to dormant or growing season wet soil conditions. Many of these rootstocks were developed in Mediterranean climates that receive their rainfall in the winter. In North America, waterlogging can occur during the growing season. Observations from Georgia during 2001 (K. Taylor, personal comm.) indicated that some of the plum rootstocks were more tolerant than peach rootstocks of waterlogging conditions during the spring, which is an important growth period for stone fruits. Furthermore, although the myrobalan hybrids ‘Mariana 2624’, ‘Mariana GF 8-1’ and ‘Myrobalan 29C’, as well as ‘Torinel™’ are incompatible with peach, they are compatible with plums and some apricot cultivars and may be better choices for stone fruits on heavy soils than apricot and peach seedling rootstocks. ‘Viŋk’, a hybrid rootstock for peaches, is also listed as tolerant of wet soil conditions.

Breeders list many of the clonal hybrid rootstocks as being tolerant of replant sites and soil diseases; however, the endemic replant or soil diseases where they were tested usually are not specifically identified. Therefore, “disease tolerant” rootstocks require regional and local testing for at least one orchard rotation to determine their adaptability to each soil type and climate.

**Winter Temperatures**

Winter cold hardiness of roots of Prunus sp. varies considerably among rootstock cultivars. The absence of snow cover or some orchard floor management practices can increase the susceptibility of stone fruit rootstocks to cold injury.

Rootstocks that are inherently cold hardy or de-acclimate at a slower rate after warm temperatures are necessary to grow stone fruit in cold regions. The majority of cold-tolerant rootstocks for peaches have originated from the Canadian breeding program (Layne, 1987). Releases of the cold-hardy peach seedling rootstocks ‘Siberian C’, ‘Harro Blood’, ‘Tzim Pee Tao’, and ‘Chui Lum Tao’ either have not conveyed outstanding cold hardiness to peach cultivars or have had some other deficiency such as susceptibility to root, knot and lesion nematodes or Armillaria and Phytophthora root rots. New cold-hardy and perennial canker (Cytospora cincta) resistant selections from the former Harrow breeding program were tested in a NC-140 peach rootstock test in 20 states and provinces with some success (Reighard et al., 2004). Some of these Harrow selections like ‘H7338013’, ‘H7338019’, ‘Tzim Pee Tao’, and ‘Chui Lum Tao’ delay scion bloom by 1-2 days in South Carolina. Three Russian rootstocks – ‘Krymsk™ 1’, ‘Krymsk™ 2’, and ‘Krymsk™ 86’ – may offer more cold hardiness than current commercial rootstocks since they were developed from Prunus sp. from regions colder than the stone fruit regions in North America.

For plums, native sand cherry (P. besseyi) is very cold hardy, but selections have not been developed for testing because of low vigor and species incompatibility. The same problems limit the exploitation of P. americana as a plum rootstock. Interspecific hybrids of P. besseyi have been made and selections from these crosses have been reported to be cold hardy in Russia (Okie, 1987).

**Vigor Control**

Peach seedling rootstocks, including brachythic dwarfs, rarely reduce scion vigor more than 10-15%. Size control of peaches through rootstocks of other Prunus sp. has not been achieved satisfactorily due to incompatibility or poor tree vigor. Without graft compatible and size-controlling rootstocks, as with apple, increases in peach, plum or apricot orchard productivity via intensive training systems will be difficult to achieve. Any new dwarfing rootstock must reduce vigor, be graft compatible, and give good fruit production without reduction of fruit size and quality.

European and Russian rootstocks listed as semi-dwarfing (approximate percent of peach standard) include ‘Rubira’ (90%), Italian peach seedlings ‘PS. A5’ (80%) and ‘PS. B2’ (90%), ‘Tetra’ (80%), ‘Castore’ (80%), ‘Polluce’ (80%), ‘Isthar’ (70%), ‘Julior’ (70%), ‘Mr.S. 2/5’ (70%), ‘Adesoto 101’ (70%), ‘Adarcias’ (70%), ‘Adara’ (80%), and ‘PumiSelect’ (70%), a Prunus pumila L. selection developed in Germany (Jacob, 1992). Dwarfing rootstocks include ‘Jaspí’ (60%), ‘Sirio’ (60%), ‘Krymsk™ 1’ (60%) and ‘Krymsk™ 2’ (50%) (Devyatov, 1996). ‘Jaspí’ has been graft incompatible with some peach cultivars but is compatible with plums, and ‘Isthar’ can be used as a semi-dwarfing rootstock for apricots.

