

Training and Culture of Dwarf Apples Using the Vertical Axis System

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Home apple production can be enjoyable and successful if a few basic guidelines are followed. These include proper site selection, fertilization, pest control, training, and pruning. The Vertical Axis System allows for early fruit production on a tree maintained at a height manageable for pruning, spray coverage, and easy access of fruit at harvest. Dwarf rootstocks are suitable for the vertical axis system, but some of the larger semi-dwarf rootstocks, such as M.106 and M.111, are not.

SITE SELECTION:

Apple trees require direct sunlight, a well-drained soil, and a soil pH of 6.0-6.5. The fertility and pH of the soil should be determined by soil testing. For information on soil testing, contact your County Cooperative Extension Service. Avoid low-lying areas where cold air will pool in the spring to reduce the potential for late-spring frost damage.

PLANTING:

1. Adequately water the potted trees before planting. Soak bare-rooted trees for several hours before planting. Plant the trees at the same depth as they are in the pots but make the hole at least twice as wide as the root ball. Spread the roots and trim any broken roots or those wrapped around the pot.
2. For dwarf rootstocks, space trees 6 to 8 feet apart and 10 to 16 feet between rows.
3. Properly fill the hole with soil and water after planting. Make sure that the graft union is 3 to 4 inches above the soil line. Don't leave a basin or a saucer around the trunk. This depression will retain excess water during the winter leading to trunk injury.
4. Mulch around the base of the tree in the spring to reduce weed germination in the spring and summer. Avoid leaving mulch over the winter to discourage attraction of moles and voles. Voles chew the bark off of the roots and lower trunk.
5. Do not fertilize with nitrogen or prune if planting in the fall. Late season nitrogen fertilization or pruning stimulates production of tender new shoots which are susceptible to winter damage. New plantings should be fertilized in the spring.
6. Stake the trees with a 10 foot metal post shortly after planting. Place the permanent stake on the prevailing wind side (generally south/southwest in Kentucky), 4 to 6 inches from the tree and drive 2 feet into the ground. Attach the tree loosely with plastic poly chain. For multiple trees, 1 to 3 trellis wires should be run through the posts for branch support (Figure 1.) When using three wires, place at 3 foot, 6 foot, and the top of the posts. If using one wire, run it at or near the top of the posts. Tie and staple wires on only one end post and use a device to allow for wire tightening at the other end post in the spring. End posts will need to be well braced or anchored.
7. To keep rodents from chewing the bark, place an 18 inch piece of hardware cloth around the trunk, pushed into the ground at least 1 inch or use a white plastic tree guard.
8. For deer control, tie strong-smelling soaps in trees. The soap will need to be regularly replaced as it dissolves.

9. Avoid excessive watering in early fall to allow the trees to harden off for winter, but don't subject trees to a fall drought.
10. In late fall or winter, remove leaf debris to reduce disease levels for the following year.

Figure 1. Wire run from anchor, across top of wood post and along the top of tree stakes.



ANNUAL SPRAYING AND FERTILIZATION

Late-Winter

- **Dormant Oil Spray:** For early control of mites and aphids, spray trees with a dormant oil spray when buds show ¼ inch of green (green tip) in the spring. For pictures of flowering stages of apple, see ID-21 ‘Disease and Insect Control for Homegrown Fruit in Kentucky Including Organic Alternatives.’
- **Fertilization:** Broadcast 3 ounces of urea or ½ pound of 10-10-10 approximately 1 foot out from the trunk of the tree to the edge of the branches. Increase or decrease fertilizer applications based on terminal bud annual growth. The annual growth of the terminal buds is also called terminal or new growth (see Figure 12.) Young trees should have 24 to 30 inches of new growth each year, and bearing trees should have 8 to 12 inches of growth.

Early-Spring:

- **Follow a Regular Spray Schedule:** A reduced spray schedule is used in years prior to fruiting. Concentrate more on the early sprays during this period. Once trees begin fruiting, they are generally sprayed every 7-10 days, from green tip through fall. Spray recommendations are available in ID-21. It is recommended that the fungicides and insecticides be purchased separately and not pre-mixed. Many pesticide labels allow tank-mixing during application. Check labels for mixing compatibility between chemicals. Be sure to follow all label instructions, especially the pre-harvest interval (minimum time between spraying and harvest). Larger operations may wish to use the commercial recommendations in ID-92 ‘Midwest Tree Fruit Spray Guide’ available at your local Extension Office.

