



Training & Pruning Fruit Trees

AG-29

Growers often neglect the annual training and pruning of fruit trees. Without training and pruning, however, fruit trees will not develop proper shape and form. Properly trained and pruned trees will yield high quality fruit much earlier in their lives and live significantly longer.

A primary objective of training and pruning is to develop a strong tree framework that will support fruit production. Improperly trained fruit trees generally have very upright branch angles, which result in serious limb breakage under a heavy fruit load. This significantly reduces the productivity of the tree and may greatly reduce tree life. Another goal of annual training and pruning is to remove dead, diseased, or broken limbs. Proper tree training also opens up the tree canopy to maximize light penetration. For most deciduous tree fruit, flower buds for the current season's crop are formed the previous summer. Light penetration is essential for flower bud development and optimal fruit set, flavor, and quality. Although a mature tree may be growing in full sun, a very dense canopy may not allow enough light to reach 12 to 18 inches inside the canopy. Opening the tree canopy also permits adequate air movement through the tree, which promotes rapid drying to minimize disease infection and allows thorough pesticide penetration. Additionally, a wellshaped fruit tree is aesthetically pleasing, whether in a landscaped yard, garden, or commercial orchard.

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Pruning vs. Training

Historically, fruit tree form and structure have been maintained by pruning. Tree training, however, is a much more efficient and desirable way to develop form and structure.

Pruning is the removal of a portion of a tree to correct or maintain tree structure. Training is a relatively new practice in which tree growth is directed into a desired shape and form. Training young fruit trees is essential for proper tree development. It is better to direct tree growth with training than to correct it with pruning.

Pruning is most often done during the winter, commonly referred to as dormant pruning. Training includes summer training and summer pruning as well as dormant pruning. The goal of tree training is to direct tree growth and minimize cutting.

Dormant Pruning vs. Summer Pruning

Trees respond very differently to dormant and summer pruning. Dormant pruning is an invigorating process. During the fall, energy is stored primarily in the trunk and root system to support the top portion of the tree. If a large portion of the tree is removed during the winter, while the tree is dormant, the tree's energy reserve is unchanged. In the spring, the tree responds by producing many new vigorous, upright shoots, called water sprouts, which shade the tree and inhibit proper development. Heavy dormant pruning also promotes excessive vegetative vigor, which uses much of the tree's energy, leaving little for fruit growth and development.

Historically, much of the vigorous, upright vegetative growth has been removed during the dormant season; heavy dormant pruning results in a yearly cycle with excessive vegetative growth and little or no fruit production.

Timing of dormant pruning is critical. Pruning should begin as late in the winter as possible to avoid winter injury. Apple and pecan trees should be pruned first, followed by cherry, peach, and plum trees. A good rule to follow is to prune the latest blooming trees first and the earliest blooming last. Another factor to consider is tree age. Within a particular fruit type, the oldest trees should be pruned first. Younger trees are more prone to winter injury from early pruning.

Summer pruning eliminates an energy or foodproducing portion of the tree and results in reduced tree growth. Pruning can begin as soon as the buds start to grow, but it is generally started after vegetative growth is several inches long. For most purposes, summer pruning should be limited to removing the upright and vigorous current season's growth; only thinning cuts should be used. To minimize the potential for winter injury, summer pruning should not be done after the end of July.

Types of Pruning Cuts

Thinning Cut - removes an entire shoot back to a side shoot. Thinning cuts do not invigorate the tree in comparison to some of the other pruning cuts.

Heading Cut - removes only the terminal portion of a shoot. This type of cut promotes the growth of lower buds as well as several terminal buds below the cut. When lateral branches are headed into oneyearold wood, the area near the cut is invigorated. The headed branch is much stronger and rigid, resulting in lateral secondary branching. Older trees can be held in their allotted space by mold and hold cuts, which are devigorating heading cuts made into twoyearold wood. Young trees and branches where heading cuts are made will be referred to as headed.