In addition, California breeders have developed size controlling rootstocks for peach (DeJong et al., 2004) that are now in advanced testing in California and thus far have reportedly maintained yield efficiency and fruit size despite significant tree dwarfing. Two pending new releases will be named ‘Controller 5’ (50% of standard) and ‘Controller 9’ (90% of standard) (DeJong, personal comm.). Other American semi-dwarfing rootstocks, ‘Hiawatha’ and ‘Citation’ (60 to 70% of normal tree size), sometimes, as in the case of ‘Hiawatha’, or often, as in the case of ‘Citation’ exhibit delayed incompatibility with peaches, though ‘Citation’ is used with plums and apricots with good success. Seedlings of selected Prunus americana genotypes are semi-dwarfing and compatible with peach and plum but have not been widely tested, and commercial availability is limited.

The degree of dwarfing of all of the above rootstocks will vary with the cultivar, climate, soils, and site history. Therefore, without prior geographic testing, it is uncertain how effective these rootstocks will be as size controlling rootstocks in different stone fruit production regions.

**Future Commercial Outlook**

Since the time from initial testing to rootstock commercialization takes many years, expedited virus testing procedures at NRSP5, Prosser, WA and the U.S. Department of Agriculture Animal and Plant Health Inspection Service in Glenn Dale, Maryland have decreased the time to get new Prunus germplasm through quarantine for field evaluation. Furthermore, new rootstocks developed in the United States, France, Italy, Spain, Russia and other breeding programs are primarily complex species hybrids that must be propagated vegetatively. These rootstocks are best reproduced via micropropagation from tissue culture.
explants. Thus, explant culture will likely be the propagation method of choice to mass-produce these unique hybrid rootstocks. Companies such as Agromillora Catalana, S.A. are just beginning this phase of stone fruit rootstock propagation in the United States.

Other factors still complicating the commercial release of new rootstocks are patent laws and licensing agreements that must be negotiated between government agencies, breeders, nurseries, and grower groups. Despite these obstacles, some new rootstocks are being tested through regional and national trials such as the NC-140 national project that evaluates new rootstocks for stone and pome fruits across the U.S., Canada, and Mexico. This, in conjunction with new screening methods and extensive cooperation among researchers, should decrease the time to evaluate promising rootstock selections so that new releases for stone fruit growers can occur more frequently than they have in the past.

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The severe winter weather of 2004 and 2005 caused the death of many peach trees in Western New York, but it gave us an opportunity to evaluate the hardiness of several new peach rootstocks. There are at least two new interesting dwarfing stocks that are showing greater hardiness than ‘Lovell’ and are more size controlling than either ‘Bailey’ or ‘Lovell’.

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ovell’ and ‘Bailey’ peach seedling rootstocks remain the recommended stocks for both peach and nectarine orchards in New York State. This remains true in spite of three separate, ten-year long experiments where we have tested over 40 other candidates. However, there is new hope! New results from the 2005 season (when severe winter cold hammered our 2002 planted Cresthaven rootstock experiment) gave rise to signs that there are at least two other interesting options. Two dwarfing stocks are showing that they possess hardness that surpasses that of ‘Lovell’ and are more size controlling than either ‘Bailey’ or ‘Lovell’. These two dwarfing candidate rootstocks are: ‘Krymsk 1’ (=VVA 1, Russian origin), and ‘Controller 5’ (K146-43 from University of California). Our results are preliminary and we need a couple of milder winters so that we can better judge their yield capacities.

2002 NC-140 National Peach Rootstock Trial at Geneva

The latest trial was planted by the NC-140 group at Geneva in the spring of 2002 and has Cresthaven as the scion variety. It has several promising new stocks from Russia, Europe and California. The planting experienced severe winter cold damage in January 2004 and again in January 2005. We lost all of the flower buds in each of those years, and there was also extensive wood damage and tree death from the cold. Although the trial is too young to make any final conclusions some of the early clues on hardiness and dwarfing are very interesting.

