Pruning and training fruit trees

Pruning and training fruit trees helps produce good annual yields of quality fruit. This practice develops a strong framework that increases the tree's life and reduces loss from limb breakage. Improvement of fruit quality depends, in part, on proper pruning.

The kind and amount of pruning is largely determined by the kind, cultivar, and age of fruit trees. Other considerations are the existing framework, tree vigor and health, and growth and fruiting habits.

Flower bud location on fruit trees

	Shoots		Spurs	
	Terminal	Lateral	Terminal	Lateral
Apple	Minor	Sometimes	Major	
Pear	Minor	Sometimes	Major	
Peach		Major		Minor
Plum		Minor		Major
Cherry		Minor		Major
Apricot		Minor		Major

Heavily pruning young trees should be avoided because it may delay the time of bearing from 1 to 3 years. On the other hand, neglecting to prune during the first 3 or 4 years can result in a poor framework with weak, narrow-angled crotches. Careful training techniques during the first few years are essential to develop a desirable framework and tree shape. Once the basic tree form is achieved, light annual pruning is desirable until the tree begins bearing.

Insufficient pruning of bearing trees may result in small, poorly colored fruit with a low sugar content and mediocre flavor. Trees that are overpruned may also produce poorly colored fruit, although of large size. Such fruit usually have large, soft cells and consequently a short storage life.

In addition to affecting fruit quality, pruning affects the fruiting potential of the tree for the following year.

Definitions of pruning terms used in this publication appear on pages 27 and 28.

Tree vigor, nitrogen fertilization, and the anticipated crop determine the amount of pruning needed on a bearing fruit tree. Excessive pruning and/or too much nitrogen fertilizer result in vigorous shoot growth with little or no flower bud formation for the following year's crop. Heavy fruiting, particularly in conjunction with too little pruning and/or nitrogen, results in a devitalized tree that is unable to form llower buds. A balance must be maintained between vegetative growth and fruiting through the regulation of pruning, nitrogen, and crop.

The best method of determining how much to prune is to judge the tree vigor and anticipated crop. For most bearing apple trees, the tree is considered to have adequate vigor if it produces an average of 10 to 15 inches of terminal shoot growth. If the terminal growth is less than this, it should be pruned more heavily than the previous year or more nitrogen should be applied. If average terminal growth is greater than 15 inches, less pruning should be done or nitrogen reduced. If a heavy crop is anticipated, the amount of pruning can be increased somewhat, but pruning should not be used as a substitute for fruit thinning.

Pruning

Season for Pruning

Most orchardists prune during the dormant season. During dormancy, undesirable branches can be more easily detected. Dormant trees are not easily debarked by climbing on the branches and the bark seldom pulls away from pruning wounds.

The best time to prune is in early spring, just before the beginning of active growth. At that time, wounds heal most readily and flower buds can be easily detected, enabling quick determination of the location and number of cuts. This is especially true of peach trees. However, the pruning of large orchards must be started earlier so the job can be finished before the trees resume growth.

Low temperature injury is the major risk with fall or early winter pruning in Iowa. Trees that have been pruned before severe weather are often seriously

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injured by the sub-zero temperatures that follow. Pruning in November and December can be more hazardous to trees than pruning in late February, March, or early April.

Summer pruning is not generally recommended because it causes more dwarfing of the tree than dormant pruning. If a dwarfing effect is desired, then. some summer pruning may be practiced. Water sprouts may be removed in June and July, when 6 to 10 inches long, either by hand or with shears. Removal of water sprouts at this time keeps the tree open for good light penetration and reduces the amount of dormant pruning required.

Pruning Equipment

For the small orchardist or home fruit grower, hand tools provide the best and most economical pruning equipment. Hand shears, lopping shears, pole pruners, and pruning saws of various sizes and styles are available. Each tool will perform well if properly used and the cutting edges are kept sharp. Two-legged or three-legged orchard ladders aid in reaching the tops of taller trees.

Power Pruning

Commercial orchardists have adapted various types of power-operated equipment to make the pruning operation easier, quicker, and more efficient. Most power pruners work on the principle of compressed air or hydraulic fluid activating a piston that operates the shear head. Hydraulic-powered chain or circular blade saws are also available.

Small chain saws are also used in orchard pruning. These saws are especially useful when large cuts must be made.

Along with the use of power pruners has come the use of various types of platforms and mobile towers that move workers through the orchard. Such equipment is commercially available, although some growers have built their own. Development and use of such equipment has increased the efficiency of power pruners, hastened pruning in large orchards, and made the entire job easier by doing away with cumbersome ladders or the need to climb trees.

The use of pruning platforms and hydraulic towers makes it possibie to prune a tree from the outside toward the center. This is an efficient and easy way to prune the outer and higher branches. More light may penetrate to the interior of a tree, inducing more productive wood in this area. The net result is greater exposure to light of the entire leaf and fruiting areas of the tree, which increases production of well-colored, high quality fruit. Use power pruners with caution since overpruning and improper cuts can happen easily.

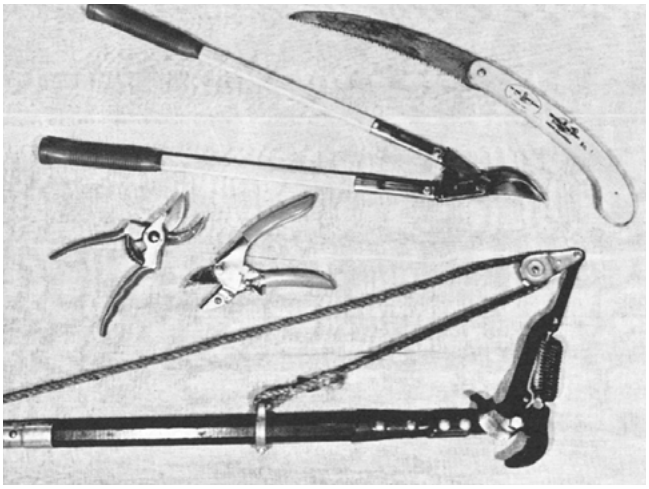


Figure 1. Basic pruning equipment includes (from top left) lopping shears, pruning saw, and hand shears of various styles. Pole pruners (bottom) aid in extending the user's reach but they are cumbersome and do not make clean cuts.

Figure 2. Hydraulically controlled towers and pruning equipment increase worker efficiency. Equipment operates from the tractor hydraulic system or is available as a self-propelled unit.

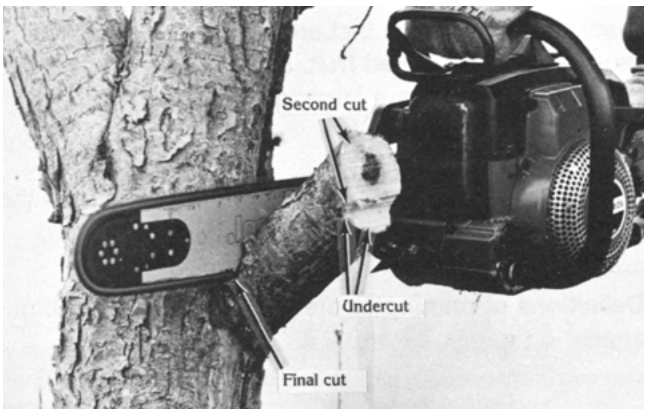


Figure 3. Small power chain saws hasten removal of large limbs. It is a three-step procedure: undercut, the second cut, and then the final cut as shown in the photo. Note the relative position of the three cuts.

Hedging machines can be used in deciduous orchards. A hedging machine does gross pruning in a short period of time. Hedging is not a method of selective pruning; consequently, orchards pruned this way still need some detailed pruning by hand or power shears. If detailed pruning does not follow hedging, the trees will grow dense and bushy in the outer areas. When this happens, fruit of poor color will be produced in the interior of trees. Hedging combined with a good annual selective pruning program can result in important time and labor savings, especially in large orchards.

Making the Cuts

Two basic cuts are used for pruning fruit trees-the "thinning-out" cut and the "heading-back" cut. The cut used depends upon the age and location of the wood and whether the intent is to prune a bearing tree or train a young tree.

The thinning-out cut is used to remove an entire shoot or branch. It is used to remove unwanted, 1-year-old shoots when selecting a scaffold system of primary and secondary branches. It is used to eliminate a "crow's foot" that, if left, can result in the choking out of the primary leader and the loss of a scaffold's symmetry. Other unwanted shoots are those growing on the top or bottom sides of a scaffold. Shoots on the top side of a scaffold, such as water sprouts, are vigorous and tend to remain vigorous with little potential for fruiting. They shade out lower portions of the tree, which results in a reduction in fruit color and potential fruit-bearing area. If these branches do fruit, the fruits are large, subject to limb rub, and have poor storage quality. Shoots arising from the bottom side of a scaffold are weak from shading and produce small, poorly colored fruits.

Desired shoots are those of moderate vigor that arise from the sides of the lateral scaffolds. On mature, bearing trees, some thinning out of branches can be practiced to reduce overcrowding, but care must be taken not to leave bare areas along the scaffolds.

Figure 4. Platforms are still used to prune large trees.

Figure 5. Hedging and topping machines of various types are being used to some extent to do bulk pruning in large orchards.

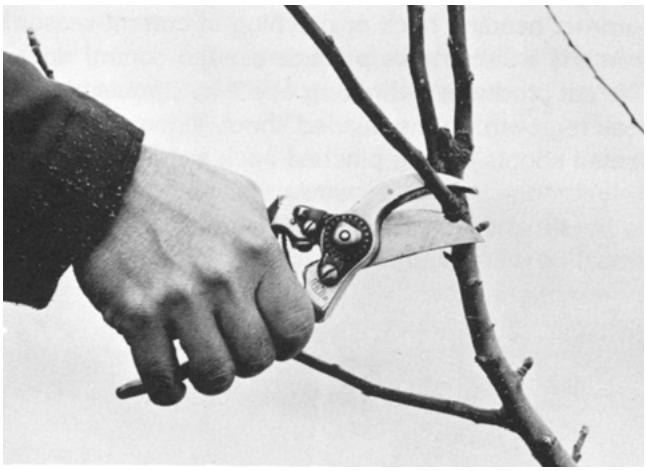


Figure 6. Thinning out of 1-year-old shoots is done to remove unwanted growth such as this crow's foot. It has developed as the result of a previous heading back cut on a scaffold leader.

Figure 7. The heading back cut on 1-year-old shoots is used to force several buds below it into vigorous growth. On the main or central leader, this cut is used to induce lateral branching for the development of additional scaffolds while on lateral scaffolds it is used to make the limbs more rigid.

The heading-back cut is used to remove a portion of a shoot or branch. When this cut is made on 1-year-old shoots, it encourages vigorous shoot development near the cut. In training young trees, this cut is used on 1-year-old shoots to encourage lateral branching on the central leader for future scaffold development. On scaffold leaders, the heading back of 1-year-old shoots is used to prevent the scaffold from becoming weak and willowy. This is especially true for cultivars that have a spreading or willowy growth habit. Overuse of the heading-back cut on 1-year-old wood will delay fruiting. For bearing trees, a similar cut is used on older wood to contain growth, reduce crowding, or rejuvenate old spur wood. Such a cut is referred to as "heading back to a lateral." This cut into older wood does not produce the invigorating response associated with the heading back of 1-year-old shoots.

Summer heading back or pinching of current season's growth is an alternative practice used to controi vigor. This cut produces a dwarfing effect by stimulating weak regrowth on the headed shoot. Vigorous unwanted shoots can be pinched back anytime from June through August. However, on apple and pear cultivars that are susceptible to fire blight, this practice should be delayed until July when fire blight infections are no longer active.

Figure 8. The heading back to a lateral cut is used to contain growth once a limb or branch has filled its allotted space. Such a cut can be used to lower the top of the tree, control the spread of the tree, and reduce crowding of lateral branches along or between scaffolds. Such a cut also can be sued to rejuvenate old spur wood when it has become too willowy and overcrowded.

