Department of Horticultural Science

Horticulture Information Leaflet 360

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HIGH DENSITY APPLE ORCHARD MANAGEMENT TECHNIQUES

M. L. Parker, Tree Fruit Extension Specialist
C. R. (Dick) Unrath, Professor
North Carolina State University

Commercial apple orchards with trees planted close together on dwarfing or size-controlling rootstocks are referred to as high density plantings. When size-controlling rootstocks are used, tree densities increase from traditional densities of 150-250 trees/acre to 500-1,000+ trees/acre. Benefits of planting higher density orchards include earlier production (especially with "fad" varieties); quicker return on investment; training, pruning and harvesting from the ground; potential increased fruit quality; and greater pesticide application efficiency.

When high density orchards are planted, the training and pruning system must also be modified. For example, characteristics of a typical full sized apple tree are: trees planted 20-35 ft apart and maintained as a central leader primarily by dormant pruning; height of 15-30+ ft with whorls of scaffolds spaced 2-3 ft apart on the central leader; and fruit production begins in the 5-8th year after planting. Characteristics of size-controlled trees, grown on dwarfing rootstocks (i.e. M.9, Mark, Bud, 9 and possibly M.26 with a non-vigorous variety) are: trees planted 5-9 ft apart trained as a miniature central leader with continuous branching along the leader; maximum height of 8-10 ft; and fruit production begins 2-3 years after planting. Trees grown on dwarf, size-controlling rootstocks require training and pruning primarily during the summer to control tree size and encourage fruiting early in the life of the tree with minimal dormant pruning. The training techniques discussed in this leaflet are for scion/rootstock combinations which produce a tree size less than 35% of full size trees.

Many different systems have been proposed for growing size-controlled trees such as vertical axe, slender spindle, HYTEC, etc. In North Carolina, research has indicated that a slender spindle-type tree, modified for North Carolina growing conditions, will be most productive. Starting with unbranched whipped trees, yields of 125 bu/acre in the third year are easily accomplished. If well branched feathered trees are planted, fruit production can begin a year earlier and yields of 1,000 bu/acre is attainable in the 5th year.

Slender Spindle-Type Tree Training and Pruning

With a slender spindle-type training system, there are several components that must be integrated to ensure success. First, the tree must have a permanent support system the height of the entire tree to promote rapid tree growth and support the tree with heavy crop loads. A common support is a 10 ft long piece of conduit or galvanized pipe 1 inch in diameter which is placed approximately 6 inches away from each tree and driven 2 ft into the ground. A 2-3 inch diameter treated wooden post works as well. Trellis systems can also be used successfully with high tensile wire. A typical trellis system will have smaller posts at each tree (i.e. bamboo stake or ½ inch conduit) attached to a top wire approximately 8 ft above the ground with large anchored posts every 50-100 ft to stabilize the top wire. Trellis systems are also used entirely with the wires spaced approximately every 2 ft apart to a height of 8 ft. Independent of the type of support system selected, the trees must be loosely tied to this support system every 15-24 inches along the entire leader. Second, the

trees must receive adequate, uniform moisture during the growing season to maintain tree growth, and irrigation is highly recommended as an insurance against drought. Third, all weed competition in the tree row should be eliminated with herbicides to at least the dripline on each side of the tree.

The slender spindle-type tree is a modified miniature central leader tree with many more limbs per tree. The trunk or central leader is maintained continuously to a maximum height of 8-10 ft. The branching should begin at approximately 24-32 inches above the soil surface. The slender spindle-type tree discussed in this leaflet has two permanent whorls of scaffolds at maturity, spaced approximately 10-12 inches apart to allow for adequate light penetration and optimal fruiting in the lower portion of the tree. During the formative years all lateral branches are left on the tree to optimize early production, branches are thinned out to the two permanent whorls as shading becomes a problem in the 3-5th year or later as required. Above the second whorl of branches, all branches are temporary and are renewed every 2-4 years. The maximum branch spread of this tree outward from the leader is approximately 3-5 ft. (Fig. 1.)

