Pruning Concepts for High Density Apple Orchards

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Modern high-density orchard systems such as the Tall Spindle are based on simple pruning concepts that include minimal pruning in the early years to induce early production and limb renewal pruning at maturity to maintain the canopy narrow and with good light distribution. Pruning is always a matter of compromise since pruning has both positive and negative effects. The adverse effects of pruning may include: 1) reduced yield, 2) delayed cropping, and 3) increased vegetative vigor while the benefits of proper pruning include: 1) improved light penetration into the canopy which improves fruit quality and spur fruitfulness, 2) containment of tree size, 3) renewal of bearing surface and 4) improved spray penetration into the canopy resulting in improved insect and disease control. Modern pruning strategies attempt to maximize the benefits of pruning while reducing the negative effects.

Pruning and Training the Young Tree

The Tall Spindle training system depends on minimal pruning of the young tree to promote high early cropping. One of the most significant differences between the Tall Spindle and the more traditional central leader tree management is that the tree is not headed at planting whether it is a whip or a feathered tree. The lack of heading allows development of a tall and more slender tree quicker than if headed and also results in earlier flowering since pruning delays flowering. Another of the important techniques to induce early cropping is limb bending. When limb bending is combined with the lack of heading in young trees, significant early cropping can be achieved in the second year. With the Tall Spindle all of the feathers should be tied or weighted below the horizontal soon after planting to induce cropping and to prevent them from developing into substantial lower scaffolds. The pendant position results in a weak fruiting branch instead of a scaffold branch. With the Vertical Axis and Slender Spindle systems the feathers were allowed to be brought down to horizontal with fruit load in the 3rd year or were tied down a little above horizontal which allowed them to grow into scaffolds over the first 4 year. Growers who attempt to plant feathered trees at the Tall Spindle spacing but do not tie the feathers down often end up with limbs in the lower part of the tree that are too strong which requires pruning at an early age which invigorates the tree and makes long term canopy containment problematic. This simple change in tree management allows for long-term cropping of many feathers and little invasive pruning for the first 5 years when using the 3-4' spacing of the Tall Spindle. After the initial tying or weighting down of feathers at planting, new lateral branches that arise along the leader do not need to be tied down. In most climates, if moderate vigor lateral shoots arising along the leader are not pruned, they will bend below horizontal in the third year and a natural balance between vigor and cropping will be established without additional limb positioning. Thus with the Tall Spindle, no additional limb tying is needed after the initial tying of the feathers at planting. However, in vigorous and/or warmer climates where winter chilling is insufficient, often limbs become too large before they set sufficient crop loads to bend the branches down. In these climates, tying down of all vigorous limbs must be done

annually for the first 3-5 years until the tree settles down and begins to crop heavily. However, in most traditional apple growing areas, growers often invest too much money in limb tying which should be limited to only the feathers at planting.

With a young Tall Spindle tree (years 1-5) pruning is limited to removing an occasional dominant side branch that begins to compete with the leader. These can be near the top of the tree of further down on the trunk. They are identified as side branches whose diameter exceeds 2/3 the diameter of the leader at that height. In the dormant season a young Tall Spindle orchard can be pruned in about 3 hours per acre by walking the rows and removing the occasional side branch that is too dominant and singling out the leader.

Pruning the Mature Tree

When Tall Spindle trees pass year 5 they are considered mature and a simple repetitive pruning process of limb renewal is implemented which is fast, has a minimal number of cuts, results in good light distribution and is easily taught. This simple pruning recipe is readily adaptable to partial mechanization using orchard platforms which can result in savings of 25-35% in dormant pruning costs. One of the most significant differences between the Tall Spindle and the more traditional Vertical Axis and Slender Spindle is that the tall spindle tree has no permanent lower tier of branches. The Tall Spindle is essentially a 10 ft (3m) trunk with small fruiting branches inserted all along its length. The basic tree structure can be developed in only 3 years since the central leader is not cut (headed) at planting. The pruning of the Tall Spindle tree can be simplified into 3 steps.

1. Limiting Tree Height. The leader is not headed at planting or for the first 4-5 years until mature tree height has been achieved. Usually in year 6 after heavy cropping in the top has begun, the leader is cut annually to a small side branch at the optimum height where light interception is maximized without causing excessive shading of the lower canopy. Our experiments have shown this height to be about 90% of the between row distance.

2. Branch Caliper Management. When a lateral branch in the tall spindle tree gets too long or too big in diameter it is removed allowing a smaller replacement branch to develop. To limit the negative effects of pruning on vegetative vigor, we limit the number of branches to be removed each year to just 2. However, if this is repeated annually the tree never develops any large branches and continues from an early to an old age to have only small fruitful branches which give the tree a narrow, slender shape. To assure the development of a replacement branch, the large branch should be removed with an angled or beveled cut so that a small stub of the lower portion of the branch remains. From this stub a flat weak replacement branch often grows.

In the early after trees reach maturity, lower branches including some of the original feathers become too large and are systematically removed (2 per year). We usually target branches larger than ¾" diameter for removal in the Tall Spindle system. At the trees age, the top of the tree tends to overgrow the bottom. To prevent this problem and to maintain good light distribution and good fruit quality as trees age, the top of the tree must be kept more narrow than the bottom of the tree. For the tall spindle system, maintaining a conic shape as the trees age is critical to maintaining good light exposure, and fruit quality in the bottom of the tree. In our experience, the best way to maintain good light distribution within the canopy as the tree ages is to remove whole limbs in the top of the tree once they grow too long rather than shortening back limbs and creating permanent scaffold branches in the tops of trees. A successful approach to managing the tops of trees has been to annually remove 1-2 of the larger upper branches using a

bevel cut. In the upper part of the tree we usually target branches larger than ½" diameter. If the replacement shoots which arise from these cuts are left unheaded they will naturally bend down with crop. When this style of pruning is repeated annually, the top of the tree can be composed completely of young fruitful branches. The younger branches do not cause as much shade as larger older branches and are naturally shorter than the bottom branches thus maintaining the conic shape of the tree.

3. Columnarizing or Simplifying the Fruiting Branches. After the 1-2 largest branches are removed each year, the remaining branches in the tree should be columnarized or simplified (secondary side branches larger than ½ the diameter of the branch should be removed leaving each branch as a long fruiting column) to improve fruit coloring. A columnar branch covered with spurs and fruit will cast less shade on the lower part of the tree than a complex branch which has secondary and tertiary laterals. Such complex branches create a "roof" of shade for the lower branches. When columarized branches become too long or too large in diameter they are removed through the annual removal of 1-2 large branches per tree. When this branch columnarizing strategy is teamed with limb renewal pruning, narrow, slender trees with good light distribution can be maintained over the life of the tree.

Summary

The key objectives for a new high density orchard are to maximize yield in the early years and still efficiently produce large yields of high quality fruit after the trees are mature. The Tall Spindle system accomplishes these objectives by combining high tree planting densities, highly feathered trees that have many small branches instead of a few large branches, minimal pruning at planting or during the first 3 years, branch angle management by tying down all of the feathers at planting to induce cropping and prevent the development of strong scaffold branches that cause difficulty in tree management in later years, and branch caliper management by the systematic removal of large branches to keep the tree manageable. Since large branches contribute to the development of large trees the Tall Spindle trees which have no large scaffold branches remain small and easily managed for many years. The removal of whole branches instead of heading back branches helps limit the adverse effects of pruning on tree vegetative vigor while maintaining a balance of vegetative growth and cropping. Although these principles apply specifically to the Tall Spindle system, they can be applied all other apple growing systems.