All cuts should be made with sharp, correctly adjusted tools that give clean, smooth cuts. In thinning out a shoot or removing a branch, the cut is made close to and parallel with the supporting limb. When heading back to a lateral, place the cut so it continues in the general line of direction of the lateral branch. Stubs do not heal and may start decay. If the cut is too close to the point of lateral attachment, the branch is likely to split out. Also, on scaffolds, heading back to a lateral that originates from the top side of the limb overcomes the tendency to split out.

When shears or loppers are used, the blade is placed under the branch to be removed and against the supporting limbs to allow for a smooth, close cut. The wood on the underside of a branch is softer so there is less risk of springing the shears. The cut can be made more easily by pushing slightly against the branch in the direction the cut is being made. Never wiggle the shears through a cut as this makes a ragged wound that will heal slowly, and may spring the spears.

In removing a large limb with a saw, it is often helpful to do so with three cuts. First, an undercut 1 to 2 inches deep is made about 8 to 10 inches from the base of the limb. Then a cut from above is made, starting 1 to 2 inches beyond the undercut. Thus, the limb will fall without tearing the bark down into the supporting limb. Finally, the short stub is removed with a close cut made against the supporting limb.

Wound Dressing

There is no particular advantage in applying a dressing to wounds under 2 inches in diameter.

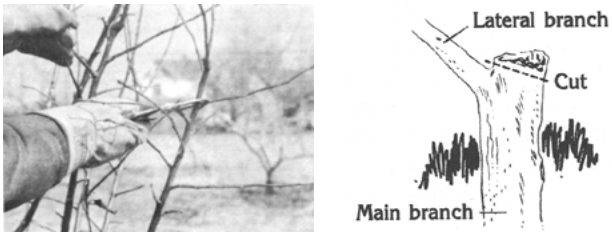


Figure 9. A heading branch to a lateral cut (left) is made just above a lateral shoot or branch. The cut above the lateral was improperly made (right), leaving a stub. Dotted line represents angle and position at which cut should have been made.

Figure 10. Wounds larger than 2 inches in diameter (left), can be treated with a suitable wound dressing. A wound resulting from the proper removal of a large branch (right) will heal quickly.

A wound dressing applied to larger wounds can prevent the entry of some wood-boring insects and diseases if cracks in the dressing are resealed. The preferred wound dressings are water-based, asphalt emulsions that do not contain creosote and are available either in a paste or an aerosol. The black color of these products can inhibit wound healing by excessive heat buildup, particularly when exposed to the sun. Exterior grade, white latex paint will overcome this effect and can be applied over the wound dressing or directly to the wound.

Pruning, Growth, and Production of Young Trees

Pruning, particularly heading back 1-year-old shoots, encourages vigor near the cut, but overall it has a dwarfing effect upon the trees. All leaves on a tree contribute food necessary for growth and any pruning reduces the total leaf surface area. Young trees should be pruned only enough to train them. Every unnecessary cut can be an economic loss.

Lightly pruned trees develop best. Research has shown that heavily pruned trees are smaller and do not come into bearing as early as those pruned lightly or not pruned. But unpruned trees, while larger, are ungainly and have many framework defects. Golden Delicious apple trees and others that come into bearing at an early age are less affected by severe pruning than are cultivars that come into bearing later, such as Delicious.

Unnecessary wood removed in the name of pruning will reduce yields. However, leaving unnecessary 1-year-old shoots will mean more pruning in future years. Because of this, pruning a fruit tree the first few years after planting should be aimed at developing a strong, well-distributed framework of scaffolds. Once the primary framework is developed, prune lightly to encourage early fruiting.

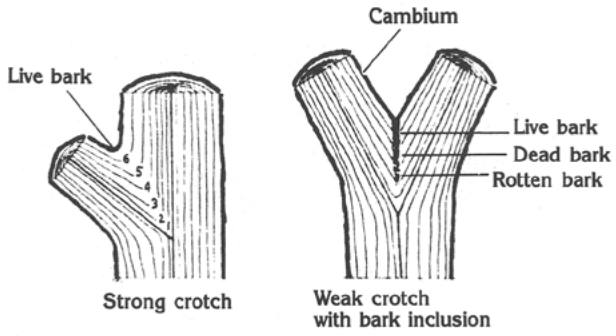


Figure 11. Wide crotch angle (left) ensures strength. Note relative thickness of the successive layers of wood (numbers) laid down by the cambium in this wide angle. Bark in the (right) narrow crotch angle comes together before crotch can fill with woody tissue. This prevents a union of wood and encourages decay. A narrow crotch is weak, splits with overloads, and is often associated with winter injury on adjacent bark.

A weak crotch usually results when one branch grows from another at a very narrow angle. The weakness in narrow crotches results from the development of a bark inclusion as the tree grows. The time to eliminate weak crotches is in training young trees through the proper selection of 1-year-old shoots to be retained as scaffolds, thinning out those shoots with narrow crotch angles. The use of clothespins to induce wide crotch angles is beneficial when the number of lateral shoots is limited.

It is often desirable or necessary to remove entirely certain branches when they develop very narrow angles. If the branch is well located with respect to the general periphery of the tree, it may be headed back severely, thus dwarfing the branch. Eventually it may be removed from the tree, especially if another branch develops that may be used to replace it.

Failure to train a tree properly during the first few years may eventually result in loss of the tree due to severe breakage.

Figure 12. Clothespins can be used to encourage the development of wide crotch angles. They are set in place when the developing shoots are 4 to 6 inches long.

Figure 13. Weak crotches with bark inclusions often split out when trees become productive, thus causing tree loss.

Pruning, Tree Size, and Planting Distance

The trend in fruit tree production is to plant higher density orchards of smaller sized trees. This is particularly true for apples and, to some extent, other fruit trees. As such trees reach mature size, it is often necessary to increase the amount of pruning in order to keep them within desired size limits.

Pruning to maintain tree size is largely a matter of judicious heading back of long terminal growth to shorter lateral branches to keep the fruiting wood nearer the interior of the tree and distributed throughout the volume of the tree. In controlling mature tree size, it is essential to accurately regulate the supply of nitrogen to the tree. Excessive nitrogen can result in vigorous growth that defeats the goal. Rates of nitrogen application should be adjusted to the amount of terminal growth and foliar analysis of the preceding season.

Training Fruit Trees

Central Leader System

The trend in recent years toward closely spaced plantings of apple trees and, to some extent, other fruit trees has resulted in a renewed interest in the central leader system of tree training. The natural growth habit of apple and pear trees to this form makes them well-adapted to the system. Interest in this system has also been enhanced by the extensive use of size-controlling rootstocks and spur-type trees of certain apple cultivars. In addition, research has shown that when shaped to a pyramidal form and held within given size limits, the central leader tree tends to expose a greater percentage of its foliage and spur-bearing surface to light than trees trained to most other forms. This consideration becomes most important in training and shaping trees in high density plantings (200 trees or more per acre).

The central leader tree is trained in a manner that permits the development of several scaffolds arranged in tiers or whorls of three to four scaffolds along a central axis, much like a Christmas tree. Scaffolds making up the upper tiers are selected so that they are 18 to 25 inches above a lower scaffold, and will be at least 1 year younger. The less dwarfing the cultivar-rootstock combination, the greater the spacing desired between scaffolds arising from different tiers. When the tree reaches the desired height, either the terminal shoot on the central leader is headed back severely, or the central leader is headed back into older wood to a short lateral branch. This height is maintained in succeeding years by continued heading back. The central leader tree is maintained in a pyramidal shape.

Figure 14. A modern high density orchard on size controlling rootstocks has 200 or more trees per acre.

Spreading — A Training Technique

Spreading the scaffolds on young fruit trees can aid in bringing about improved tree form, earlier fruit production, and improved fruit quality. Branches growing in an upright position tend to be vegetative and unfruitful for a longer period of time than those growing in a more horizontal position. The reason for this is related to the natural growth regulators in the tree. Thus, spreading the scaffolds of a young fruit tree favors initiation of spur growth and flowers. Proper limb position is important when spreading branches, particularly when heading the scaffold

Figure 15. Abundant and well-distributed fruiting spurs through this tree are the result of proper thinning out of shoots or branches, and heading back to laterals.

Figure 16. Limb spreading has become a useful technique for training young trees. Scaffolds can be positioned during or after their second year of growth.

leader. The technique involves initially bending upright growing scaffolds down to about a 45-degree angle and holding them there. If they are positioned too flat, vigorous upright shoots will develop along the scaffold and terminal growth will be greatly reduced. Vigorous growing scaffolds can usually be positioned after they are 2 years old. This can be done on the primary tier of scaffolds during or after the second growing season. In the dormant stage, l-year-old shoots should only be spread to overcome narrow crotch angles.

Stiff, steel wire with sharp points cut in desired lengths can be used to hold limbs in place. Another method is to use spreader sticks, made from wood pieces, 3/4-inch square, cut to desired lengths. In each end of the spreader stick, drive a 4- to 6-penny nail in to half its length. Cut off the heads of the nails and grind to a sharp point. The pointed nail in each end holds the spreader in place. Inspect trees frequently and replace spreaders if dislodged or otherwise removed. Often it is necessary to replace them with longer spreaders in succeeding years. Usually these spreaders need to be left for two or three growing seasons before removal. By then the limbs will be stiff enough to remain in position.

Limb spreading can also be achieved by tying the scaffolds into position with polyethylene twine that is anchored to the ground. Polyethylene twine will last over a season and does not tend to girdle the limb at the point of contact. It is important that the twine is tied loosely around the scaffold and the knot does not slip. The taut-line hitch works well because the twine can be anchored to the ground first and adjustments to the limb position can be made after the knot is tied. The tiedown procedure is beneficial when the use of wood or wire spreaders forces the central leader to lean over and out of position. For sweet cherries, this is a more desirable spreading method because the wounds created by the metal points of the spreaders exude gum.

Spreading the scaffolds of young trees is an essential practice with most spur-type apple trees and such cultivars as Delicious, Rome Beauty, and others with a vigorous, upright growing habit. Spreading can be of benefit on young pear, sweet and sour cherries, and possibly other fruit trees. Its value on peach trees is doubtful at this time, in view of other training systems used.

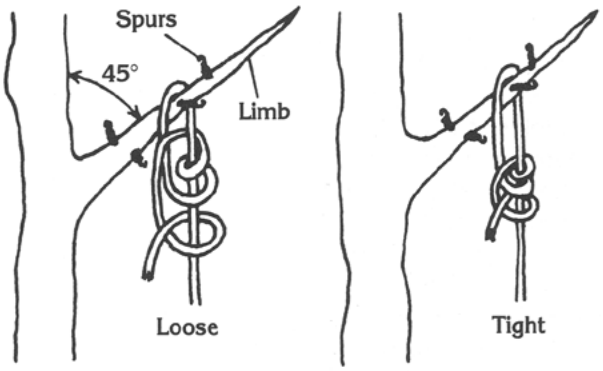


Figure 18. The taut-line hitch is used to secure polyethylene twine around limbs when using the tie-down procedure for limb spreading.

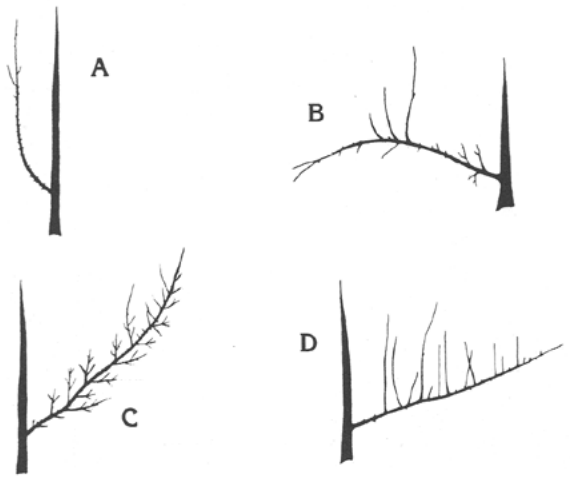


Figure 17. Proper limb position is important when spreading scaffolds, particularly when the heading back cut is used on the scaffold leader. A: Upright limbs produce few side shoots. The terminal shoot is only vigorous growth; remaining growth is weak. B: A bowed limb develops vigorous upright shoots at the high point of bend. Terminal growth is dwarfed. C: Spreading to 45-degree angle results in equal distribution of vigor and the development of fruiting side shoots along the entire limb. The terminal remains as the highest point of the limb. D: When limb is too flat, vigorous upright shoots develop and terminal growth is reduced.