The most vigorous stock in this planting was ‘Lovell’ followed by ‘Adesto’, ‘Cadaman’, ‘MRS 2/5’, ‘Penta’, ‘Pumiselect’, ‘Controller 5’, ‘Krymsk 1’ and ‘Krymsk 2’ (Table 1). The last three stocks were about 65-70% as large as ‘Lovell’. Following the two severe winters in 2004 and 2005, the trees with

2001 NC-140 National Peach Rootstock Trial

The national fruit-tree rootstock testing group, known as the NC-140 project, has continued to test new peach rootstocks from all over the world. A national peach rootstock trial, not planted at Geneva, is showing some significant differences in dwarfing and yield. In Utah and New Jersey the most vigorous rootstock has been ‘Cadaman’, followed by ‘Lovell’, ‘BH-4’, ‘Slap’, ‘SC17’, ‘Pumiselect’, ‘Hiawatha’, ‘Bailey’, ‘Controller 9’ (=P30-135), ‘K146-44’, ‘Controller 5’ (=K146-43), ‘Jaspi’, and ‘Krymsk 1’ (=VVA 1). The two Controller stocks and the elite K146-44 all originated from a joint breeding project of the University of California and the USDA-ARS. In both Utah and New Jersey, ‘Bailey’ has had the highest cumulative yield efficiency after two years of fruiting.

Figure 1. The semidwarf peach rootstock ‘Controller 5’ is in the foreground and the standard peach rootstock ‘Lovell’ is in the background.
the greatest survival rate and the greatest percentage of functional canopy were ‘Controller 5’ and ‘Kyrmsk 1’ followed by ‘Pumiselect’, ‘Lovell’, ‘Cadaman’ and ‘Krymsk 2’. The other three stocks (‘Adesto’, ‘MRS 2/5’ and ‘Penta’) all had less than 40% survival. Although ‘Lovell’ had relatively good survival, the canopy was largely non-functional. ‘Pumiselect’ had good survival with a good canopy, but it had poor anchorage and is likely too weak to resist wind storms. It will need a trellis if planted commercially.

**2002 Nectarine Rootstock Trial**

We planted another peach rootstock trial in 2002 with ‘RosePrincess’ nectarine to answer the question whether nectarine scion cultivars perform differently than peach with several new peach rootstocks. This trial compared ‘Cadaman’, ‘Penta’, ‘Ishtara’, ‘Jaspi’, ‘Krymsk 1’, and ‘Mariana’ GF 8-1 rootstocks. ‘Ishtara’, ‘Cadaman’ and ‘Penta’ were the three most vigorous stocks – all three with significantly greater trunk cross-sectional area than ‘Jaspi’, ‘Krymsk 1’, and ‘Mariana GF 8-1’ in descending order of vigor. Almost half of the ‘Mariana GF 8-1’ trees died within four seasons and we suspect that this stock is probably incompatible with the ‘RosePrincess’ scion. The behavior of the ‘Ishtara’ stock in this trial was quite different from what we saw in an earlier trial with ‘Redhaven’ Peach which was planted in 1994. In that trial ‘Ishtara’ was one of the three least vigorous stocks among 19 other stocks.

**Summary**

For the immediate future, ‘Lovell’ and ‘Bailey’ peach seedling rootstocks remain the recommended stocks for both peach and nectarine orchards in New York State. Two new dwarfing stocks (‘Krymsk 1’ (=VVA 1, Russian origin), ‘Controller 5’ (K146-43 from University of California are showing that they possess hardiness that surpasses that of ‘Lovell’ and are more size controlling than either ‘Bailey’ or ‘Lovell’. We have also found that some peach and nectarine cultivars are graft incompatible with some of the peach and plum rootstocks in our trials.

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Theory and Practice of Genetically Manipulating Peach Tree Architecture

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Each production world-wide 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 trees, 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 using the standard tree type, 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 not certain.