CULTIVAR AND ROOTSTOCK SELECTION:

Most apple cultivars require cross-pollination for proper fruit set and development. ‘Golden Delicious’ trees are used as a pollinator for many apple cultivars. Cultivars not recommended as pollinators include ‘Mutsu’ or ‘Crispin,’ ‘Jonagold,’ ‘Gravenstein,’ and ‘Stayman Winesap.’

All apple cultivars are grafted on a rootstock. The scion or the top part of the graft is the cultivar selected for its desirable fruit quality. The rootstock or the bottom part of the graft is another cultivar used for the characteristics it may impart to the tree. These include controlling the mature tree size, improving soil adaptation, and enhancing disease and insect resistance. Many rootstocks are available and their dwarfing capability range from 20% to 80% of a standard seedling tree or a tree grown on its own roots. Dwarfing rootstocks range in size from 20% to 50%, while semi-dwarfing rootstocks range in size from 50% to 80%. Both dwarfing and semi-dwarfing rootstocks result in precocious trees. Precocious trees bear fruit earlier than trees grown on their own roots, or standard rootstock.

One-year-old trees survive better and establish themselves sooner than older trees. One-year old trees are often called whips because the trunk has few branches at this stage. New buds will develop into side branches in the second year of growth.

Both dwarf and semi-dwarf trees bear fruit in 2 to 3 years, depending on the rootstock chosen. In the first few years, the training system described in this publication allows for fruit production the second season after planting for dwarf and smaller semi-dwarf rootstocks in Kentucky.

Although plant heights listed for dwarf trees are 8 to 10 feet and for semi-dwarf 12 to 20 feet, trees are often much bigger in Kentucky. With a long growing season, apple trees are more vigorous, grow taller, and produce fruit earlier than in the northern states. Trees can annually produce anywhere from 2-4 bushels on dwarf rootstocks and 6-10 bushels on semi-dwarf rootstocks. The dwarf rootstock, Bud.9, is recommended for this training system except for certain apple cultivars such as ‘Gold Rush’ or for spur type trees. These trees should be grafted instead on the M.7 semi-dwarf rootstock.

PRUNING:

Properly pruned apple trees can be kept smaller with good care and will provide nutritious quality fruit for the whole family. With selection of suitable dwarf or small semi-dwarf rootstocks and proper pruning and training on a regular basis, it is possible to grow several cultivars in a relatively small area. Annual pruning is much easier than extensive pruning on neglected and overgrown trees. Regular thinning of old wood rejuvenates the tree for continued production of high quality fruit.

As a general rule, it should be possible to ‘look through a tree’ that’s properly pruned (Figure 2.) There should be good light penetration to avoid a dark, dense mass of leaves and branches. The amount pruned will vary as not all cultivars grow with the same vigor.

Figure 2. A well-pruned tree allows light and air circulation through the canopy.



PRUNING CUTS:

There are three types of cuts used to prune trees:

1. **Heading Cut:** With heading cuts, the branches are tipped. The purpose of a heading cut is to remove the growing point or the branch tip to encourage branching in one year old wood. This changes the shape of the tree and causes denser growth. Heading cuts tend to encourage branching and are generally used on younger trees to develop branches where they are desired. Heading cuts tend to delay flowering and fruiting.
2. **Thinning Cut:** Thinning cuts can be used to remove or reduce size of limbs competing with the central leader, to keep lower tier of scaffold branches out of the center aisle, and to limit overlapping branches between trees. When making a thinning cut, the entire branch is removed back to its base or collar (Figure 3.A), or to another limb (Figure 3.B). The collar is the raised area at the base of the branch. A branch cut back to its collar leaves a smaller wound which is more rapidly grown over sealing out pathogens. A branch cut back to another limb is usually made by cutting back into two-year old wood or older. This cut prevents excessive growth. To determine where new growth begins, look along the branch, starting at the tip, until you see a series of rings very close together, all within about a quarter inch (Figure 4.) These are the terminal bud scale scars separating two years of growth. Do not use pruning paint on tree wounds.