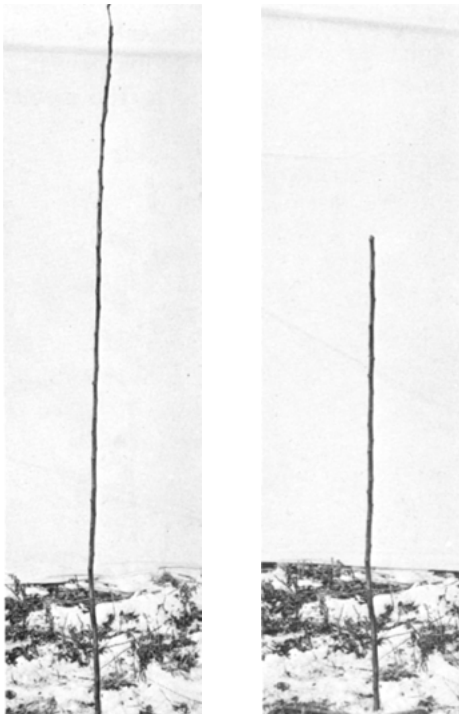


Figure 19. One-year-old apple whip after planting (left). The same tree (right) after heading back 10 inches above the minimum desired height for the lowest scaffold.

At Planting

When possible, it is best to plant 1-year-old unbranched trees of larger sizes. Such trees are well supplied with stored food reserves and will get off to a good start. Such a newly planted, unbranched tree is headed back 28 to 30 inches from the ground, or 10 inches above the point where the lowest scaffolds are desired, The uppermost remaining bud will develop into the central leader and continue the vertical extension. The next two or three buds will usually develop narrow crotch angles and are not suitable for scaffolds unless clothespins are used to improve the crotch angles. Lower buds are best suited for developing into scaffolds.

If branched 1- or 2-year-old trees are planted, then select two to four of the most desirable lateral shoots and remove all the others. The selected laterals should have wide crotch angles and be well distributed around the tree at the desired height above the ground. Head back the lateral shoots about 50 percent and head the central leader just above the point where the next tier of scaffolds is wanted, or at a height to complete the development of the first tier of scaffolds. If there are less than two desirable lateral shoots, then it is better to remove all of them and treat the tree the same as a whip, or unbranched tree.

Deshooting — An Alternate Training Technique

Results of experiments show that removal of undesired shoots during the first growing season is most helpful in the proper training of fruit trees. All new shoots are allowed to grow on the tree until early or mid-June, or until they are 4 to 6 inches long. At this time, three to four lateral shoots, well distributed at the proper height, are selected to become the main framework. All others are removed or pinched back to reduce their growth and competition with the selected shoots. The shoots remaining for the main scaffold branches should have the widest crotch angles possible, preferably greater than 45 degrees. Clothespins can be used to ensure wide angles. It may be necessary to check the trees again a month later and remove or pinch back any new shoots that arise from the trunk, as these may interfere with growth of the selected shoots.

On small trees, only two or three laterals may be selected the first year. The remaining one or two are chosen the second year from shoots that develop higher on the trunk.

First Dormant

If not already done during the first growing season, select three to four well-distributed lateral shoots to develop into the first tier of scaffolds. For spur-type Delicious, up to five shoots can be selected. Thin out the unwanted shoots. Head back the lateral shoots about 25 percent to stiffen the developing scaffolds. Head back the central leader more severely to induce lateral shoot development for the next tier of scaffolds. The amount of growth made by the central leader will determine whether or not the second tier of scaffolds can be fully or partially developed, or whether it is necessary to wait another year. An ideal heading height would be just above the point where the next tier of scaffolds is desired. If insufficient growth was made, head it below this level with the intent to either develop a portion of the next tier or wait another year. In either case, make sure that the central leader remains the tallest shoot. When heading the lateral shoots, it is beneficial to head back the upper shoots so that they are a little taller than the shoots arising just below. This will aid in preventing one of the lower scaffolds from becoming dominant

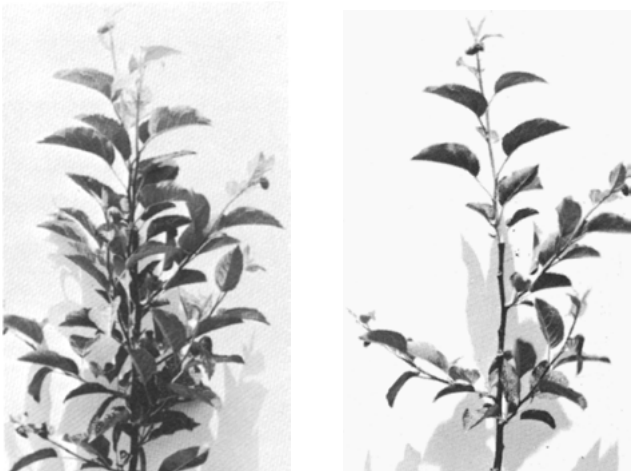


Figure 20. Deshooting an apple tree during the first growing season. Before deshooting (left). After deshooting (right) with a central leader and three well-distributed lateral shoots remaining to develop into the first tier of scaffolds for a central leader tree.

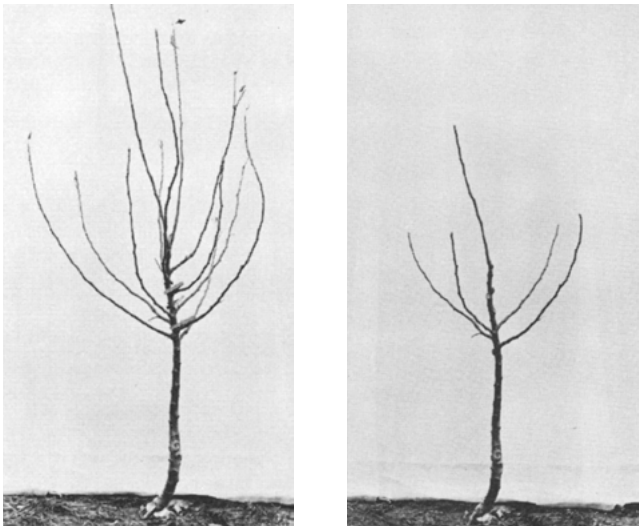


Figure 21. Apple tree being trained to the central leader system after the first growing season. Before pruning (left). Note that clothespins were used to maintain wide crotch angles. After pruning (right) with lateral shoots headed back approximately 25 percent and the central leader headed back more severely but maintained as the tallest shoot.

over the central leader. Spreading of 1-year-old shoots should only be done to overcome a narrow crotch angle. If they are spread, the leaders will grow upright leaving a bow in the scaffold. Such a bow would make it necessary to use a much longer spreader the following year.

Frequently, young trees do not grow well during the first growing season or all the lateral shoots develop on one side of the tree. In either event, rather drastic measures need to be taken to ensure the development of a suitable tree. If the lateral shoots are less than 1 foot long or are all growing from one side, it is often better to thin out all of them and head back the central leader to a 2- or 3-inch stub. When this is done, a tree that grew little the first year will grow more vigorously than if it were pruned in the normal manner, while a lopsided tree will be stimulated to produce shoots on all sides of the tree. The following year, such a tree should be pruned following the normal first dormant procedures.

Another procedure that can be used to stimulate shoot development on the bare side of lopsided trees is bud scoring at the time of dormant pruning. A sharp knife blade is placed in a horizontal position about 1/4 to 1/2 inch above a bud that failed to grow the previous season. The blade is pressed through the bark, cutting the bark in a line that extends slightly beyond both sides of the bud.

Second Growing Season to Bearing — An Alternative

Each of the following procedures can be practiced independently: If sufficient space exists above the lower tier of scaffolds, select the next tier of lateral scaffolds by deshooting the central leader when the shoots are about 4 to 6 inches long. Clothespins can be used to improve the crotch angles of the new lateral shoots on the central leader. At this time, the two vigorous shoots arising just below the leader on the lateral scaffolds can be removed. Also, vigorous upright shoots or water sprouts arising on the topside of the scaffold can be rubbed off or pinched back. Beginning in about mid-July, or when vegetative growth has slowed down or stopped, scaffolds that are in their second season of growth can be spread to about a 45-degree angle.

Second Dormant

If not already done during the second growing season, spread the first tier of scaffolds to about a 45-degree angle, and select the second tier of scaffolds, making sure it is at least 18 inches above the first tier. Thin out any unwanted shoots (crow's feet and vigorous upright shoots or water sprouts) arising on the scaffolds. Head back the leader of each scaffold about 25 percent and head back the central leader more severely but maintain it as the tallest portion of the tree. It is essential to remove shoots that would interfere with the proper development of desired scaffolds. After heading back the scaffolds, thin out any lateral shoots arising on the scaffolds that are taller than the headed leader. The oldest scaffolds should form fruiting spurs during the third growing season on most spur-type trees and trees on dwarfing rootstocks.

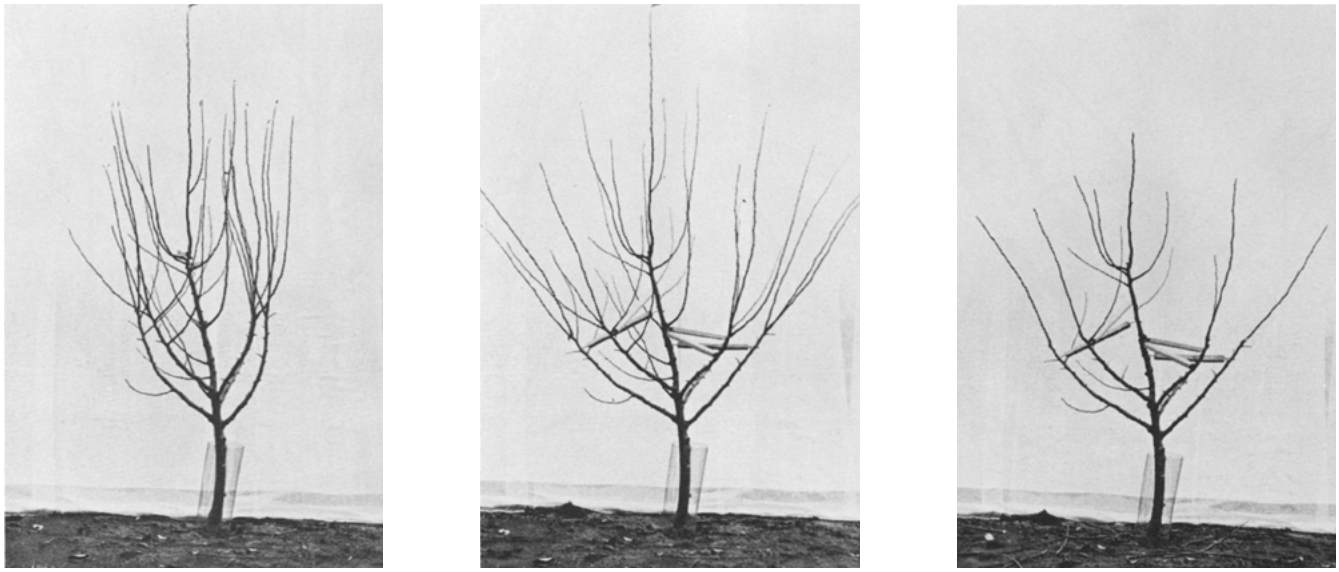


Figure 22. Apple tree being trained to the central leader system after the second growing season. Before spreading and pruning (left). The same tree (center) after spreading the 2-year-old scaffolds to about a 45-degree angle. One-year-old shoots are not spread unless they have narrow crotch angles. After spreading and pruning (right). Note that a second tier of three scaffolds has been selected and the headed leaders on the first tier of scaffolds have been maintained as the tallest portion of those limbs. The lateral shoots retained on the scaffolds of the first tier and on the central leader below the second tier of scaffolds have not been headed.

