Pruning high density peaches for yield and fruit quality

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Pruning is an essential cultural practice in the production of peaches. Pruning establishes the structure of the tree, its shape and form, provides a framework to support the crop and facilitate mechanical operations. As trees age, pruning removes broken and diseased wood, stimulates new growth, and provides essential light distribution throughout the tree for the formation of strong fruit buds and acceptable fruit quality with appropriate fruit color, soluble solids, and ripeness. In addition, since peaches are extremely fruitful, pruning can be used to judiciously remove a significant portion of the unwanted potential crop at a lower cost than hand thinning.

Basic Concepts for Pruning Peaches

As a review, here is a list of important concepts that must be understood to successfully prune any peach tree.

1. Fruit are produced only on 1 year old wood.
2. The formation of secondary shoots from adventitious buds is rare.
3. Small caliper wood produces small peaches and is most susceptible to winter injury and canker invasion.
4. Peaches require more light exposure than many other fruit crops to grow and mature wood.
5. Peaches are weakly apically dominant compared to apples, cherries and pears.
6. Peaches in the Northeast are very sensitive to canker causing, wood rotting fungi. There are no effective fungicides that can rescue a tree from infection. Since pruning can be the cause of canker formation, the timing and methods used are critical

Timing of Pruning

In the Northeast, pruning must be done when conditions are unfavorable for infection by Perennial Canker (Valsa sp.). Perennial Canker is a weak pathogen that requires a wound to enter the tree and become established. Wounding is commonly caused by winter injury, acute branch angles, and pruning. This fungi is particularly active during periods of cool, wet weather when temperatures are typically below 50^{o}F and wood growth is slow as in the spring and fall.

Pruning timing also influences fruit size at harvest. The later in the growing season trees are pruned, the smaller fruit size. A good compromise for preventing canker infection and maximizing fruit size is to prune during bloom when periods of dry weather are predicted and trees are growing rapidly so wounds heal quickly.

Differences between pruning high and low density

The main difference between pruning high and low density peaches is in the establishment phase when tree shape is being determined. Depending on density and planting scheme, the heading height, the number of scaffolds, branch angles and orientation, and the importance of the role of apical dominance must be determined. All these factors are integrated into the chosen planting system.

The collection of techniques used to prune both high and low density peaches orchards are the same and consist of a) heading cuts, b) thinning-out cuts, and c) bench cuts. However, the selection of the technique and the timing of pruning vary among planting systems depending on the result one wishes to achieve. One must have a good idea of the final outcome desired to prune successfully. Imagining the intended planting system's mature structure is the best way to visualize a formative pruning scheme.

Heading cuts are those made into last year's wood to shorten or stiffen existing shoots. Heading cuts can also be made to thin off some of the potential crop on overset trees. Thinning cuts are those made to remove entire limbs and are the basis of renewal pruning. In peaches, unlike apples, for renewal purposes, at least one viable existing buds must be left after pruning. Thinning-out cuts will remove a limb permanently if renewal buds are not left. This type of cut is used where renewal limbs are not needed.

Role of Planting Systems

Research conducted across the United States has examined and compared the relative merit of various planting systems for peaches (Marini and Rossi 1985, Miles and Guarnaccia 1999, DeJong et al. 1999, Robinson and Hoying 2005, Day et al. 2006). Each geographic region is unique in its requirements for a planting system. In the Northeast, canker diseases caused by winter injury limit a peach plantings economic life to less than 15 years. Early cropping is the most important factor to pay off investment and provide an economic return before the orchard is lost. Even though mature yield and labor efficiency are less important than early yield, those planting systems that are most efficient are often favored over those that are more profitable.

Our research has clearly shown that high density planting systems are much more profitable than low density ones. Increasing densities from 150-778 trees per acre showed increasing profitability using Net Present Value analysis (Fig.1) although profitability slightly declined at the highest density. For maximum profit in the Northeast, growers should plant trees at the densities much higher than they are presently planting and use appropriate pruning schemes.

Vase or Open Center System

The Vase or Open Center system is the most common planting system used in the Northeast today. It requires the establishment of a significant support structure consisting of trunk and scaffolds. The frame of the tree must be strong and fill a larger footprint to support a greater number of peaches compared to trees in higher density systems (Table 1). In order to achieve this goal, this system must start branching close to the ground, be widely spreading and not be allowed to grow more than 8 ft tall. This is often accomplished by using thinning out and bench cuts. The low tree numbers at planting and aggressive pruning to fill abundant space restricts early cropping. At maturity this aggressive pruning provides abundant new fruiting shoots most of which must be removed. All growers are familiar with this traditional style of pruning and many pruning plans have been published (Funt et al. 1982, Lamb and Edgerton 1983).

- Density of 155 trees per acre, spacing 14 X 20 ft.
- Heading height 24 inches above the ground
- 3 or 4 main scaffolds spaced equidistant around the tree
- Upright shoots bench cut out to fill open available space
- Annual removal of upright shoots

- Low early and mature yields

High Density Open Center or Steep Leader System

A modification of the Open Center system that uses more renewal pruning and allows for higher densities is called the "Steep Leader" system. This system uses weaker benching cuts to spread the tree to fill the available space and is allowed to grow more upright and taller. This system allows for more upright growth but still uses bench cutting to fill the available space. Increasing density and additional canopy volume improves early and mature yields compared to the Open Center. It is difficult to keep sufficient light in the lower portion of trees resulting in increased risk of weak wood, smaller fruit size, and canker development.