Figure 3. (A) Thinning cut to the base of a branch, and (B) Thinning cut back to another limb.

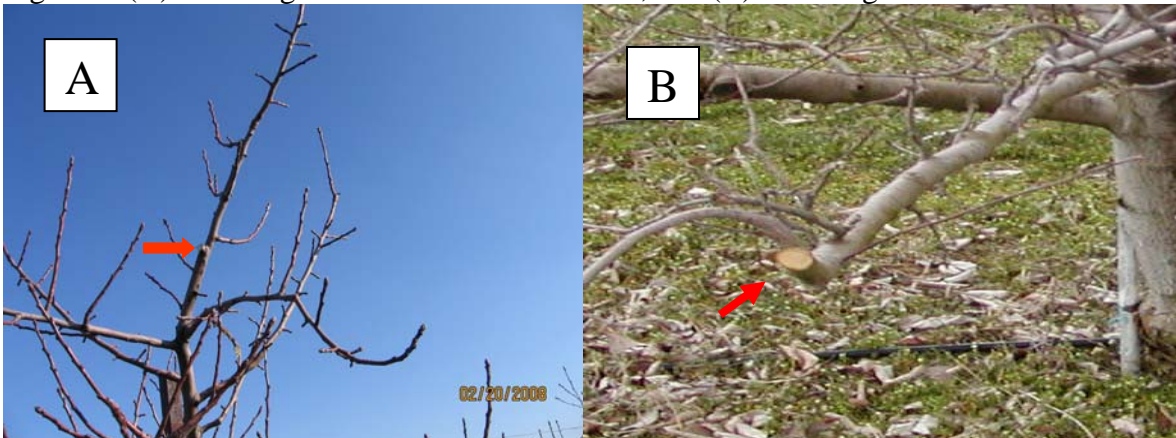


Figure 4. Two-year old wood is on the right side of the arrow, one-year old wood on left.



3. **Bench Cut:** A branch is cut near the trunk leaving a 1 to 2 inch stub from which new branches develop to fill the space recently emptied. The branch cut is made at near-horizontal with the ground leaving a flat or 'bench' surface. The bench cut usually results in new shoots from which one can be selected to fill in the empty space. This cut is often used to maintain the pyramidal shape of a tree by renewing a larger branch in the upper portion of the tree or a broken lower scaffold limb (Figure 5).

Figure 5. Two newly developed shoots (arrow) from a bench cut.



VERTICAL AXIS SYSTEM

This system is designed: 1) to grow a tree to its desired height quickly by not heading the central leader during the development years and by removing all competitive shoots within 12 inches of the leader's terminal bud position at the start of each growing season, and 2) to prevent the development of strong upper tiers of scaffolds by removing and renewing back to the trunk any upper branches that get too large and shade the bottom branches. With this training system, the only time the central leader is headed is at planting. This allows the tree to establish 4-5 permanent lower scaffolds and to balance the top growth with the root system. The leader should not be headed again until the tree is at its mature height and crop load has bent the top of the leader over and limited its height.

With the Vertical Axis System, trees are trained to a Christmas tree shape with strong near-horizontal lower scaffold branches and weak yet fruitful upper branches to maintain good light penetration and air movement. The improved light penetration and air circulation reduces disease pressure and increases flowering and fruit development. Training to the vertical axis system reduces the amount of pruning, and makes it easier to spray for disease and insect pests, thin unnecessary fruit, and harvest.

1ST SEASON TRAINING

Spring:

- At planting, head back the central leader to a height of 43 inches above the soil line if the tree already has 3 or more branches (often referred to as "feathers") at least 10 inches long. The branches will become the scaffold branches on the mature tree. Head back the feathers or branches by removing one third of their length (Figure 6.) For trees with fewer than 3 branches 10 inches in length, head the leader to 35 inches above the soil line, and cut back all branches to a one inch stub.

Figure 6. A newly planted tree: branches were left facing 4 sides of the tree. These will become the 1st set of scaffold branches of a mature tree.