Third Dormant to Bearing

Spread the first tier of scaffolds more if necessary. Spread the second tier of scaffolds to 45 degrees and select a third tier if not done during the previous growing season. Head back the scaffold leaders about 25 percent and the central leader more severely. Thin out the unwanted shoots. Essentially. the procedure used on each tier of scaffolds is what was done to the tier below it the previous year.

In the following years, the central leader is headed back each spring to induce lateral branching and promote its growth. When the tree does reach the desired height, the central leader is either headed back to a short lateral shoot or is headed back severely. In succeeding years upright growth is removed annually from the top or is severely headed back in order to maintain the desired height.

When the desired tree spread is reached, scaffolds are likewise headed back to a shorter lateral branch and the new terminal shoot or leader is not headed. Some thinning out or heading back to laterals of secondary branches along the scaffolds is frequently necessary to reduce overcrowding and promote good light penetration.

It is important to maintain the pyramidal tree shape throughout the life of the central leader tree. To do this, it will be necessary to promote maximum fruiting on all scaffold branches. This involves thinning out unwanted shoots, heading back to laterals on secondary branches arising from the scaffolds so that fruiting spurs near the center of the tree can receive good light exposure. In addition, upper tiers of scaffolds need to be maintained shorter than those lower on the tree. This can be accomplished by selectively heading back to lateral shoots, spurs, or branches.

Sometimes a lower scaffold will become dominant over the central leader. The first indication of this occurring will be more vigorous growth on the scaffold becoming dominant than on the central leader and other portions of the tree. Also, terminal shoots on that scaffold will be taller than the central leader. If allowed to continue, the dominant scaffold will choke out the upper portion of the tree. When this begins to occur, it is a better practice to remove the dominant scaffold to maintain tree form than to severely head it back to a lateral branch. Once a lower scaffold becomes dominant, such severe heading back encourages the development of vigorous upright shoots and very little fruiting on the scaffold.

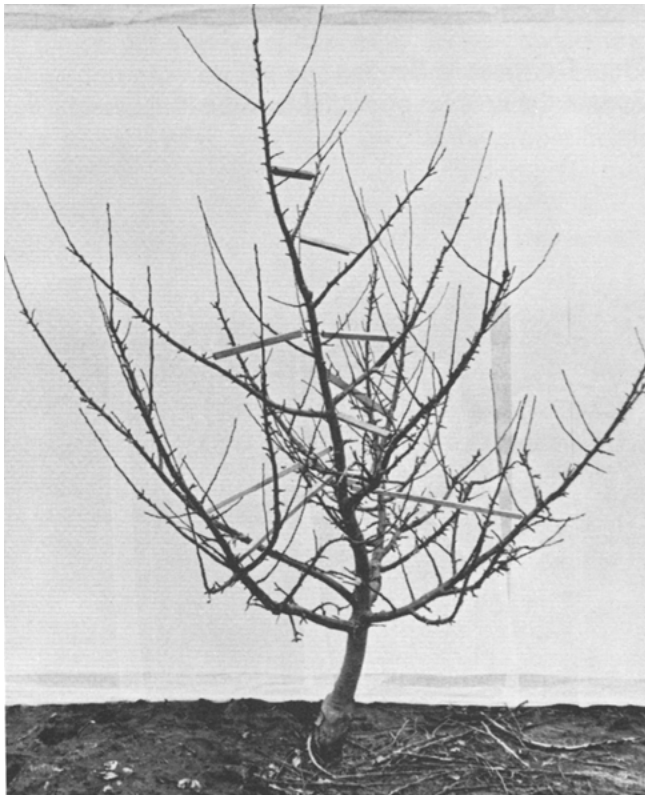


Figure 23. A dwarf spur-type Delicious apple tree trained to the central leader system with the aid of limb spreaders. Longer spreaders may be necessary to maintain the 45-degree limb position. Note that the upper scaffold tiers were not developed in a single year.

Modified Central Leader System

Experience and research have shown the modified central leader system of training to be quite satisfactory for standard size fruit trees. It is especially suitable for apple and pear trees. The same system of training may be followed with semi-dwarf and dwarf trees at wide spacings. However, in dense plantings other systems may be more suitable.

Figure 24. A bearing semi-dwarf Golden Delicious apple tree that has been successfully trained to the central leader form. The central leader has been headed back to a lateral branch to control tree height. The pyramidal shape is maintained throughout the life of the tree.

At Planting

When possible, it is best to plant 1-year-old, unbranched trees of larger sizes. Standard trees about 11\l6 inch in diameter and 5 to 7 feet tall are best. Such trees are well supplied with stored food reserves and will get off to a good initial start. This also permits heading standard trees as high as 44 inches after planting. This height allows for adequate vertical spacing between the laterals to be selected for framework development.

Apple trees on size-controlling rootstocks as well as stone fruit trees may be pruned essentially the same as standard trees. Dwarf trees on the Malling (M) 9 or M 26 rootstocks may be headed back to a point 28 to 30 inches above the bud or graft union if low-headed trees are desired. Spur-type trees on seedling rootstocks and semi-dwarf trees on M 7, Malling Merton (MM) 106, and MM 111 are headed to a height of 36 to 40 inches above the bud or graft union. Stone fruit trees would be headed at heights similar to semi-dwarf apple trees.

If branched 1- or 2-year-old trees are planted, as is often the case with peaches, cherries, and sometimes with apples, then pruning involves selecting the most desirable laterals and removing all others. Selected laterals should have good wide-angled crotches. They should be 8 to 10 inches apart vertically, each occupying a different sector of the tree. For some trees, when only one or no lateral may be suitable enough to remain, it is better not to leave any laterals. In other cases, two, three, or four may be satisfactory the first year for developing into the primary scaffold branches. No more than four should be left for primary scaffolds. These should be cut approximately in half, and the leader, or top lateral, is usually left longer than the longest side lateral.

Small 1-year-old trees are less desirable than larger ones, but sometimes they may be all that is available. Such trees should be headed back to more mature wood depending on the height of the whip. Only one shoot is allowed to grow into the leader the first year. The second year, training may begin as described above, or in the section on deshooting.

Spreading

It is important to have the lower scaffold branches growing in a somewhat horizontal position to promote early bearing and reduce extension growth. Therefore, it is essential to spread these lateral scaffolds in the manner described in the section on spreading.

First Growing Season

Refer to the section entitled Deshooting — An Alternative Training Technique.

First Dormant

Pruning after the first season's growth involves the selection of primary scaffolds. Ideally, if not done by deshooting, the four lateral shoots chosen for the framework should be spaced 8 to 10 inches apart vertically on the trunk, if possible, the lowest being at least 20 inches above the ground. Each lateral should occupy a quarter sector of the tree and it may require two seasons to grow and select the proper scaffolds.

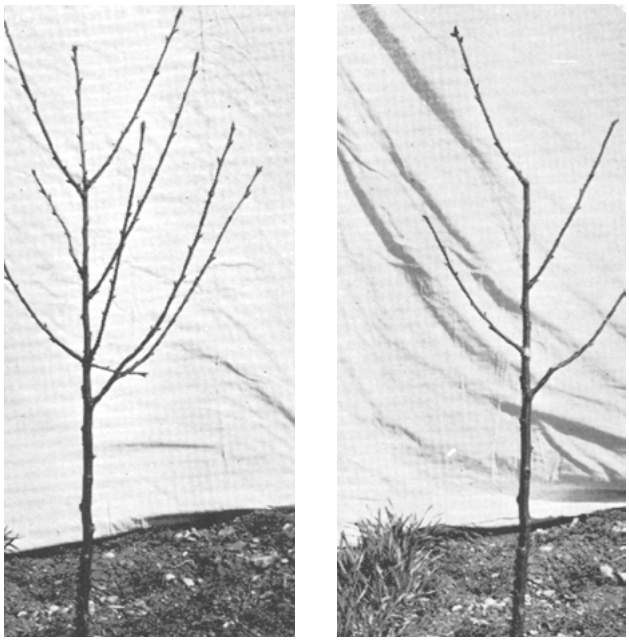


Figure 25. A 1-year-old Montmorency cherry tree at planting, before pruning (left). After pruning (right), the four well-spaced shoots selected for the primary scaffolds have been headed back approximately 50 percent.

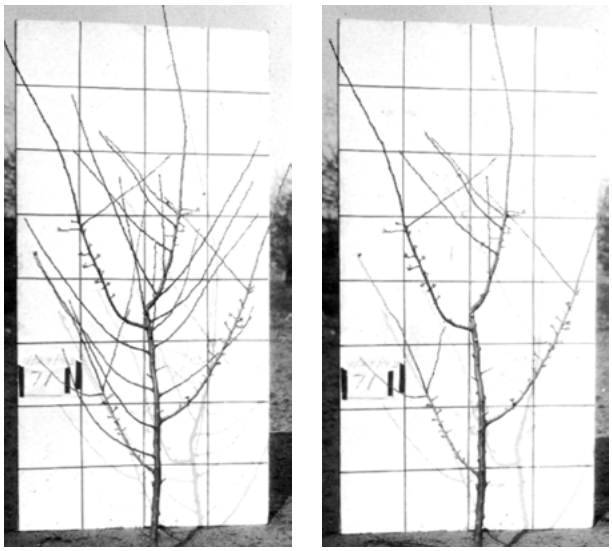


Figure 26. Apple tree trained to the modified central leader system after 2 years' growth in the orchard, before pruning (left) and after (right). Note that shoots from the main trunk that compete with the primary scaffolds have been removed.

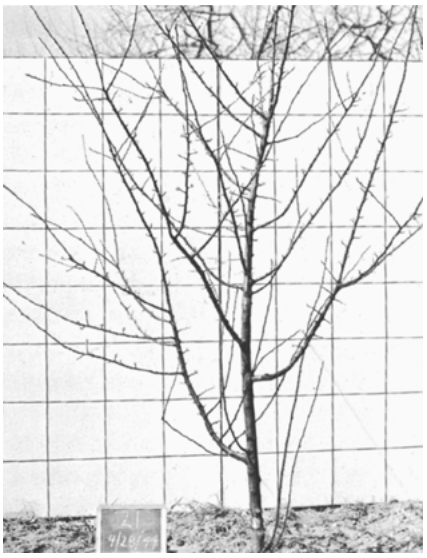
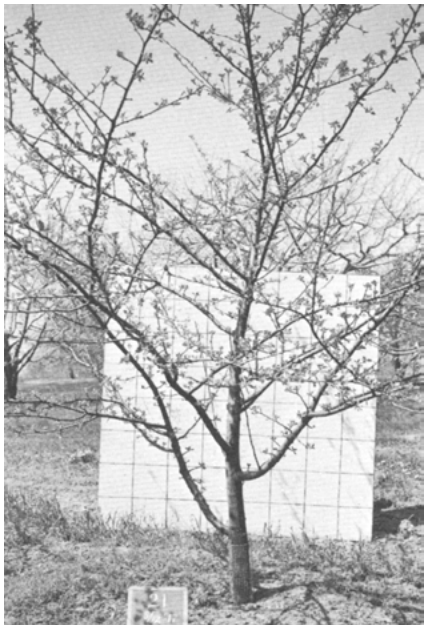


Figure 27. Apple tree trained to the modified central leader system after 4 years' growth in the orchard, before pruning (left). After pruning (right), note that the center of the tree has been kept relatively open while little pruning has been done on the lateral branches.