Peaches, as currently grown, produce rather poorly when compared with other tree fruits. The average production of peaches in the U.S. is approximately half that of apple on a per acre basis. The advantages of high-density fruit production have been clearly demonstrated in improving apple yields and reducing labor inputs. Over the last 50 years apple productivity on a per acre basis has increased 200-300% in the United States. The apple systems rely on the use of dwarfing rootstocks and spur-type varieties. Commercially acceptable dwarfing rootstocks are not available for peach (Marangoni et al., 1984) and, although spur-type peaches exist, they are not commercially available. While the possibilities exist for the development of dwarfing rootstocks for peach, there are opportunities for other approaches to growth habit manipulation through breeding scion varieties with new growth habits. These opportunities are based upon the existence of a great variety of naturally occurring peach growth habits. Also, unlike apple, the vast majority of commercial peach varieties have been developed through breeding programs. Therefore, the development of new varieties using germplasm with different growth habits is feasible within our current peach breeding programs.

Variation In Tree Growth - Vavilov’s Law Of Homology

Clearly, as one walks through a tree filled landscape, the wide variation in tree growth forms is apparent. This is even more striking when we consider the array of growth forms used in the ornamental landscape, including dwarf, weeping, columnar, bushy, globose. In some cases these growth forms can be found within the same species. Nikolai I. Vavilov (1887-1943), noting the genetic variation in plant populations, put forward a theory stating that characters found in one species may be found in another, depending on their relationship. Vavilov’s “Law of homology” has remained a principal that has proven to be useful to horticulturists for pointing the way to plant characteristics that may remain as yet undiscovered in a particular species by observing characteristics in a related, or perhaps unrelated, species. It was this law that provided the impetus for our search for alternate peach tree growth habits. Knowing that numerous tree forms exist in the family Rosaceae (stone fruits, apple, pear, quince and many other fruit and ornamental species) we surmised that many of these forms could be found in peach and, in fact, this is the case. In this report I outline the characteristics of the major classes of growth habit in peach and present information on the potential advantages and disadvantages of each type. The development of cultivars expressing alternate growth habits is also discussed.

Currently, peach growers can choose from an array of different peach fruit types (peach, nectarine, yellow flesh, white flesh, melting, non-melting, low acid, saucer shape, etc.). However, few choices exist in terms of tree form. No one form is ideal for all growers because each grower has different needs related to land area, available labor, and equipment. The columnar-shaped tree may be more suitable for high-density peach orchards than the standard spreading type. Such orchards could be trained as a tree wall and harvested using mechanized platforms.

Genetics Of And Breeding For Peach Growth Habit

Most of the peach tree growth habits are controlled by single genes (Table 1; Figure 1). These single genes control, for example, the number of lateral buds that are produced or that grow into branches. This affects canopy density. Some genes control the length of growth between nodes which affects branch length and therefore tree size. Other genes control branch angle and affect the form of the canopy, for example upright or spreading. Since most traits are controlled by single genes, the breeder can generally predict what percentage of seedlings from a cross will carry the new trait. Also selection for growth habit is relatively easy because many growth habits are readily apparent in the field as opposed to a trait like disease resistance that may
require time-consuming inoculation tests to separate susceptible from resistant plants. Nevertheless, most breeding programs produce varieties exclusively of standard growth habit. Since no growth habit is perfect, perhaps there is comfort in working with the problems that one is familiar with versus new, unfamiliar problems that may result from the use of novel tree types.

**Peach Growth Habits**

**Dwarf.** Dwarf trees vary in size but rarely reach over 2.45 m (8 ft) in height. There are at least two types of dwarf trees. Very short internodes, long leaves, and a dense canopy characterize the “brachytic” dwarf. The brachytic dwarf has received some attention in breeding programs and high fruit quality brachytic dwarf varieties have been released (Hansche, 1989; Fideghelli, 2002; Stanica, et al., 2002). The dwarf tree suffers from a number of difficulties beginning at the stage of nursery propagation. Internodes are very short, making propagation through bud-grafting difficult. Trees must be budded high on rootstocks to allow for orchard operations, rootstocks thus require an extra season of growth. In the orchard, the dense, shaded canopy is an ideal habitat for fungal and bacterial pathogens. It is difficult for chemical sprays to penetrate the canopy, and fruit are difficult to locate for thinning and harvesting. These characteristics detract from the commercial potential of the brachytic dwarf. We have evaluated the potential of the brachytic dwarf as a dwarfing rootstock and our results agree with those of Murase et al. (1990) in that it does not dwarf the scion.