- Once the terminal or topmost bud is ¼ to 1 inch long, remove the next two buds below it. This eliminates weak narrow-angled branches that compete with the central leader.
- Clear lower trunk by removing leaf bundles or shoots on the trunk to a height of 24 inches above the ground to allow space for the rodent guard.
- Deflower by removing blooms. At this stage, the tree needs to put all nutrients into developing branches and a root system. Failure to do this causes the tree to ‘runt out’ and delay fruit production.
- When the growth of new side shoots is 2 to 4 inches, use wooden clothespins clipped to the trunk pushing down on the lateral shoots to promote favorable crotch angles (60 to 90 degrees) with the main trunk.

Summer:

- Tie the leader loosely to the support pole with a permanent tie leaving a 2 inch diameter loop.
- Remove clothespins or spreaders when branches have stiffened, usually after 4 to 8 weeks. Do not allow them to girdle the trunk.
- Remove suckers growing from the ground or from the main trunk below the graft union (Figure 7.)

Figure 7. Remove root suckers.



2ND SEASON TRAINING

Winter (Dormant)

- Do not head central leader or prune trees.
- If additional scaffolds or branches are needed to fill an empty space, find a dormant bud at the desired location on the trunk and score above it or take a thin sliver of bark out. Do this at bud break to encourage growth of the dormant buds.

Spring

- After 4 to 6 inches of growth, remove (pinch or cut off) the terminal bud and 4 to 5 expanding leaves of any new lateral shoot in the top ¼ of last year's central leader growth.
- Tie the developing leader to the stake or support system with a permanent tie.
- If the tree averaged at least 24 inches of terminal growth the previous season, remove all fruit on one-year old wood and thin fruit on older wood to 4 to 6 inches apart. Without thinning, fruits will be smaller, quality will be lower, and trees will be stressed and become biennial bearers (bear every other year). If the tree made poor growth the previous season, less than 24 inches, remove all fruit.

Summer

- Re-pinch vigorous lateral shoots in top ¼ of last year's growth.
- Spread and/or tie down the 4 or 5 permanent lower scaffold branches to a 60 to 90 degree angle with the trunk.
- Remove upright suckers, water sprouts, and downward growing branches.

3RD SEASON TRAINING

Winter (Dormant)

- Do not head central leader.
- Remove vigorous upright limbs that are more than 2/3 the diameter of the leader using a bench cut.
- Tie, weigh down, or use commercial spreaders to spread limbs to an angle of 60 to 90 degrees with the trunk of the tree (Figure 8.) Branches at this angle bear more fruit, and are much stronger than narrow angled branches.

Figure 8. Commercial spreaders are available in multiple sizes.



Spring

- After 4 to 6 inches of new growth, remove any new lateral shoots in top ¼ of last year's central leader growth. Alternatively, if more fruiting spurs are desired, about 2 inches of each of these new lateral shoots should be removed by pinching the terminal bud and 4-5 expanding leaves.
- Tie the developing leader to the stake or trellis.
- Hand thin fruit to 4 to 6 inches apart.

Summer

- Re-pinch vigorous lateral shoots in top ¼ of last year's central leader growth.
- Prune back scaffold branches to maintain a cone or Christmas tree shape. Pinch, rub, or cut off water sprouts or branches that are growing straight up throughout the season. Water sprouts are not fruitful and make the tree dense with foliage which reduces effective spray coverage (Figure 9.)
- Lower scaffolds not expected to support the crop should be either tied up or pruned back to prevent limb breakage, and preserve tree structure.

Figure 9. Water sprouts removed from a branch.



4TH SEASON TRAINING

Winter (Dormant)

- Do not head central leader.
- Use a bench cut to remove overly vigorous upright limbs that are more than 2/3 the diameter of the central leader.
- Tie, weigh down, or use commercial spreaders to spread limbs to an angle of 60 to 90 degrees with the trunk of the tree.

Spring

- Hand thin fruit 4 to 6 inches apart.

Summer

- Remove upright suckers and water sprouts to open the canopy up for better sunlight penetration, and head back and/or thin branches as needed to maintain the Christmas tree shape of the tree.
- Tie leader to support system with a permanent plastic poly chain tie (Figure 10.)

Figure 10. Plastic ties loosely supports the trunk.



5TH AND 6TH SEASON TRAINING

Winter (Dormant)

- Do not head central leader.
- Use thinning cuts to shorten lower scaffold limbs as needed to facilitate movement of equipment and to preserve fruit quality on lower limbs.
- Annually remove one of the least desirable lower tier scaffold branches until only 4 remain.
- Shorten branches growing downward back to a horizontal branch.
- Remove up to one upper scaffold limb with a bench cut each year to begin renewal of fruiting branches.