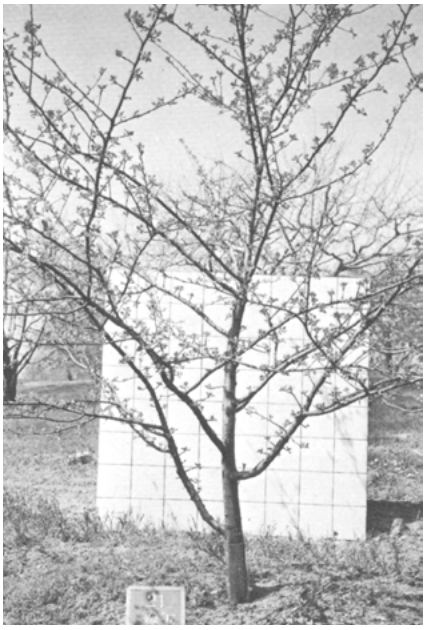
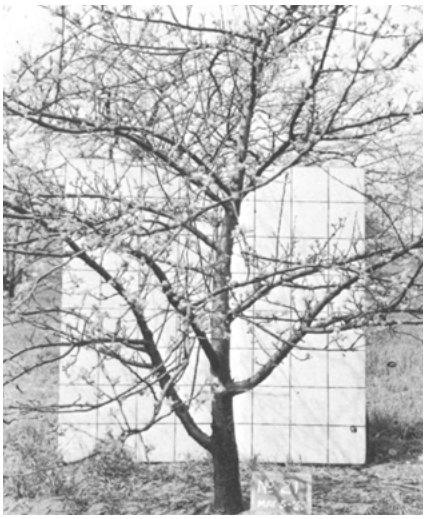


Figure 28. The same apple tree (figure 27) after 7 years' growth in the orchard, before pruning (left), and after pruning (right). It is especially important during the early years of tree training to remove as little wood as possible. The more severe the pruning, the later the trees will reach bearing age.



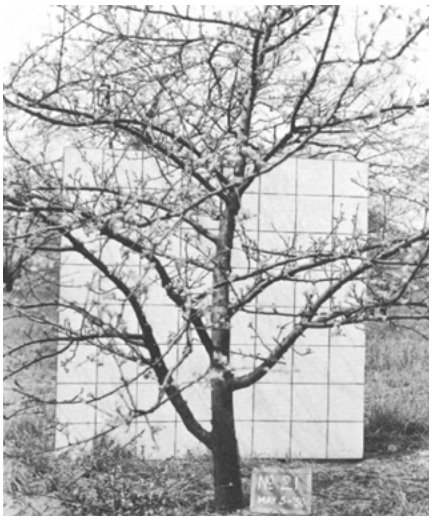


Figure 29. The same tree (figures 27, 28) after 10 years' growth in the orchard, before pruning (left), and after pruning (right). Even at this bearing age, very little wood should be pruned out annually. Removal of a small amount of wood each year maintains a better shaped and more productive tree than severe pruning every 2 or 3 years.

It may also be necessary at this time to change the framework of the tree and select one or more laterals that are better located. All shoots not needed for scaffolding should be thinned from the trunk.

If a weak crotch develops between a scaffold branch and the main trunk, removal Is desirable. A more suitable lateral may then be selected from growth made the first year. If a lateral shoot makes exceptional growth to the point of being taller than the leader, head it back from one-third to one-half its length, thus dwarfing its growth; otherwise no heading of terminal shoots is done. This will allow the leader to maintain its dominance with respect to the other scaffold branches.

Second Dormant to Bearing

If the newly planted tree is properly trained during the first 2 years, little pruning will be necessary for the next 4 to 5 years. During this period, training is still important in order to maintain the shape of the tree through optimum and balanced growth of the main scaffold branches.

The leader or any scaffold should not be allowed to completely dominate the growth of the tree to the point where another scaffold is dwarfed. An overvigorous scaffold should be headed back, possibly one-third or one-half its length. If it has branched, removal of side branches will retard its growth. In this manner the leader may be maintained as the dominant scaffold in its relative growth position. Pruning during the prebearing and even early bearing years involves removal of crossing branches, those that rub together, water sprouts, and some small branches from the interior of the tree. Branches growing in undesired directions should be removed completely or cut back to a lateral growing in a desired direction. Any branch that is interfering with the development of a primary scaffold or leader should be removed or severely headed back.

Figure 30. A satisfactory peach tree can be developed with only two wide-angled primary scaffolds.

Open Center System

This training system involves pruning techniques that result in the development of two to four, preferably three, primary scaffolds arising near each other on the trunk. All primary scaffolds are pruned to develop about equally for spacing as equally as possible around the trunk, and to arise at a point 18 to 24 inches from the ground. Secondary scaffolds that fan out from the primary scaffolds are developed further up the tree giving it a vaselike structure.

All kinds of fruit trees can be trained to the open center system, but it is especially adaptable to peach and nectarine trees. The training procedure, as described in the following paragraphs, is concerned with peach trees, but the steps will apply to other fruit trees as well.

Peach and other trees trained to this system, in which the primary scaffold branches make wide-angled crotches with the trunk, possess a high degree of winter hardiness in the tree framework. Preferred crotch angles are those of 60 to 90 degrees. Bark and wood tissues in and around narrow crotch angles are usually quite susceptible to sub-zero temperature injury, especially if such crotches have considerable bark inclusions. Winter injured crotch areas are also more susceptible to disease infections such as peach canker and insect invasions, for example by the

Figure 31. A mature 8-year-old peach tree with good open center framework is strong and less subject to low temperature injury than one with narrow angles.

lesser peach tree borer. Branches with bark inclusions associated with narrow crotches often split out when under heavy fruit load.

The immediate objective of this training method is to prune the tree in a manner that will induce growth of branches to form wide angles with the trunk. Steps in the pruning procedure are described in the following sections.

At Planting

The 1-year-old tree is headed to a height of 28 to 30 inches. It is possible that the tree will have one or two shoots already started that could be used as primary scaffolds. If so, these are headed back so that only two or three buds remain on each. Preferably, such shoots should arise from 2 to 4 inches below the point where the tree was headed. All other shoots are removed. If no laterals suitable for scaffolds are present, then all shoots are removed.

June of First Year

By early June most buds on the trees will have developed into leaf rosettes or growing shoots. The most vigorous shoots usually arise from the uppermost two or three buds on the trunk and often form much narrower angles with the trunk than do the lower shoots. Thus, they are often unsuited for developing into the tree framework. If shoots with such narrow angles are headed back to 2 or 3 inches, the less vigorous shoots below them with more desirable angles will be induced to grow more vigorously. If no shoots exist below those headed back, this severe pruning will usually cause buds to break and shoots to develop below them. From these can be selected the shoots to develop into primary scaffold branches.

Three lateral shoots generally are selected to develop into the primary scaffolds. Some trees may develop only one suitable shoot the first season while others may have several. Any shoots arising below the selected scaffold branches are headed back severely, leaving only a few inches of growth. If one of the shoots left for a scaffold is overly vigorous and tends to dominate the tree, it should be shortened to bring it into balance with the other shoots. The best framework results if all the scaffolds grow at about the same rate. Should additional scaffolds be needed to complete the framework, these can be selected at this time.

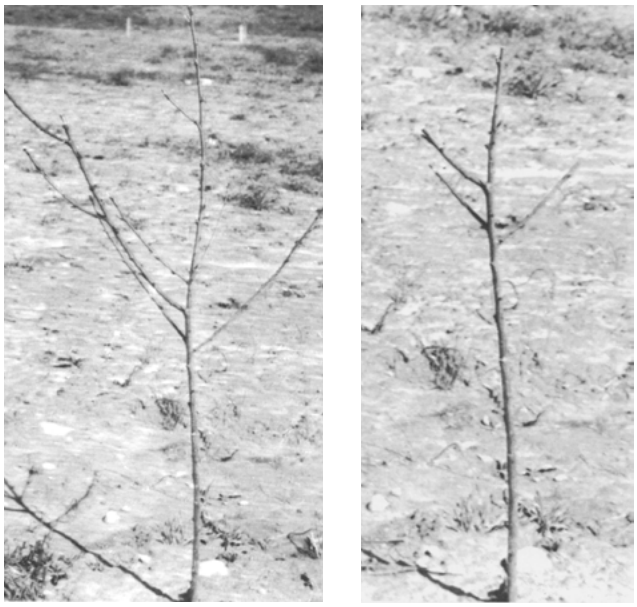


Figure 32. Peach tree at planting, to be trained to the open center system, before pruning (left). The same tree after pruning (right) with three wide-angled lateral shoots remaining for primary scaffolds. The central leader has been headed back to a 2- to 3-inch stub.

Figure 33. Summer pruning of a peach tree in June of first year, before pruning (left), and (right) after removal of unwanted shoots and heading back shoot growth on stub in tree center.

Figure 34. The center stubby growth is headed back so it will not compete with other growth of the tree.

First Dormant

While the trees are still dormant, preferably in March, additional pruning cuts will be necessary for the training process. At this time, those shoots remaining in the center above the primary scaffold shouid be cut back. Only short stubs should remain from which a small cluster of shoot growth will develop in the center of the tree the second season to help maintain the open center. Any growth arising on the scaffolds within 6 inches of the trunk or on the trunk should be removed at this time. If, for some reason, the two or three primary scaffolds could not be selected the previous June, they may be chosen at this time. All shoots below the scaffolds are removed, and those above are cut to short stubs as explained previously.

Avoid cutting the main scaffold unless necessary to maintain balance in the tree. If one scaffold dominates the tree, it should be headed back to a size proportionate with the others. It is necessary to have all the scaffolds continue growing at approximately the same rate in order to maintain a well-balanced tree.

Figure 35. A peach tree after 1 year's growth in the orchard, before pruning (left) and after pruning (right). Note the center stubby growth remains.

June of the Second Year

Shoots arising from the stubby growth above the scaffolds should again be cut back severely. Any growth arising from the trunk below the laterals should be removed. It may be necessary to do light pruning on the scaffolds in order to maintain tree balance.

Figure 36. Pruning of peach tree during June of the second year. Before pruning (above) and after pruning (below) after short growth has been removed from the center.

Figure 37. Peach tree after 2 years' growth in the orchard, before pruning (left), and after pruning (right).

Center Stubby Growth

If the tree has grown sufficiently to "shade out" the center stubby growth, prune it out completely. Should the stubby growth in the center still exhibit vigor, prune it back severely and leave for another growing season.

The only other pruning normally needed is corrective in nature-removal of shoots or branches with very poor crotches, branches growing through and across the tree, broken branches, or those that show severe insect or disease injury Moderate heading back of branches will be necessary in order to maintain a balanced, open-center tree form.

Removing Nonbearing Parts

After the third season's growth, the permanent shape of the tree should be well established. Dormant pruning during this period will consist of light heading back where needed and removal of damaged as well as undesirable branches. Only sufficient pruning need be done to maintain the tree within desirable size limits. As the trees come into bearing, the weight of crops can be expected to open and spread the trees.

Special Training Techniques

Trellising

With the advent of size-controlling rootstocks for fruit trees and high density planting, growers have become interested in trellis support for fruit trees. This is especially true with apple cultivars on the most dwarfing rootstocks, M 9 and M 26. Dwarf trees trained and secured to wire trellises have been established in commercial as well as home plantings. This method of growing apples can accommodate from 400 to 600 dwarf trees per acre, depending upon the planting distances.

Training fruit trees to a trellis is quite similar to training grapevines to the four- to six-arm kniffen system. The trellis may be constructed to accommodate three to six more wires, depending upon vertical spacing of the wires and the ultimate

Figure 38. The tree shown in figure 34 after 3 years' growth in the orchard, before pruning (left) and after pruning (right).

Figure 39. The same tree after 4 years' growth in the orchard, before pruning (left), and after pruning (right).

height desired. In most instances, the wires are spaced 18 to 24 inches apart vertically with the bottom wire 18 to 24 inches from the ground. The height of the top wire will be determined somewhat by the harvesting methods used. If all picking is to be done from the ground, the top wire should be 6 to 8 feet from the ground. If a picking platform or short ladders are anticipated, it could be 8 to 10 feet from the ground. The cost of available posts of the desired length would also be a determining factor.

Posts to carry the wires may be set before or after planting the trees, and spaced in the row between every two to four trees. The wires, usually No.9, should be in place and secured firmly to the posts by the middle of the first growing season.