Another dwarf type tree (A72) was reported by Monet and Salesses (1975) in France, but it has, surprisingly, received little attention. We have found that seedlings from open pollinations of A72 exhibit a wide range of sizes including those ranging from standard size, semi-dwarfs, full dwarfs, and extreme dwarfs that reach less than a foot in height after five years. Leaves are not “oversized” as they are in the brachytic dwarf and overall the canopies are more open than those of the brachytic dwarfs except in very dwarf seedlings. Fruit quality of A72 and its first generation progeny is poor and at least several generations of crossing to high fruit quality types will be necessary for variety development.

**Compact.** Examples of compact growth habit are ‘Com-Pact Redhaven’ and ‘Compact Gold Medal,’ which is sometimes marketed as ‘Compact Elberta.’ Both of these are presumed single gene mutations of their respective standard varieties (Mehlenbacher and Scorza, 1986). A third compact tree that has been identified is ‘Elbertita,’ presumably a mutation of ‘Elberta.’ 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). While the reduction in tree size (20-50% smaller than standard) is desirable for peach production, the dense canopy and excessive pruning necessary for adequate light penetration would be disadvantageous for commercial growers. However, our observations suggest that if pruning is kept to a minimum ‘Com-Pact Redhaven’ will produce numerous spurs that produce fruit throughout the canopy. This reduces the need to prune for new fruiting wood and it may be possible to develop a new strategy of pruning compact trees that would reduce the density of foliage and still favor fruit production. In terms of rootstock potential of the compact genotype, the dense canopy is accompanied by high root system density that may increase exploitation of soil resources by compact trees and affect shoot development (Tworkoski and Scorza, 2001).

**Semi-dwarf.** Semi-dwarf trees are generally between compact and standard trees in overall size. Their branch growth is similar to standard trees so the dense canopy is not an issue. Breeders at the Istituto Sperimentale per la Frutticoltura, Rome, have obtained semi-dwarf trees from open-pollinated standard varieties such as ‘Sentinal’, ‘Redhaven’, and ‘Southland’ (Fideghelli et al., 1979). These

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*Table 1: Inheritance of peach tree growth habits (from Scorza and Sherman, 1996).*

Figure 1. A selection of peach tree growth habits that can be developed through breeding: Standard form (ST), semi-dwarf (SD), spur-type (ST), upright (UP), columnar (PI), weeping (WE). From Bassi et al (1994).
semi-dwarfs vary in size but are generally about 50-60% the size of standard trees (Quarta and Scortichini, 1985), otherwise they are quite similar to standard trees in appearance. ‘Gage Elberta’, a variety no longer commercially grown, is another semi-dwarf tree. By simply selecting for reduced tree size and high fruit quality, progress in developing semi-dwarf peach trees is being made. Such trees may allow growers to space trees closer, reduce pruning, and increase yields per hectare.

**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 in 1987. Spur-type growth peaches were found in 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 dwarf (Dw/dw) x compact (Ct/Ct) peach hybrids. The spur-type trees recovered were apparently heterozygous at the Dw locus (Dw/Dw) and homozygous recessive (Ct/Ct) (standard growth type alleles) (Scorza, 1987). Spur-type peach trees require a completely different production strategy in order to take advantage of spurs. For example, severe pruning, as practiced on non-spur peach trees, induces vigorous shoot development and does not allow for the development of spurs. Pruning and production systems for fruits such as apricot, plum and cherry may be appropriate models for spur peach.

**Weeping.** Weeping peaches have generally been released as ornamentals. There are at least two programs in Europe, including one in Bologna, Italy and one in Bordeaux, France that currently are (Italy) or have in the past (France) worked on the development of weeping peach varieties for commercial fruit production. Bassi and co-workers (1994) in Italy have suggested that the weeping peach may be of interest for new training systems, similar to the Lepage system in pear with a zig-zag stem made from the scaffold branches alternately radiating from the trunk one above the other.