- Density of 218 trees per acre, spacing 10 X 20 ft
- Heading height 24 inches above the ground
- 4 main scaffolds each divided to form 8 secondary scaffolds and 16 tertiary scaffolds
- Tree height limited by annual benching to side branches 10 feet from the ground
- More labor intensive since ladders needed for pruning, thinning and picking.

Upright Renewal Pruning Systems

In our trial, we included the Perpendicular V (2 permanent upright scaffolds) and the Quad V (4 permanent upright scaffolds) systems. These allowed higher planting densities and used renewal pruning along the scaffold limbs to generate new fruiting wood (Table 2).

Quad Vee System (4 scaffolds)

- Tree density of 366 trees per acre, spacing 7 X17 ft
- Single short trunk started 18 inches above the ground depending on nursery tree type. Trees with abundant buds on the lower trunk can be headed several inches lower.
- Four suitable scaffolds developed from buds on the trunk.Scaffolds should be upright and approximately 15 degrees from vertical.
- 4 main scaffolds, each scaffold should be weakly benched to side shoots annually to maintain upward and outward growth. Upwind scaffolds can use double sectoral cuts.
- Upright shoots in the interior of the tree should be completely removed as they occur to keep a good light environment throughout the tree.

Perpendicular V System (2 scaffolds).

- Tree density of 650 trees per acre, spacing 4 X 17ft.
- Headed at a maximum of 18 inches above the ground but lower depending on nursery tree type.
- Two main scaffolds arising from the trunk approximately 30 degrees between the scaffolds. The center of the tree is open allowing light to penetrate throughout the canopy. This requires one or two summer pruning passes to keep centers open and ensure good light distribution in the bottom of the trees.
- Renewable fruiting wood developed along each scaffold. A significant portion of shoots renewed by cutting back to 2-3 buds for next year's crop.
- Scaffolds are trained over the tractor alley with a 6 foot open gap at the top. Tops are cut back annually to stiffen scaffolds, remove excess crop and maintain tree height.
- Established older trees may have main scaffolds strapped to maintain their integrity.
- This is the most productive system tested and the most profitable.

Single Leader Systems The Central leader and Fusetto (Slender Spindle) have been the system of choice in Eastern Canada (Miles and Guarnaccia 1999) since their research showed that this tree form provided improved production efficiencies particularly in the reduction of labor costs. In addition, orchard workers could understand pruning concepts better since it mirrored what was being done in apples. In our trials, the peaches upright growth habit caused many scaffolds to be too upright and crotch angle management was much more difficult than in the divided canopy systems which naturally trended upright. Tight crotch angles in the CL resulted in canker formation on the main trunk resulting in tree girdling and loss. The tight stacking of fruiting branches one on top of another along the central leader made it more difficult to maintain good light distribution to fruit shoots, buds and fruit resulting in weaker and smaller shoots, invasion sites for canker, smaller and more poorly colored fruit.

Central Leader System

- Tree density of 444 trees per acre, spacing 7 X 14.
- Headed at 40 inches to produce weak permanent bottom tier scaffolds.
- 3 or 4 permanent scaffolds with renewable fruiting shoots above the bottom scaffolds.
- Fruit is produced close to the central leader and stacked vertically but separated to allow for light penetration throughout the canopy
- Aggressive removal of competitive shoot to promote a strong leader is necessary to produce a single upright leader. Weak apical dominance and crop loads on weak non structural shoots in the tree top help to limit vigor and tree height so that they can be planted at closer in-row spacings than the other system types.

Fusetto

- Tree density of 778 trees per acre, spacing 4 X 14 ft.
- Headed at 40 inches above the ground to produce weaker shoot growth
- No permanent bottom tier branches and only thinning out pruning resulting in the earliest yields of any system.
- The high tree numbers combined with early high fruit numbers to produce the best early yield.
- Smaller fruit size than other systems.

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Table 1. The average number of fruit and yield on mature Allstar peach trees on 6 planting systems (2004-2006).

Planting System	Density	# Fruit/tree	Yield (lb/tree)	Yield (bu/acre)
Open Center	155	233.9	97.2	315.8
Steep Vase	218	257.4	101.6	460.7
Quad-V	366	215.6	88.0	614.8
Central Leader	444	122.0	46.7	432.9
Perpendicular-V	641	139.2	49.4	658.2
Fusetto	778	87.1	32.8	529.9

Table 2. Six orchard planting systems evaluated in the New York peach systems trial.

System Name	Scaffold Arrangement	Tree Density/ Acre	Tree Spacing (ft)	Initial Tree Heading Height (in)
Open Center	4 scaffold branches with 4 bifurcations.	155	14 X 20	24
Steep Vase	4 scaffold branches with 2 bifurcations.	218	10 X 20	24
Quad-V	4 scaffold branches without bifurcation and with renewal pruning.	366	7 X 17	18
Central Leader	Central trunk with permanent lower tier of 4 branches.	444	7 X 14	40
Perpendicular-V	2 scaffold branches without bifurcation and with renewal pruning.	641	4 X 17	18
Fusetto	Central trunk with no permanent lower tier branches.	778	4 X 14	40

Figure 1. Effect of tree density on profitability for two peaches and a nectarine variety using a Net Present Value analysis of Profit.