Bench Cut - removes vigorous, upright shoots back to side branches that are relatively flat and outward growing. Bench cuts are used to open up the center of the tree and spread the branches outward. *This is a major cut and should only be used when necessary.*

When making pruning cuts, it is important to use techniques that will allow the cut surface to heal quickly. Rapid healing minimizes the incidence of disease and insect infection. Pruning cuts should be flush with the adjacent branch without leaving stubs. Also, when large horizontal cuts are made, they should be slightly angled so that water does not set on the cut surface, allowing the growth of rot and disease organisms.

Many compounds are available as wound dressing or pruning paints. But the best treatment is to make proper pruning cuts and allow the tree to heal naturally. If preferred, tree paints and wound dressing may be used for aesthetic reasons, but they will not promote healing.

Training Systems

One of the most frequently asked questions is, "To what shape should I train my fruit tree?"

It is difficult to give one answer. You can choose from many different training shapes and forms with multiple variations on each form. This bulletin focuses primarily on the central leader and open center training systems for medium density orchards. A list of fruit trees conventionally trained to each system is also included. A fruit tree may be trained to any system. Depending on the form and function of the desired shape, you may want to train a tree to a nontraditional system.

Whatever system is chosen, keep in mind that the objectives of training and pruning are to achieve maximum tree life and productivity.

Central Leader Training - Apple, Cherry, Pear, Pecan, Plum

A central leader tree is characterized by one main, upright trunk, referred to as the leader. Branching generally begins on the leader 24 to 36 inches above the soil surface to allow movement under the tree. The first year, 3 to 4 branches, collectively called a *scaffold whorl*, are selected. The selected scaffolds should be uniformly spaced around the trunk, not directly across from or above one another. Above the first scaffold whorl, leave an area of approximately 18 to 24 inches without any branches to allow light into the center of the tree. This light slot is followed with another whorl of scaffolds. Alternating scaffold whorls and light slots are maintained up the leader to the desired maximum tree height. See Figure 1.

The shape of a properly trained central leader tree is like that of a Christmas tree. The lowest scaffold whorl branches will be the longest and the higher scaffold whorl branches will be progressively shorter to allow maximum light penetration into the entire tree.

Developing a Central Leader Trained Tree At Planting

Fruit trees are frequently purchased as whips, which are unbranched trees ranging from 1/2 to 3/4 inch diameter. The tree should be planted in early winter with the graft union 2 inches above the soil surface. Just before the buds start to grow in the spring, the tree should be headed, or cut off, at 30 to 34 inches above the soil surface. The height at which the tree is headed depends upon where you want the first whorl of branches. Once the tree is headed, permanent branches will be selected from buds growing within 4 to 12 inches below the heading cut. See Figures 1 and 2.

Figure 1. Pruning a central leader tree

At Planting

As the buds begin to swell, head the tree at 30 to 34 inches above the soil surface.

Dormant Pruning

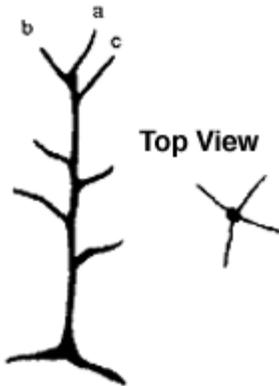
Head the tree at 24 to 30 inches above the highest branch of the first scaffold whorl.

Top View



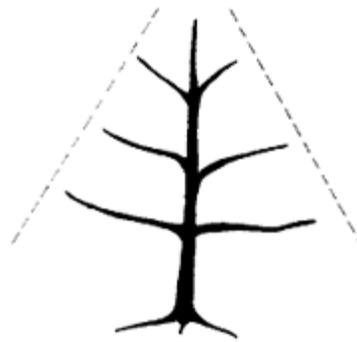
First-Year Summer Pruning

Summer prune when new growth is 3 to 4 inches long. Leave **a** as the new leader, and remove **b** and **c**. Select four uniformly spaced laterals for the first scaffold whorl, and remove the remaining lateral branches.