**Narrow-leaf.** Narrow-leaf or willow-leaf peaches represent a novel growth habit due to a genetic change in leaf width. Narrow-leaf trees produce leaves that may be less than half as wide as normal peach leaves (Glenn et al, 2000) (Figure 2). This may produce a more open canopy that would increase light penetration and potentially, improve color, favor more uniform ripening, and reduce disease incidence. Research has shown that narrow leaf trees are more efficient in their water use and may perform better under conditions of water stress than standard leaf peach trees (Glenn et al., 2000). Studies of the productivity of narrow-leaf trees as well as the pruning requirements for commercial production are underway at the USDA stations in Kearneysville, West Virginia and Byron, Georgia. Selection for variety development is also underway at these facilities (Okie and Scorza, 2001).

**Columnar.** Columnar trees appear to have a long history in Japan where they have been developed as ornamentals (Yamazaki et al., 1987). Left to grow naturally, they will attain a height of up to 5 m (16 ft) and a crown diameter of around 1.5m (5 ft). The most striking feature of the columnar tree is its narrow branch angles (Scorza et al., 1989) (Figure 3). The fruit quality of the columnar (also known as “pillar”) tree that was originally available in the U.S. was poor and yields were low. The breeding program at USDA, Kearneysville and at several locations in Italy (Bologna and Forli) have significantly improved the fruit quality and productivity of columnar trees and several varieties suitable for commercial trials have been developed. These include, ‘Crimson Rocket’ released by R. Scorza USDA-ARS Kearneysville, WV and ‘Alice-col’ released by A. Liverani CRA, Forli, Italy, with new advanced selections under test in both programs. The fact that columnar trees have a naturally narrow canopy appears to make them ideally suited to high-density spindle tree or “wall” systems. The narrow canopy also fits well with mechanical harvesting technology or with picking platforms, since each side of the tree is naturally only several feet in width, making it easy to reach into the canopy to collect fruit. Clearly, the columnar tree presents a radically different approach to peach production. To address the need for information on columnar peach orchard management, pruning and spacing trials have been established in the U.S., Italy, and Canada (Miller and Scorza, 2001). Grower trials have also been established in the U.S. in collaboration with Adams County Nursery.
Upright or Semi-Columnar. Columnar growth habit is semi-dominant with homozygous brbr producing columnar and BrBr producing standard tree forms (Figure 4, Table 1). The heterozygote (Brbr) produces a unique upright or semi-columnar growth habit. This phenotype is neither columnar nor standard but possesses an intermediate growth habit. The upright cultivar ‘Sweet-N-UP’ was released from ARS-Kearneysville. In experimental trials it has shown good fruit quality and size with high productivity. Upright trees can be readily trained to central leader and “Y” systems. The upright tree, while notably different from the standard peach tree, presents a less radical departure from the standard when compared to the columnar tree.

“Mixed” Growth habits. We have hybridized a number of different growth habits such as pillar x dwarf, pillar x compact, dwarf x compact, narrow leaf x pillar, etc. Many of these crosses have produced predictable combinations of traits, and others have produced unique new types. It is clear that desirable growth traits can be mixed and combined in new ways to produce a range of growth habits that are limited only by the imagination.

The Future

Breeders have the potential to develop a number of different growth habits with relative ease due to the single gene nature of most growth habits studied thus far. This does not mean that the process of combining high fruit quality, productivity and new growth forms is a simple, short-term task. Currently, peach growers can choose from an array of different peach fruit types (peach, nectarine, yellow flesh, white flesh, melting, non-melting, low acid, saucer shape, etc.). Few choices exist in terms of tree form. No one form will be ideal for all growers because each grower has different needs related to land area, available labor, and equipment. Real progress lies in making available to growers a variety of growth types so that they can choose. Input from, and collaboration with growers, the nursery industry, and extension and research scientists along with careful study, critical observation, and rigorous testing will decide which traits and combinations of traits are most beneficial for commercial peach production in the future.