Spring

- Thin fruit 4-6 inches apart as in previous seasons

Summer

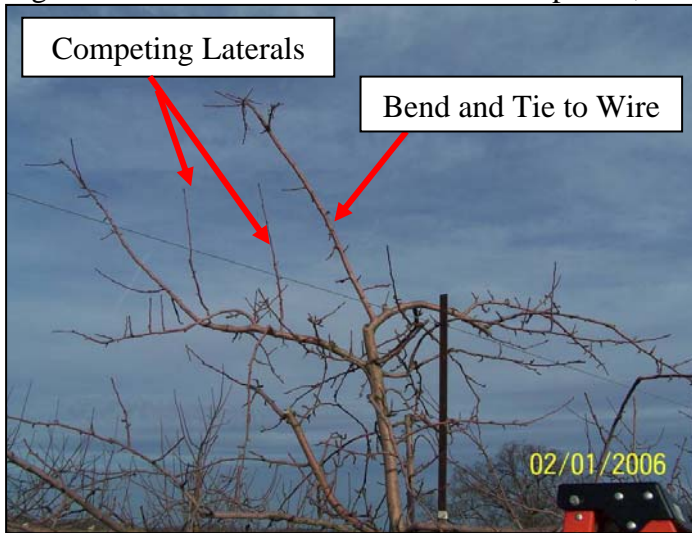
- Remove upright suckers and water sprouts as needed to open the canopy up for better sunlight penetration, and head back and/or thin branches as needed to maintain the Christmas tree shape of the tree.

MATURE TREE TRAINING (7TH SEASON AND BEYOND)

Winter (Dormant)

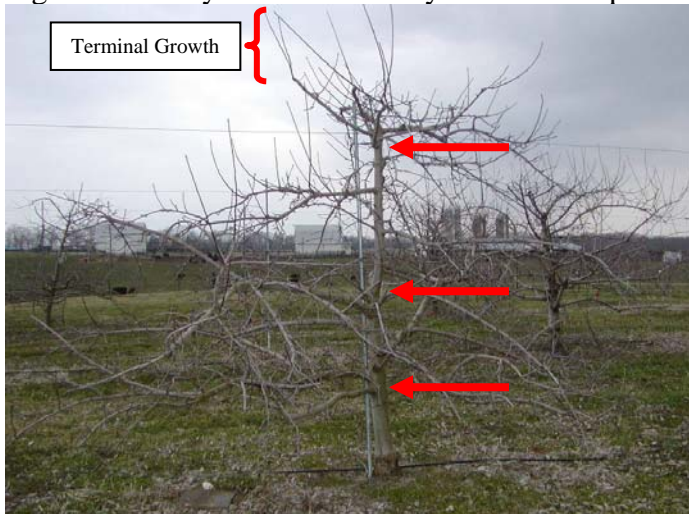
- Remove and renew 1 to 2 vigorous upper scaffold limbs each year. Leave weak fruiting wood and permanent lower scaffold limbs.
- When the tree has reached the height you desire (10 to 14 feet, depending up on the rootstock), tie the central leader over horizontally to the stake or trellis or cut back the leader to a fruitful side branch (Figure 11.)

Figure 11. Bend the leader and tie to the top wire, and thin out branches taller than the leader.



- Shorten bottom tier of scaffolds by pruning back to a side branch to facilitate equipment movement and preserve fruit quality on lower limbs.
- Remove water sprouts and root suckers, and any dead, diseased, crossed, or otherwise poorly placed branches. Scaffold limbs and main branches should spiral out around the trunk. Make sure they are not directly opposite each other to make the branches stronger and not directly over each other to prevent shading. Annual pruning will result in little pruning at maturity since the main structure is achieved (Figure 12.)

Figure 12. A 7-year old tree ready for dormant pruning. Notice the 3 sets of scaffold branches.



Spring

- Thin fruit as in previous seasons.

Summer

- Prune branches as needed to maintain the Christmas tree shape of the tree. (Figure 13.)

Figure 13. A properly trained and pruned mature apple tree.



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