After pruning the third year

Three scaffold whorls have been developed with three to four branches uniformly spaced around the tree in each whorl. A light slot of 18 to 24 inches is left between each scaffold whorl. Note the Christmas-tree shape that allows light penetration to the lower branches and interior of the tree.



Steps in Pruning:

- Leave only one trunk for the central leader.
- Remove branches with crotch angles less than 60 degrees.
- Remove all branches directly across from one another on the leader.
- Space lateral branches uniformly around the leader to prevent crowding as the limbs grow in diameter.





Figure 2. Newly planted apple tree headed back

Summer Pruning

After the new vegetative growth has reached 3 to 4 inches in length, summer pruning should begin. The first step is to select one upright shoot near the top of the tree to be the leader. After selecting the leader shoot, remove all other competing shoots for approximately 4 inches below it; rehead the tree above this leader. See Figures 3 and 4.



Figure 3.

Left: Heading an apple tree at planting results in several competing shoots below the cut.

Right: For central leader tree, a single leader needs to be selected by removing the undesired shoots.



Figure 4. Central leader plum trees must also have competing shoots removed.

At this time, side shoots (laterals) should be spread out to form an angle of 60 to 70 degrees between the leader and the side shoot. This angle is referred to as the branch or crotch angle. Branches that do not have a wide branch angle are overly vigorous and have a weak point of attachment to the leader. These branches frequently break under a heavy fruit load. Spreading the lateral branches will also slow the growth of the branches to a manageable level and promote the development of secondary or side shoots on the scaffolds. When growth is only 3 to 4 inches, toothpicks or spring clothespins can be used to spread branches. See Figure 5. After a proper branch angle is attained, clothespins can be moved to the ends of longer limbs to weigh down the branches as they start to grow upward.



Figure 5. Central leader apple trees. Toothpicks are used to spread the lateral branches outward during the first growing season.

During the first year, minimize further summer pruning. Limit it to the removal of shoots growing upright or downward. Summer is the optimal time to select the leader and scaffold branches and remove undesirable growth. Branches lower than the desired height should also be removed. A young orchard or tree should be summer trained and pruned once a month through July to remove unwanted growth and to properly orient young branches. Summer pruning will greatly reduce the amount of dormant pruning needed.

Failure to summer prune the first year will result in an improperly trained tree, and drastic dormant pruning will be required to correct tree structure.

Succeeding Years

Managing the central leader is one of the most important aspects of dormant pruning. The leader should be headed at approximately 24 to 30 inches above the highest whorl of scaffolds to promote continued branching and scaffold whorl development. Dormant pruning should also eliminate dead, diseased, and damaged wood. Unwanted growth, such as upright growing shoots and laterals with sharp branch angles not removed during summer pruning, should also be removed at this time. Unbranched lateral branches should be headed back by approximately 1/4 of their length to encourage side branches and to stiffen lateral branches.

Summer pruning in succeeding years should eliminate competing shoots where dormant heading cuts were made (on the central leader and laterals) as in the first year. Summer is also the optimal time to remove unwanted side shoots and excessive growth. All laterals should have a wide branch angle, and spreading of lateral branches is essential for many varieties. Lateral branches will need to be spread for about the first five years, using a larger spreader each year.

Spreaders can be made with 1inchsquare wood pieces with a finishing nail driven in the end and cut off at an angle. Spreaders are frequently made in lengths of 6, 12, and 18 inches. See Figure 6.



Figure 6. Wooden limb spreaders can be made from wood and finishing nails in various lengths.

Spreading branches in later years reduces vigor and promotes fruit development on the lateral branches. The reduced growth rate and the weight of the crop load will also help pull the branches down to a proper angle. However, it is important that the young tree is not allowed to crop too early where the weight of the fruit pulls the branches below horizontal. Once the branches are below horizontal, they are weak and nonproductive and need to be removed and replaced. See Figure 7.