Training begins at planting. If no shoots are present just below the bottom wire, the tree should be headed at the height of the bottom wire or just below it. If two good shoots do exist, then the tree should be headed just below the second wire. The uppermost new shoot will assume the central leader position. At least two other shoots will arise below this one. The two most suitable shoots, preferably arising 3 to 6 inches below and in line with the wire, are tied to it as soon as they are long enough. Initially tying them down between 45 to 30 degrees from horizontal is sufficient. Any other shoots are cut back to a stub or rubbed off. In tying a shoot to a wire, do not bend it downward so that the tip is at a lower level than any portion of the shoot. To do so greatly retards extension growth and induces vigorous risers on the scaffolds.

The following spring, tie the 1-year-old shoots on the first wire down to 30 degrees and do not head them. Head the central leader just below the next wire. In the second growing season, select two shoots to tie to the second wire as was done previously for the first wire. If vigorous upright shoots are developing along the scaffolds tied to the first wire, either stub them back or tie them down to a horizontal position. As growth begins to slow down, tie the 2-year-old portion of the lower scaffolds down to a horizontal position allowing the new terminal growth to grow upward at about a 30-degree angle. In the third spring, repeat what was done in the previous spring and tie the 2-year-old wood down to a horizontal position if not done during the growing season. In succeeding years repeat these procedures, practicing what was done on the lower wires on the next wire up. Dormant heading cuts on 1-year-old wood are not used on the scaffolds trained to the wires. When adjacent trees begin to grow into one another, the scaffold leaders are headed back to a lateral shoot, spur, or branch. This can be done either in the dormant or during the growing season in late August.

Figure 40. Dwarf apple trees on Malling 9 rootstocks trained to a wire trellis for support in high density planting.

Figure 41. Delicious apple tree being trained to the wire trellis. Branches are bent down to near the horizontal position and secured to the wire with plastic tubes.

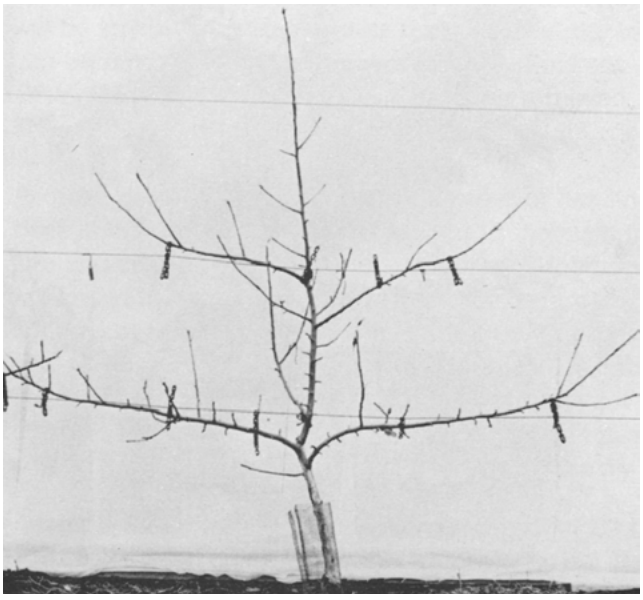


Figure 42. A Golden Delicious apple tree trained to a trellis system. Two-year-old and older scaffold wood is tied down to a horizontal position along the wires while the 1-year-old scaffold leaders are allowed to grow upward. Note that the scaffold leaders are not headed back, and upright shoots developing along the scaffolds have been suppressed by summer pinching.

When the central leader reaches the top wire, one of two procedures may be chosen. The leader may be bent in one direction and tied to the top wire. Then, when a lateral shoot develops below the bend and becomes large enough, it may be secured to the wire in the opposite direction. The other procedure is to head the leader just below the top wire. When new lateral shoots develop, tie the two uppermost to the top wire as soon as they have sufficient length, extending each in opposite directions. The latter method gives a little more assurance of adequate branches developing into scaffold branches.

Each year, pruning on the scaffolds should be limited to thinning out for good light penetration, and pruning side branches to maintain the desired width of the tree row, which is ordinarily 3 to 4 feet.

Mature plantings in the trellis hedgerow system require only a moderate amount of annual dormant pruning. It is often helpful to go over the planting in June or July each year and pinch back or remove excessive or unwanted shoot growth. Such summer pruning helps greatly in maintaining tree size at a given level, as well as reducing the shading of lower branches.

In another popular trellis system, the scaffolds are positioned at 30 degrees from horizontal by training them across the wires rather than along them. The pairs of scaffolds are not restricted to the number of wires and usually an extra pair can be developed either along the bottom wire or between the wires. The scaffolds are also allowed to extend into adjacent trees as much as 25 to 50 percent. Otherwise, all other pruning practices remain the same.

Figure 43. Apple and other fruit trees can be trained to various espalier forms. This one is trained to a house wall.

Dwarf pear trees may also be trained easily to the trellis system. The various stone fruits may be trained to a trellis, but the procedure is more difficult because the growth habit of these trees does not lend itself to easy manipulation of branches. Spur-bearing trees can be trellised more easily than those that bear fruit on long shoots, as does the peach.

Espalier

The training of fruit trees to grow in various forms, including picturesque shapes on walls or other permanent structures, is a technique of long standing use in European gardens. This method also makes it possible to grow fruit where the area is very limited, as on a small home lot.

Through proper pruning and fastening of shoots or branches in place, the grower may develop any design desired. Here are a few general pruning principles that can be used in espalier training:

1. Head back central leader and branch terminals by cutting into 1-year-old wood at points where additional branching is desired.

2. Secure shoots in desired places the year they first develop. Each year new shoots, as well as older branches, need to be secured in place and kept there until permanently formed to the shape. This may require 2 or more years.

3. Regulate growth of branches by summer pruning. In most cases this involves pinching back young succulent shoots to dwarf the growth. This practice is essential with shoots that tend to grow vigorously.

4. Each spring thin out unwanted shoots and head back older branches to laterals to suppress extension growth and to induce spur development close to the primary arm or scaffold branches.

As the expaliered tree grows older and full of secondary branches, some thinning out of these branches and fruiting spurs will be necessary each year to maintain the shape as well as productivity of the tree.

Slender Spindle

This is a training system that can be used for apple trees on dwarfing rootstocks such as M 9 and M 26 that have to be supported in some way. With this system each tree is supported by a stake. It can be

used in commercial as well as home plantings. and can accommodate from 400 to over 600 trees per acre. The system requires the least amount of pruning and will bring the trees into production earlier than any of the other training systems.

In this system, the dwarf apple trees are trained to a 6- to 8-foot stake with short lateral branches trained out in a horizontal position around the central leader. Such limb positioning reduces vigor and promotes fruiting.

Training begins at planting. If the tree is a whip, it is headed at 36 inches. If it already has lateral shoots, they are tied down to a horizontal position and are not headed. The central leader is headed about 18 inches above the top lateral. In the second spring, all the lateral l-year-old shoots are tied down to a horizontal position and no heading cuts are made either on the lateral shoots or on the central leader. The same practices are continued until the tree reaches its desired height. As fruiting begins on the lower lateral branches (in the third year for a whip, or second year for a tree with laterals at planting), they may need to be tied up to maintain the horizontal position.

When the tree reaches its desired height, the procedure used will depend upon the vigor of the central leader. If the central leader is not vigorous, either nothing is done or it is headed back to a short lateral shoot or spur. If the central leader is vigorous, it is headed back to the nearest lateral branch that has been tied to the horizontal position. That lateral branch is then tied up to assume the position of the central leader.

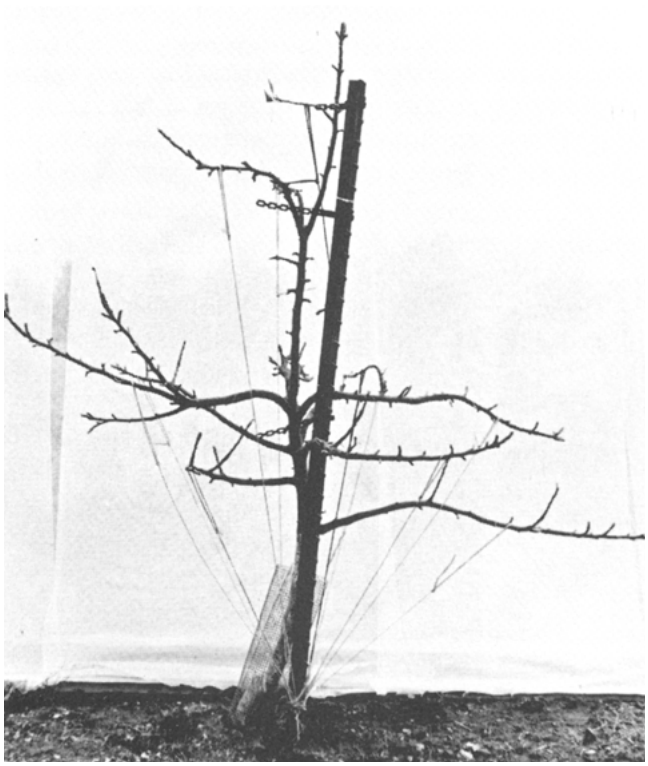


Figure 44. A 3-year-old dwarf spur-type Delicious apple tree trained to the slender spindle system. Training consists of tying 1-year-old shoots down to a horizontal position. Other than heading back the whip to 36 inches at planting, no pruning cuts have been made.

As the branches fill their allotted spaces, they are headed back to laterals keeping the upper branches shorter than the lower ones. This can be done either during dormancy or in late August. Once the trees are in production, some thinning out of branches and replacement of older branches with l-year-old shoots can be done.

Pruning Bearing Fruit Trees

Pruning to maintain tree shape and size is necessary throughout the life of a tree. In addition to maintenance pruning, young bearing trees do require some branch thinning to increase light penetration. If properly trained, the removal of large limbs should be unnecessary. Good soil management and fertilizer practices will maintain satisfactory terminal growth without producing excessive amounts.

The first step in pruning a bearing tree is to remove any large, unwanted limbs and dead, diseased, or damaged branches. This should be done annually, regardless of tree age. Likewise, remove water sprouts each year except for an occasional one that is needed for developing new bearing surfaces. The best time to remove water sprouts is in early summer when they are soft and succulent. At this time they can be easily rubbed off with a gloved hand. If done after sprouts become woody at the base, shears will be necessary to prune them off. If removed in the summer, water sprouts seldom grow back, or if growth does occur, it will be small. Any water sprouts remaining on the tree can be removed during dormant pruning. Suckers arising from the rootstock should also be removed annually.

As trees grow older, an increased number of heading back cuts into older wood are needed to maintain tree size and shape. Also, the amount of branch thinning may need to be increased to provide for development of good bearing wood throughout the tree. Color of fruit produced the previous season is also an important guide to the amount of pruning needed. Poor color will, in many cases, indicate a need for more detailed pruning, particularly of the thinning out type. Heavy pruning, however, may result in large, poorly colored fruit. This is very likely if nitrogen applications have been heavy. The rate of nitrogen application should be reduced in years when pruning is heavier than normal.

Annual pruning is recommended. When followed, only a moderate amount is necessary each year. One objective is to remove branches that are severely

shaded and will bear few fruiting spurs. Remove branches that bend to the ground or head back to upward growing laterals.

Annual dormant pruning of bearing trees helps to promote regular bearing. It also tends to reduce fruit overloads, as well as the labor expenditure for hand thinning. When pruning is irregular, trees become too thick and often biennial in bearing.

Apples

Apple cultivars differ in growth and fruiting habit. The major portion of the flower buds are produced terminally on spurs with a minor portion being produced terminally on shoots. Sometimes cultivars will produce flowers laterally on 1-year-old shoots. This means it is advisable to consider the growth habit of each cultivar when developing pruning techniques. N1 color strains or mutations of a given cultivar are pruned the same as the parent cultivar. Overcolor of the fruits of the all-red mutations is good, but proper pruning is essential to improve fruit size.