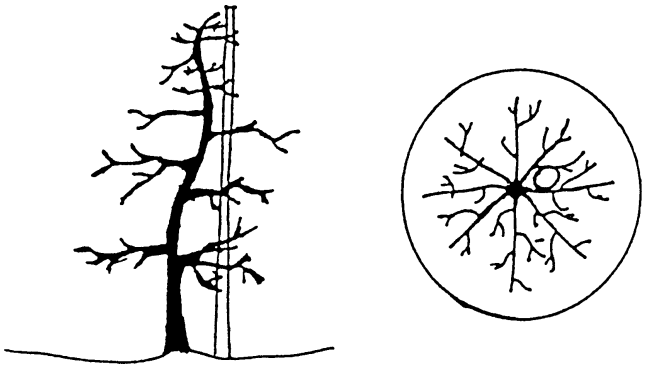

Figure 1: Slender spindle-type training system
Left: General tree structure
Right: Overhead view of scaffold whorl branches showing branch orientation

There is a misconception that "dwarf" trees only grow 8 ft tall and only spread 3-4 ft, when in fact they will grow 10-15 ft tall and spread 6-8 ft outward from the tree if not properly managed. To train a slender spindle-type tree to an allotted space and ensure optimal productivity, it is necessary to use techniques that will maintain leader growth as well as encourage lateral branching. If a tree has a maximum height of 10 ft and there is 2 ft of the tree height without branches (referred to as blind wood), then the tree has lost 20% of its potential productivity. In order to avoid this problem, training techniques for a slender spindle-type tree, from planting to maximum productivity, are discussed below.

Leader Management

After planting an unbranched "whip", the traditional leader management technique would be to head the leader or cut off the leader approximately 30-34 inches above ground just before budbreak. After approximately 3-4 inches of new growth, a new shoot would be selected as the leader from the 3 or 4 most terminal upright shoots and then all shoots beneath the new leader for approximately 4 inches would be removed. If a well branched ("feathered") tree is planted with 5-9 usable branches with wide crotch angles, starting approximately 24 inches above the soil, then the trees should produce fruit at least 1 year earlier than a whip. The traditional leader management technique with a feathered tree would be a modified heading of the leader at 10 inches above the highest usable branch, with usable branches being those that have lower branches within 6 inches. Frequently what is observed in North Carolina is that there are lower branches and then a 1-2 ft length of the leader without branches and then several more branches. In this case, the leader would have been cut off during the dormant season 10 inches above the lower branches to ensure continuous branching along the leader. This is not a preferred technique as the pruning would invigorate tree growth and delay fruit production. Techniques to be discussed in the remainder of this leaflet are those that may be used to produce a high density orchard system which has the potential for early fruit production. The best leader management techniques are those that do not rely upon pruning to maintain the tree shape. Research has shown that any pruning of young trees will reduce or delay fruit production early in the life of the orchard.

A preferable leader management technique is called "weak leader renewal" (Fig. 2 A). This management technique removes the vigorous upright leader and replaces it with a weaker branch to devigorate the leader, maximize branching, and encourage early fruit production. Weak leader renewal involves pruning the central leader during the dormant season, or after bud break if excessive vigor is a problem, just above the highest usable lateral. The lateral is then pulled up and headed at 12 inches and tied to the tree stake as the new leader. Weak leader renewal can also be used to maintain the leader in ensuing years. Weak leader renewal can also be utilized with feathered trees that have lower branches and no higher branches. The leader is removed above the highest usable lateral and then that lateral branch is pulled up to replace the leader.

A remedial technique that also may be used for feathered trees with blind wood is to notch above each node in the unbranched region of the leader 2 weeks before bloom with a hack saw blade going approximately 1/3 of the

way around the tree. Caution should be used so that the cut is only through the bark (phloem) and not the structural wood beneath the bark. Enough of the buds should break in that region, as a result from the notching, to avoid having to head the tree and eliminate the higher branches which would reduce early fruit production.

Another leader management technique that can be used is called "snaking", which is done during the growing season (Fig. 2 B). Snaking is the process of bending the leader when it is 18 inches long to a 60 degree angle and taping or tying it to the tree stake. After the leader grows another 18 inches it is bent back towards the tree at a 60 degree angle and taped to the tree stake. Snaking is a technique that can be used to devigorate the leader and increase lateral branching continuously along the leader. In research plots in North Carolina, snaking resulted in greater early fruit production than weak leader renewal or modified heading because the leader was not pruned. Snaking is one technique that can successfully be used to properly train a leader in high density orchards without pruning.