Figure 7. Well-trained apple trees. Note the branch angles and the development of scaffold whorls.

Another objective of dormant pruning is to control the length of the lateral branches. In order to maintain the Christmastree shape (Figure 1), lateral branches need to be cut back. Once the tree has reached its desired height and lateral spread, it will be necessary to mold and hold the lateral branches and the central leader with heading cuts. This can be done by cutting the laterals and leader back into two-year-old wood to a sidegrowing shoot. It is a good rule to cut back to a side shoot that is close to the same diameter as the lateral or leader being cut.

Mature Trees

Mature trees that have been properly trained and summer pruned will require minimal pruning. The first step would be to remove dead, diseased, and damaged wood and then upright shoots and shoots below horizontal. To prevent shading, it is important to maintain the Christmastree shape by heading lateral branches with mold and hold cuts. See Figure 8. For quality fruit production, it is also essential that the light slots between the scaffold whorls be maintained.



Figure 8. Mature, well-trained apple trees, left, and pecan trees, right. Note that the distance between branches needs to be increased for larger trees.

Mature fruit trees that have not been properly trained frequently do not have a true central leader shape. For those trees, the objectives of training and pruning as discussed earlier must be considered. In many cases, too many lateral branches and upright limbs (some may be 6 or more inches in diameter) have been left and need to be removed to allow proper light penetration. This pruning needs to be done during the dormant season.

Neglected trees often have overgrown tops that act as an umbrella, shading the rest of the tree. The tops of these trees need to be cut back or removed. Remember, if the principles of pruning are followed, there are no perfect cuts and no incorrect cuts. However, do not remove more than 30 percent of the tree top to avoid shifting the tree into an excessively vegetative state with little fruit development.

Pecan Tree Consideration

Pecan trees should be trained to a central leader. The lateral branches, however, should be spiraled up the leader. Approximately 12 to 15 inches should be left between branches for adequate light penetration initially. As the tree matures it will be necessary to remove branches to prevent crowding and allow light penetration. See Figure 8, above.

Modifications of the Central Leader

Multileader Tree

A multileader tree is the goal of another training system and an ideal option for pear varieties that are susceptible to fireblight. With a multileader tree, if one leader is infected with fireblight, it may be removed without loss of the major portion of the tree. See Figure 9.



Figure 9. An apple tree trained to a multileader system. This would be an ideal training system for pear trees in North Carolina where fireblight is a threat.

The multileader tree uses the same concept as the central leader tree except there are several leaders in the center of the tree. Each leader is maintained the same as an individual central leader tree. The only difference in training a multileader from the central leader is that in the first and second year instead of removing the competing leaders, several should be left and maintained. On the tree in Figure 1, it would be necessary to leave shoots a, b, and c for a multileader tree. However, it would be necessary to put spreaders between the selected leaders to get the shape of the tree in Figure 9.

Higher Density Central Leader Training Systems

In the commercial apple industry, there is much interest in high-density orchards with 1,000 or more trees per acre. The first requirement for high-density systems is smaller trees, which is accomplished with size-controlling rootstocks. Two of the better-known high-density training systems are the slender spindle and vertical axe. Both are modified central leader trees with branches continually along the central leader to the top of the tree. Light penetration is not a problem as the maximum height of the tree is limited to approximately 6 to 12 feet, with a canopy spread of 3 to 4 feet outward from the leader.

There are many other types of high-density training systems, some with elaborate trellis systems. The slender spindle-type tree is the most popular high-density training system. High-density training systems, however, will not be discussed in this bulletin because of the differences in management practices.

Open Center or Vase Training - Peach, Nectarine, Plum

With the open-center system, the leader is removed, leaving an open center. Instead of having a central leader, the open-center tree has 3 to 5 major limbs, called scaffolds, coming out from the trunk. This training system allows for adequate light penetration into the tree, which minimizes the shading problem prevalent in high-vigor trees such as peach.