Cortland

Cortland trees tend to produce a major portion of their flower buds terminally on short shoots, many of which need to be removed annually. This requires detailed pruning. Removal of slender, underhanging branches is very important as these produce poorly colored fruit and also shade other branches and fruits. Larger branches may be thinned out by making several small, evenly distributed cuts, beginning at the end of the branch and working to its base.

Delicious

Delicious and its various strains possess an inherent tendency to develop narrow crotches. This is particularly true for the spur-type strains. Such crotches frequently develop bark inclusions which contribute to a weakened tree structure. Therefore, spreading, deshooting, and corrective cuts to space the most desirable branches along the trunk of the trees are important procedures during the second to fourth years.

Because the spur-type strains have a severe tendency to develop narrow crotch angles, the use of the heading-back cut on 1-year-old scaffold leaders is of questionable merit. One alternative is to head the scaffold leaders until the primary framework is developed, then discontinue using the heading-back cut on 1-year-old wood. The second alternative is to continue to use the cut on the lateral leaders and in the summer remove the new shoots that develop just below the new leader when they are about 4 to 6 inches long.

Nonspur-type Delicious trees may develop too many medium-sized branches, resulting in overdense trees, unless wise removal of excess branches is carried out. Since this cultivar is planted primarily for fresh sale for eating, sufficient annual pruning is necessary to produce a high percentage of attractively colored apples. This means that trees must be kept reasonably open to permit entrance of sunlight. Removing small diameter and underhanging branches from both the interior and the periphery of the tree will allow light to enter. Such is not the problem with spur-type Delicious trees, which may require little or no annual pruning once they come into bearing.

Delicious has a somewhat precarious fruit-setting habit. Detailed pruning may improve the set of fruit. Fruit thinning is important with Delicious to secure a high percentage of large, well-colored fruit, particularly if pruning has not been done properly. Trees are also prone to produce an abundance

Figure 45. Large pruning cuts cause heavy water sprout development, especially in the tops of trees. These are removed in dormant pruning, if not rubbed off in the summer. An occasional water sprout can be left to develop a new bearing surface where voids exist.

Figure 46. Water sprouts can be easily removed at this stage in the summer by rubbing them off with a gloved hand.

Figure 47. Older trees can develop productive wood throughout the tree if proper training and pruning procedures are followed annually. Light in the center of the tree is essential for productive spurs.

of water sprouts. These are best removed as they develop early in the growing season.

Golden Delicious

This cultivar is an early bearer and is prone to produce flower buds laterally on 1-year-old shoots and on newly formed spurs. Consequently, tree form should be developed as early as possible. It is not difficult to develop a strong, well-shaped scaffold system on this cultivar. However, care must be taken that the trees do not begin to fruit before they are capable of carrying a load. When they first come into production it is wise to thin the fruits so that the remaining fruits are restricted to areas of the tree where the scaffolding is at least 3 years old, or the lower half of the scaffolds. If this is not done, the desired shape of the framework may be lost.

Golden Delicious has a tendency to develop weak, narrow-angled crotches, but much less so than Delicious. It is, therefore, necessary to develop a framework with wide-angled crotches. Developing branches often become long and may break with the first heavy crop of fruit because the wood of Golden Delicious is rather brittle. Pruning annually and keeping all branches within a reasonable length is essential.

Jonathan

These trees have a spreading willowy growth habit and naturally develop a dense, fine growth. Unless properly pruned, bearing trees become thick and shading occurs throughout the tree. Because of its tendency to produce many flowers laterally on the shoots, Jonathan does not respond well to heading-back cuts. Detailed, thin-wood pruning and branch spacing are essential for good fruit size and color throughout the tree. This cultivar tends to be small-fruited. If good, commercialize fruits are to be produced, careful attention must be given to pruning practices.

Heavy pruning of Jonathan increases the hazard of fire blight, a disease to which the cultivar is very susceptible. It may also reduce fruit color. Nitrogen fertilizer should be restricted on Jonathan in order to improve fruit color and to reduce fire blight suscep≠tibility. The heavier the pruning, the less nitrogen should be applied.

Lodi

Lodi is similar in growing habit to Yellow Transparent and both should be pruned similarly. This cultivar tends to set fruit heavily in alternate years, especially on the smaller wood in the center of the tree. Fruits produced in the shaded interior are usually of inferior size, green in color, and mediocre quality. Annual, detailed pruning in the interior section is necessary to remove most of the thin wood that produces the inferior fruit. Branches in the outer portions of mature trees also need annual thinning out and some heading back of long branches.

McIntosh

The McIntosh cultivar naturally produces scaffold branches with reasonably wide-angled crotches, resulting in a spreading-type tree with many secondary branches. Therefore, considerable branch thinning is necessary to permit thorough spraying. McIntosh tends to produce fruit spurs throughout the tree, similar to Golden Delicious. Pruning to keep the tree open is important to producing well-colored fruit of good size.

Rome Beauty

Trees of this cultivar produce the major portion of their flower buds terminally on shoots as opposed to spurs and are characterized by many slender branches that cause much shading. These branches require considerable thinning out. Each large branch is best pruned as a unit from tip to the base. The cuts are distributed as evenly as possible, and weak wood is removed.

A common mistake in pruning bearing Rome Beauty trees is to start at the base of a large branch and prune outward, removing all the bearing surface for a considerable distance. This leaves a long stretch of barren wood with a cluster of unpruned, bushy twigs at the ends. If the full crop potential is to be gained, special care must be given to the placement of thinning-out cuts on all strains of Rome Beauty trees.

Stayman

This cultivar tends to develop many rangy, rather large branches. Consequently, heading back and proper selection of primary and secondary branches are necessary on young trees. As a mature tree, Stayman is an open grower that requires few large branch removals. Corrective cuts, when necessary, should be made to avoid double leaders and weak crotches.

Stayman, especially if slow-growing, develops sharp-angled crotches. Limb spreading or making corrective cuts to eliminate these structural weaknesses before the branches attain large size is desirable. Because Stayman is an open grower, much of the pruning can be done with lopping shears. Small cuts distributed well give a large food supply to the remaining fruit spurs.

Wealthy

Red overcolor is important with Wealthy. The pruning program should prevent trees from ever becoming dense. If Wealthy is allowed to overbear, it becomes a weak grower and a biennial cropper more quickly than if moderate annual crops are encouraged. It

is important to do considerable thin wood pruning throughout the tree in order to promote vigorous, productive growth. Pruning should also be sufficient to produce a considerable amount of new shoot growth. Pruning and fruit thinning are both important with Wealthy; neither practice can be substituted for the other. Due to Wealthy trees' susceptibility to fire blight, pruning, which induces vigorous growth, should be kept to a minimum.

Yellow Transparent

These trees produce many branches and may become very dense. When the main branches are well spaced, weight of the fruit spreads the tree quite satisfactorily. Very little heading back to outward growing laterals is needed if enough large branches are removed in pruning. Small cuts, well distributed on the branches that are left, help considerably to improve fruit size. The amount of thin-wood pruning necessary is increased as trees grow older.

Yellow Transparent also is greatly benefited by early fruit thinning. Since it is difficult to sell small fruits, extensive pruning and thinning are needed to improve the fruit size of this cultivar and aid it in overcoming biennial bearing. Over-pruning should be avoided since it induces succulent growth that is very susceptible to the fire blight disease.

Pear Trees

Pear trees have the same fruit-bearing habits as apple trees, with the major portion of the fiower buds produced terminally on spurs. The amount of crop produced laterally on shoots is much less than that occurring on apple trees.

Very light pruning is practiced on bearing pear trees. Even moderate pruning may induce development of water sprouts and fast-growing terminal growth. This type of growth is very susceptible to fire blight infections.

Pruning cuts may be restricted to branches that severely rub each other and to water sprouts as they appear. In all cases, cuts should be confined to limbs of smaller diameter. Heading back of terminals should be done only as the tree becomes too high. Heading back to a lateral branch at that time should be light and cuts made into smaller diameter wood. It usually is not necessary to prune pear trees each year because new growth should not be heavy or vigorous. However, each year trees should be examined to determine if pruning is necessary.

Remove Fire-Blighted Branches

During dormant pruning remove all fire blight infected branches on pear and apple trees. Blight cankers can be detected by their dead, blackened, and sunken appearance. Blighted terminals are blackened and often retain the dead leaves throughout the winter.

Beginning shortly after bloom, inspect trees weekly until midsummer for shoots and spurs that may be infected with blight. Promptly remove the diseased portion 4 to 6 inches below the obviously diseased part if such a practice is economically feasible.

Water sprouts shoot growth, and spurs on the trunk and base of the scaffold branches of pear trees should be removed prior to blooming. This will eliminate possible blight infection of lowering points at the terminal ends of these spurs and shoot growth, thus preventing blight development that will often girdle the trees.

For more information on fire blight, see PM 225, *Fire Blights of Fruits and Ornamentals*.

Peach and Nectarine Trees

Peach and nectarine trees are pruned the same way. Annual pruning of bearing trees is essential to the production of fruiting wood and high yields of quality fruit. Since the flowers of these trees are located only laterally on l-year-old shoots, all the fruiting wood must be essentially renewed each year. Proper pruning will aid in production of good fruiting wood. This becomes particularly important as the trees become older. Pruning the bearing tree must also be done to help in pest control and to provide for favorable light conditions throughout the tree. Routine pruning can reduce overbearing, the amount of fruit thinning needed, and improve orchard efficiency and the quantity of marketable fruits produced.

Time of Pruning

Pruning of peach and nectarine trees should be delayed until the danger of a severe freeze is past. Generally, pruning should be done from mid-March to early April. It should not, in normal seasons, be delayed so long that buds might be knocked off in the pruning operation. If severe winter temperatures have been experienced, delayed pruning may be especially beneficial. Delaying pruning means the removal of buds that have survived can be avoided. Winter injured flower buds can be identified in late winter or early spring by the characteristic dark centers when cut in cross section. Wood that has been injured by low temperatures will appear wrinkled or withered and when cut will show a brown layer of tissue under the bark. Such wood can be easily detected and removed by early spring. If low temperature injury to the wood was extensive, it is often better not to prune the trees in the spring and wait until summer to remove the dead wood.

Pruning Procedures

Peach and nectarine trees that have reached bearing age require annual heading back of old fruiting wood to lateral shoots developed on this wood, and careful thinning out. In addition, all damaged or diseased wood should be removed, as well as that growing in an objectionable direction, Nso remove hangers, branches that grow downward, and branches that interfere with the movement of equipment through the orchard by heading back to a lateral shoot or by thinning out, if 1-year-old shoots are available. In general, trees should be pruned to the extent that fruit can be harvested handily from a 6-foot ladder.

When thinning out shoots, distribute cuts over the tree so as not to leave a cluster of twigs at the ends of branches. The "horse tail" effect can be avoided when pruning proceeds from the tip to the base of each scaffold branch. When selecting fruiting wood to save, those shoots that made 10 to 18 inches of growth the previous season generally are the most productive.

Vigorous, upright water sprout growth frequently develops in peach and nectarine trees. It is most abundant following severe pruning or loss of large limbs. Such growth may reach 5 or 6 feet and may present a special problem. Most water sprouts need to be thinned out during dormant pruning, but a few may remain for developing into new scaffolds. These are headed back to an outward lateral shoot with some thinning out of the remaining laterals. So handled, they may develop into fruiting wood replacing what was lost or pruned away.

To maintain the trees at the desired height, it is important to head the upward-growing branches to strong, outward-growing laterals. It is preferable to make the cuts easily reached with lopping shears or short pole pruners when standing on the ground. The renewal point is first established by heading back each main branch as soon as it reaches the desired height. This cut is ordinarily made in 1-year-old wood. In successive years the renewal cuts should be made in the vicinity of the original cuts; cut above it some years and below it some years. The center of the tree is kept reasonably open in order to maintain the spreading form.

Avoid climbing in peach trees while pruning, especially with hard-soled shoes. The bark can be easily scuffed, which results in open wounds where canker infections can take place. If trees are too tall to be pruned from the ground, it is best to prune from ladders.