NOTE: for a comprehensive summary, including illustrations, and germplasm resources, of stone fruit growth habits see Bassi (2003).

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Scorza, R., L. Melniconco, P. Dang, A.G. Abbott. 2001. Early selection for co-

Figure 4. Standard peach tree (BrBr), upright peach tree (Brbr), columnar or “pillar” peach tree (brbr).
lumnar growth habit in peach using a microsatellite marker. 

Ralph Scorza is a research scientist with the USDA Agricultural Research Service. He specializes in peach tree genetics and breeding.
Stone fruit species are susceptible to a number of viruses, which can cause serious production losses and decreases in product quality. *Prunus* necrotic ringspot virus (PNRSV), tomato ringspot virus (ToRSV), and prune dwarf virus (PDV) are widespread in production areas worldwide and are very destructive for peach, plum, cherry, and apricot production (Gilmer *et al*., 1976; Ogawa *et al*., 1995). Plum pox virus (PPV), one of the most serious diseases for stone fruit, has devastated stone fruit production in Europe (Kegler *et al*., 1998; Ravelonandro *et al*., 2000). Discovery of PPV in the U.S., Canada, and Chile presents a potential threat that PPV may spread widely throughout North and South America and raises a serious concern about containing and eradicating the virus. Hence, development of new cultivars with resistance to multiple virus pathogens is highly desired by growers. Although breeding for virus-resistant varieties has been pursued for decades, progress remains slow because of the inherent long juvenility of tree species, the lack of resistant genotypes, and the genetic complexity of resistance. To date, no stone fruit germplasm resistant to multiple viruses has been reported. In this regard, biotechnology provides an advantage over conventional breeding and can meet industry’s and growers’ needs in a more timely manner. For example, a new PPV resistant cultivar has been developed in plum via genetic transformation (Scorza *et al*., 2001). More importantly, biotechnology makes it possible to manipulate and improve plant resistance to multiple viruses, which is especially important for stone fruit.

Concerns regarding pollen and seed-mediated gene flow and potential food safety of transgenic crops are growing and spurring intense debates. These concerns significantly impact the confidence of both farmers and consumers in adopting and accepting transgenic crops and foods. It is generally feared that copious pollen derived from genetically modified (GM) crops could pollinate and hybridize with their wild relatives, leading to the introgression of superior engineered traits into wild species, thus boosting hybrid fitness through selectively gained advantages (Ellstrand *et al*., 1999; Ellstrand, 2001; Mikkelsen *et al*., 1996; Snow & Palma, 1997). It is also feared that seeds released into the environment from transgenic crops could form unwanted, ‘weedy’ plants in competition with unmodified crops of subsequent years. These volunteer populations could naturalize and persist as feral weed populations and serve as reservoirs from which a transgene could be passed into the genome of a wild relative (Snow, 2002). These prospects raise concerns regarding the creation of super weeds with acquired superior attributes (Hall *et al*., 2000), which have the potential to add management burdens to farmers, and may result in further invasion of natural habitats, compromising the biodiversity of these habitats (Dale *et al*., 2002). In addition, the concerns on potential food toxicity and allergenicity derived from transgenic crops have also been raised.

We are fully aware of the serious virus threat challenging stone fruit production and the public concerns on potential biological risk of transgenic plants, and we are responding by developing a comprehensive strategy to address those problems and concerns. Here we present our current research strategy, progress and results in the course of developing new stone fruit cultivars.
that is composed of gene fragments from each of the six stone fruit viruses. The
PTRAP6
gene was used to construct a dsRNA silencing-competent carrier, PTRAP6i, that
is expected to confer resistance to all six viruses targeted by expressing viral genespecific siRNA in transgenic plants. PTRAP6i was first introduced into Nicotiana benthamiana to test if it was able to confer a strong resistance to the multiple viruses targeted. Characterization of transgenic Nicotiana plants showed that the majority of transgenic lines carrying PTRAP6i underwent gene silencing as evidenced by DNA methylation of the inserted genes and siRNA production. Virus inoculation studies showed that the gene silencing lines were resistant to multiple virus infections. The present study shows evidence that it is feasible to engineer multi-virus resistance in herbaceous plants; hence, this approach can be directly applied to engineering multi-virus resistance in stone fruit in the future.