At Planting

At planting, peach trees should be set so that the graft union will be 2 inches above the soil surface. As the buds begin to swell, the unbranched trees (whips) are generally headed approximately 30 to 34 inches above the soil surface. As discussed with the central leader system, new branches will come from the buds that are 6 to 9 inches below the heading cut.

Trees that are branched at planting are handled differently than the whips. The work that needs to be done under the tree determines the appropriate height for branching, which is usually 24 to 32 inches. Remove branches that are too low. If there are 3 to 4 uniformly spaced branches around the tree that can be selected as scaffolds, the tree is headed just above the highest selected scaffold. Any remaining branches not selected as scaffolds should be removed. However, if there are less than 3 scaffolds the tree should be cut back to a whip and the side branches removed. See Figures 10a and 10b.

Summer Pruning

After the new vegetative growth is approximately 3 to 4 inches long, it is time to select the shoots that will become the major scaffolds. The lowest scaffold should be 24 to 32 inches above the soil surface to avoid interfering with cultural work under the tree, such as harvesting and weed control. It is best to select 3 to 4 scaffolds that are uniformly spaced around the tree, with wide branch angles, and not directly across from another scaffold. See Figure 10a.



Figure 10a. Training and pruning young peach trees.

Left: Well-branched peach tree to be trained to an open-center system

Right: 3 to 5 well-spaced scaffolds are selected and the tree is headed above the highest scaffold.

During the summer, these shoots should be spread out to a 45 to 60 degree angle and held in place with a toothpick or clothespin. All other upright growth should be removed. It is best to come back through every month during the summer to remove upright growth that is shading the primary scaffolds and to make sure that the scaffolds have been spread to a proper angle. Many times the crotch angle is proper initially, but as the scaffolds grow, they turn upright. A spring clothespin placed on or near the end of a shoot will pull the scaffold down to a proper angle. Extreme care must be taken when using the clothespins as weights. Periodic checking is essential to assure that the scaffolds are not too flat.



Figure 10b. Training and pruning young peach trees.

Left: Tree after heading, branches lower than 24 inches are also removed.

Right: Top view of uniformly spaced scaffolds.

Succeeding Years

After the first year of growth, the primary scaffolds should be selected and properly trained outward. Scaffolds should be headed during the dormant season of the first three years to promote continued lateral branching on the scaffolds and to stiffen and strengthen the scaffold. Scaffolds should be headed to outwardgrowing shoots similar in angle to those being removed. Bench cuts should be avoided. See Figure 11a.



Figure 11a. Dormant pruning a mature open-center peach tree.

Left: Tree before pruning.

Right: Heading a scaffold to an outward growing shoot.

If summer pruning is being practiced, undesirable shoot growth can be removed as soon as growth is 4 to 6 inches long. Summer pruning can also be used to direct scaffold growth outward to the desired growing points instead of waiting until the dormant season.

For bearing trees, the goal of dormant pruning is to remove vigorous upright growth on the scaffolds and trunk that was not removed during the summer. See Figure 11b.



Figure 11b. Dormant pruning a mature open-center peach tree.

Left: Removal of vigorous upright shoots in the center of the tree.

Right: Tree after pruning.

The upright growth left in the tree during the growing season may shade out lateral growth near the trunk. This shading causes lateral fruiting wood only on the ends of the scaffolds, which results in broken scaffolds under a heavy fruit load. It is best to keep the fruiting wood on the scaffolds as close to the tree trunk as possible to reduce tree breakage and to produce the highest quality fruit.

Also, during the dormant season, damaged, dead, and diseased wood, such as cankers, should be removed from the tree. Shoots with shriveled and dried fruit from the previous season, called mummies, should also be removed from the orchard to reduce disease pressure for the coming season.

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