Another technique that has recently been found to be very effective in North Carolina for increasing lateral branching on the unbranched leader, is referred to as "bagging" (Fig. 2 C). Bagging is appropriate for the apple grower who will take the time to properly bag trees and remove them in a timely manner. Bagging is done by cutting the unbranched leader to a maximum length of 30-36 inches above the highest usable lateral branch 3-4 weeks before budbreak. Then the unbranched central leader is covered with a 2-3 mil, small diameter, clear polyethylene bag similar to an Italian bread loaf bag. Rolls of polyethylene sleeving can be purchased and cut to desired length. The bag is then secured at the top and bottom of the unbranched leader with clothespins or staples. The bag is left on the leader until new lateral growth is 1-2 inches long (or until heat build up in the bag threatens to scorch the succulent tissue), usually 4-5 weeks after bud break. Do not be concerned when the youngest leaves are desiccated several days after removing the bag; trees quickly out grow this condition. For varieties that are difficult to branch, spray the portion of the leader that was in the bag 3-5 days after bag removal with a 250 ppm mixture of Promalin (8 oz. per 5 gal of water + 2.5 oz of surfactant), a plant growth regulator compound of a cytokinin and gibberellins. Promalin will encourage the new shoots to elongate to increase fruit production. For instance, unbranched whips at planting can be bagged to encourage lateral branching instead of heading newly planted trees. Feathered trees with low branches and no high branches can also have the upper portion of the leader bagged without having to prune the tree to encourage lateral branching.

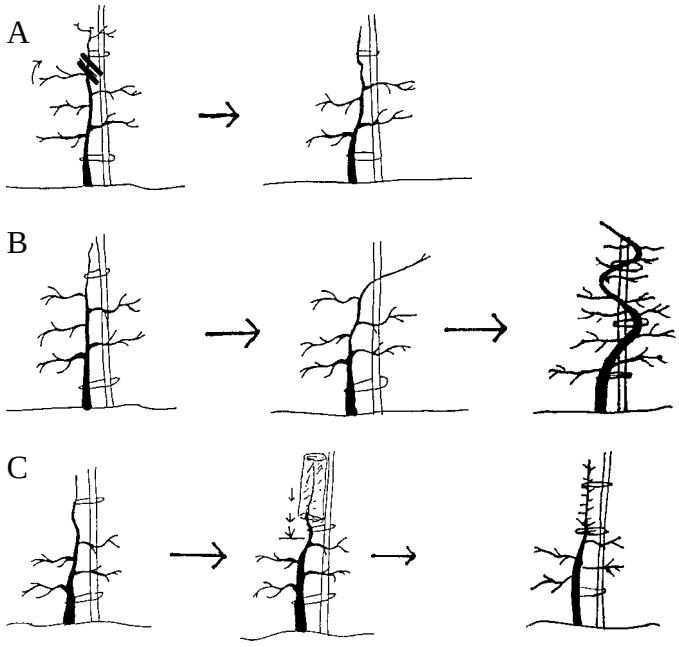

Figure 2. Leader management techniques
A. Weak leader removal
B. Snaking
C. Bagging

Lateral Branch Management

When the emerging lateral branches are 3-6 inches long they should be spread outward to develop a wide crotch angle which will form a strong union for future fruit production. Two tools that are effective for spreading branches are toothpicks or spring loaded clothespins (Fig. 3 A and B). Branches are spread outward as they are 3-6 inches long and maintained to approximately an 80-85 degree angle. As the branches grow, the branch can be held down with concrete weights attached to clothespins and clipped to the branch (Fig. 3 C) or by tying down with string or twine wrapped loosely around the limb and to the base of the tree stake or clips in the soil (Fig. 3 D). All upright secondary growth on the lateral branches is pulled over to horizontal with weights or pulled over and clipped to other lateral branches or removed when 3-4 inches long. Lateral branches that are spread will grow slower due to reduced apical dominance, have more secondary branching and initiate flower buds much earlier due to the reduced vigor. Again, the goal is to avoid pruning and promote early fruit production which is essential for both reducing tree vigor and pulling down lateral branches.