Development of the Tissue-Specific Transgene Removal and Containment System

To address consumer concerns on the safety of transgenic plants, we proposed the Tissue-specific transgene REMoval and Containment System (TRECS). The TRECS is principally based on the execution of two events in a temporal manner: excision of the transgene during the early stage of reproduction and further containment of the transgene by selectively eliminating the tissues that fail in gene excision during later stages of reproduction. The ideal TRECS should carry a single transgene that contains all the components necessary for transformation selection, agronomical improvement, and its excision and containment. The TRECS transgene should be bracketed by specific DNA fragments that can be recognized and cleaved by molecular scissors and can be efficiently excised in targeted tissues. Ideally, the molecular scissors must be highly efficient to ensure that the transgene is excised in all targeted cells or tissues, and the excision events should take place early in the stage of floral meristem initiation to ensure that the derived pollen and gynoecia are free of the transgene. Any pollen and fruit, which fail in gene excision, are subsequently eliminated by activating the gene whose product is able to ablate or arrest or abscise the targeted tissues. Apparently, the entire TRECS transgene can not be inherited through sexual reproduction due to its nature of suicide action in pollen and fruit tissues; therefore, it must be stably maintained through asexual propagation. The TRECS transgene must also be maintained in a single copy, hemizygous state in transgenic plants for maximal excision efficiency. Stone and other fruit crops are routinely maintained, regardless of their hemizygosity or homozygosity state, from generation to generation through vegetative propagation, without altering their genetic makeup. Therefore, fruit crops, by any standards, satisfy all requirements imposed by the TRECS.

We have made a series of TRECS constructs by assembling a molecular scissors gene, a selection marker gene, a suicidal gene and a fluid (GUS) gene into a roughly 18 kb TRECS transgene fragment that is flanked by two copies of Target sites in a tandem repeat. The Target sites are recognized and cleaved by the molecular scissors gene expressed in early floral meristem tissue by a tissue-specific promoter. As a result, the entire 18 kb TRECS transgene is completely excised in the floral meristem tissue. Hence, the 18 kb TRECS transgene serves as a gene excision initiator and target. The suicidal gene is only activated in pollen and stigma tissues under a specific promoter so that any pollen and fruit derived from floral meristem tissue carrying the unexcised TRECS transgene will be automatically eliminated by the suicidal gene action. Thus, gene excision efficiency can be directly analyzed and compared by evaluating fruit setting, viable pollen, as well as loss of GUS expression in these tissues. We have introduced the TRECS constructs into Arabidopsis and found that some of the transgenic lines were able to efficiently excise the entire integrated TRECS transgene, as evidenced by production of viable transgene-free pollen, seed, and fruit or silique. Further molecular and genetic characterization of transgene excision is in progress.

Future Research

The TRECS technology directly addresses the consumer and scientific concerns on biological risk of transgenic crops and will potentially strengthen the confidence of consumers and growers on the acceptance and adoption of transgenic food and crops. Our long term goal is to develop the reliable and efficient TRECS and multi-virus resistance approaches and ultimately integrate them together into a breeding program developing biologically risk-free, strong multi-virus resistant, and consumer-accepted stone fruit cultivars.

Conclusions

The development of new stone fruit cultivars that are resistant to virus diseases is highly desired by breeders and growers but encompasses enormous genetic and biological challenges for conventional stone fruit breeders. Biotechnology and molecular biology provide an alternative approach that can facilitate the improvement of virus resistance in stone fruits and other woody plants without the lengthy genetic crosses. However, the concerns about food safety and pollen and seed-mediated gene flow of transgenic crops are growing and spurring intense debates, which are deteriorating the confidence of growers and consumers of transgenic crops. We are currently developing a new approach to engineer multi-virus resistance in stone fruit to address the serious virus problems encountered in agricultural practice. We are also developing and testing a tissue-specific transgene excision system in transgenic plants to address the concern about food and environmental safety of transgenic plants. Ultimately, we wish to integrate the two approaches to produce multi-virus resistant, biologically risk-free stone fruit cultivars in the future.

Literature Cited


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