On newly planted trees, all branches with wide crotch angles are left during the first several years to increase initial cropping. If and when shading starts to become a problem in the center of the tree after approximately 3-5 years, branches are thinned out to create two distinct whorls of branches approximately 10-12 inches apart as mentioned earlier to maximize light penetration.

Lateral branches also need to be controlled in length. During the summer the branches can be cut back to their desired length by cutting into wood that is at least 1-year-old to a secondary lateral branch similar in diameter to the branch being cut. If this cut is made during the dormant season, the following spring there will be a vigorous flush of new growth from the are near the dormant cut creating a greater regrowth problem than initially present and will not help in controlling tree size.

With these techniques, a slender spindle-type high density tree can be developed and maintained in North Carolina. These techniques can be combined to help the apple grower produce slender spindle-type trees that are both smaller in height for ease of pruning, training and harvesting, and will consistently bear high quality fruit early in the life of the orchard. Although, high density systems have many advantages, summer training and pruning must be conducted approximately every 4-6 weeks during the growing season. High density systems are not like traditional systems which can be "corrected" after a period of neglect. When high density systems are neglected during the growing season, tree structure, early fruiting, and potential orchard profitability are lost. Because of the greater establishment cost of high density orchards, a commitment to properly train the orchard is essential. However, the advantages of early high quality fruit production, and an earlier and greater return on your investment are real incentives for high density orchards.

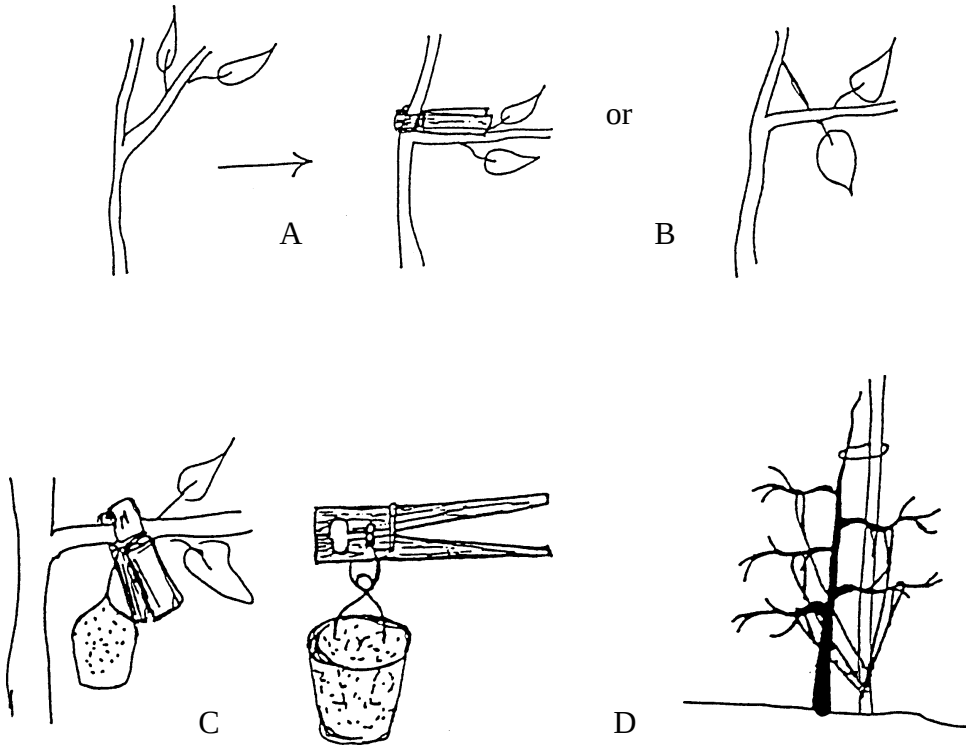

Figure 3. Methods for creating wide crotch angles:
A. Clothespins
B. Toothpicks

Methods for holding branches down:
C. Concrete weights with clothespins
D. Tying down with string or twine