Severe heading back into older wood or "dehorning," may be acceptable sometimes. This practice most logically fits into the pruning program after trees have been allowed to grow rather tall from lack of pruning in years when frost damage occurred and crops were borne only in the upper parts of the trees. When such trees have a complete crop loss, dehorning may be

Figure 48. Mature peach trees need annual thinning out and heading back to laterals to induce development of new productive wood.

Figure 49. Height of mature peach trees can be controlled by annual heading back of upright growth to outward growing laterals.

the best way to induce new shoot growth lower on the trees and thus increase bearing surface for the next year.

Peach Canker Removal

The peach canker disease presents some special problems in pruning peach and nectarine trees. Complete removal of a canker-infected branch is necessary when the canker is near its base. When the canker area is farther out on a branch the cuts should be made 6 to 8 inches below the visible canker edge. In any case, cutting through a canker should be avoided. If cuts are made through a canker, then the disease organisms may be transmitted to healthy wood at the next cut unless the shears are disinfected between cuts. Prunings with diseased wood should be removed from the orchard and buried. Pruning out of cankered branches should be as complete as possible if this disease is to be kept at a minimum. Where canker is a problem, prune as late in the spring as possible. This avoids wounds that are points of easy entry for the pathogen in early spring when it is most active.

Sour Cherry Trees

Since the modified central leader system is usually preferred in training sour cherries, bearing trees are pruned to maintain this shape and for high production of quality fruit. Trees that have been trained to three or four primary scaffolds are equally satisfactory for mechanical harvesting and for hand picking. There is little difference in the performance of cherry trees when trained to the modified central leader system or to the open center system.

Characteristically, the sour cherry tree tends to produce narrow crotches. Trees tend to open up with the crop, but the use of spreaders in young trees may be helpful in developing a strong tree framework.

The sour cherry tree tends to produce a dense top that requires an increasing number of thinning-out cuts in order to keep the trees open. Unless special attention is given to these trees, the fruiting wood in the lower interior portions will shade out and perhaps die. Since the trees have a spur-bearing habit, care must be exercised not to remove this portion of the surface when thinning out. Such limbs can severely shade the lower portions and may cause limb rub damage to main scaffold members. Hence these should be pruned out each year. Occasional heading back of upright wood to outward laterals is necessary on the main branches.

Mature sour cherry trees perform best under light, annual pruning. Remove dead wood and broken branches as they appear as well as cross-growing branches. With well-grown trees some thinning-out

Figure 50. Proper pruning is essential to control peach canker disease. Cankered branches should be removed, as is being done with the one on the left which has a canker near its base.

Figure 51. A mature Montomorency cherry tree before pruning (left). The same tree after pruning (right) to thin out weak wood and open up the tree for good light penetration.

pruning is necessary to aid through pest control and make harvesting easier.

Sweet Cherry Trees

A sweet cherry tree develops into a large tree. The modified central leader system of training. as described for apple trees, is most desirable for the sweet cherry tree. Three or four primary scaffolds are desirable, with 8 inches or more vertical distance between them and with proper spacing around the trunk. The sweet cherry tree is occasionally injured by low winter temperatures and the injury is usually greatest in the areas of narrow crotches. Special attention must be given to avoid narrow crotches in selecting the primary scaffold branches.

After the primary scaffold branches have been selected, care should be used in the selection of secondary branches with wide angles. These are an important part of the tree structure and should not be developed closer than 15 to 18 inches from the trunk. Thinning-out cuts are essential as trees grow older. When the leader reaches the desired height, it should be headed back to an outside branch. Because of the natural tree size, sweet cherry trees, particularly on Mazzard rootstocks, are difficult to maintain less than 16 to 18 feet in height. Tying limbs down so that the terminals are positioned below horizontal can aid in earlier fruiting and control of tree height. The trees require only light, annual pruning. The primary objective here is to remove dead, broken, and weak branches, especially those in the center of the tree. As trees grow older, it may be necessary to head back branches when they become too long, Such a procedure should help to develop new fruiting wood near the center of the tree and may also prevent limb breakage,

Plum Trees

A well-pruned tree is especially important in the spraying operations for the control of brown rot in plum orchards. European plums, such as Stanley, and Damson plums, are best pruned and trained to modified leader, as described for apple trees. Selected scaffold branches on the plum tree may be closer vertically than with apple trees. However, about 6 inches of vertical space in between scaffold branches is desirable.

Lighter pruning may be followed with European and Damson plums than with apple trees. As trees reach heavy bearing, there is reduced growth of terminals and increased growth of fruiting spurs, At this time, the amount of pruning may be increased. Detailed pruning throughout the tree and enough thinning out to maintain desirable growth over the lower branches is recommended for mature trees.

Cultivars of the Japanese-type plums, such as Superior and Premier, grow in a more spreading fashion than European plums. The trees also tend to grow thicker. Thus, techniques for training young trees and pruning mature trees are similar to those of the peach tree, except that, generally, fewer heading back to lateral cuts are required. Considerable thinning out of small diameter wood in mature trees is necessary to maintain production of large plums.

Removal of Black Knot

Pruning is the most important means of controlling black knot disease in plums. Branches with these canker-like growths, generally a brown or black color, should be carefully cut from the trees and removed from the orchard. Twigs or branches with the characteristic swellings or knots may be removed at any time the infections are first noticed, but most certainly cut out during dormant pruning. Cut the branches off 6 or more inches below the apparent knot to be sure all infected tissue is removed.

Apricot Trees

Apricot trees are best trained to the open center system as described for peach trees, but the modified central leader system can also be satisfactory. With young as well as mature trees, long, slender branches require some heading back to laterals that are growing in an outward direction, Trees should be kept open with considerable thinning out pruning in order to induce annual formation of fruit-bearing wood. In the case of the apricots, fruits are borne

Figure 52. The black knot disease of plum can be partially controlled by pruning out affected branches, as shown by the dotted lines.

on short spurs that are rather short-lived. A primary objective is to remove those branches loaded with spurs that are 6 years or older. Annual heading back and thinning out will help ensure formation of young, productive spur growth.

Apricot trees that are neglected and produce short annual terminal growth often fall into a biennial bearing habit, producing a heavy crop of small fruits 1 year and a light or no crop the next. To overcome this, pruning and fertilizer programs should be coordinated to result in 16 to 24 inches of terminal growth annually.

Apricots bloom very early; consequently, all or most of the flowers or young fruits are frequently killed by frost. Delaying pruning until after bloom may be advisable with apricots.

Pruning Neglected Trees

On occasion it becomes necessary to prune fruit trees that have been neglected for a period of years. The situation is often confusing to the pruner when approaching a tree that has overgrown its desired bounds, is too tall, overly dense, and unproductive in a large portion of its interior. The primary pruning objectives with such trees are to reduce tree height and thin out older branches. This will permit good light penetration through the tree and ensure better spray coverage as well as fruit production. The following procedure is for pruning a neglected tree:

1. Lower the height of the tree where necessary by heading back to lateral branches. Up to 4 or 5 feet of growth can be removed in 1 year. If it is necessary to remove more top growth, spread the pruning over 2 or 3 years, removing 3 to 5 feet of the older wood each year. Most of the water sprout growth in the treetop, resulting from the previous year's pruning, will be removed with the older growth taken out. The final cut in the top should be just above an outside lateral branch. Subsequently, pruning in the treetop will consist largely of annual water sprout removal.

2. Remove undesired, large (over 2 inches in diameter) branches from the interior of the tree, if necessary. It is usually best to remove all branches at once rather than distribute the cuts over a period of years as in top removal. However, if more than four large branches must be removed, remove half the first year and half the next.

3. Prune off low-hanging branches and dead, diseased, or broken branches wherever they exist in the tree.

4. Head back lateral branches that are too long, bringing the tree to a desired spread. Prune upper branches to shorter lengths than those lower on the tree.

5. Thin out branches in all parts of the tree. Remove under-hanging branches, strong upright growing shoots, and water sprouts as well as other weak growth. Thin the outer areas of the tree first and the interior last. The procedure permits the pruner better vision to leave some bearing wood near the center of the tree and avoid leaving all the bearing surface in the tree's periphery. The amount of thinning out pruning will be determined by the original density of the tree. Prune sufficiently to permit some light penetration to the center of the tree when in leaf. Light is necessary to the regeneration of fruiting wood in any part of the tree.

Figure 53. Pruning a neglected apple tree can aid in bringing it back into useful production. Before pruning (left) and after partial pruning the same season (right). Heavy pruning should be carried out over two or three seasons.

6. Complete rejuvenation of a neglected tree may take 1 to 3 years of rather severe pruning, as indicated in the previous paragraphs. For apple and pear trees, it is usually best to distribute the pruning over 2 or 3 years, especially when large cuts are needed. Peach, plum, and cherry trees can often be completely pruned back and thinned out in one year.

7. Follow annual, moderate pruning once the tree has been rejuvenated.

Pruning Terms

Terms are defined primarily as they are used in the text of this bulletin.

Bearing tree—A fruit tree that is mature enough to produce fruits annually.

Branch—A shoot that has developed to maturity and has passed through two or more dormant seasons.

Bud—The initial of an unelongated branch or tip of a shoot. A bud may develop into leaves or a vegetative shoot, or into flower and their subtending parts. It may be terminal as at the end of a branch or shoot, or lateral as in the axil of a leaf.

Bud union—The point of attachment between the scion cultivar and the stock or rootstock upon which it is budded or grafted.

Crotch, crotch angle—The angle between two contingent shoots or branches near the point of their union.

Crow's foot—Three or more shoots arising in very close proximity to one another, generally resulting from a heading-back cut on a l-year-old shoot. If left alone, the leader or dominant shoot is often choked out. In pruning, thin to a single shoot.

Cultivar—A term that is now used in place of the older term, variety, when designating a specific horticultural variation in a plant species.

Deshooting—The practice of removing young shoots from a tree or other plant during the growing season for the purpose of aiding in the training of the plant.

Disbudding—The removal of dormant buds, a practice sometimes followed on newly planted or young trees in the selection of buds for development of scaffold branches.

Dwarf tree—Generally, a cultivar that has been propagated on a size-controlling rootstock, such as Mailing (M) 9 or 26 in the case of an apple, and produces a small size tree.

Espalier—A wall or framework upon which a tree or other plant may be trained; or the shape to which a plant is trained to be more or less picturesque as well as productive.

Fruiting wood—Branches or shoots of a tree or other plant carrying flower buds and the potential for bearing fruit.

Growth regulator—A chemical substance that may inhibit or accelerate vegetative growth, or may affect the initiation of floral or vegetative buds, or in some way may alter the normal growth habit of the plant. The substance may occur naturally in plants or it may be formulated and applied to plants for the purpose of producing desired effects upon growth habit.

Heading back—Usually refers to cutting away a portion of the terminal growth of a shoot.

Heading back to a lateral—Refers to cutting away the terminal portion of a branch by cutting into 2-year-old or older wood at an axil of a shoot or branch so that the shoot or branch assumes the terminal position.

Hedging—A term applied to pruning by mechanical devices that cut away, in bulk fashion, portions of the top and sides of the trees.

Leader—The terminal shoot of a scaffold that is in the dominant position or is in line with the primary scaffold.

Limb—A large primary branch of a tree--synonymous to scaffold.

Mailing rootstock—A group of rootstocks classified at the East Mailing Resarch Station in England to represent various degrees of size control of the trees of cultivars propagated on them.

Old wood—In pruning, this refers to branches that have been productive or bearing for a number of years, generally for more than 5 or 6.

1-year-old wood—Spurs or shoots that were produced by the previous season's growth. A term generally used during the dormant pruning season.

Pome fruits—A specific type of fruit classified according to structure. Refers to apples, pears, and other similar fruits where the seeds are surrounded by thin leathery tissue and a fleshy receptacle.

Rootstock—The root system and portion of attached stem upon which another plant part is propagated (budded or grafted).

Scaffold—One of the branches comprising the basic framework of a tree or other plant Primary scaffolds are those arising directly from the main trunk of the tree.

Semi-dwarf tree—A cultivar that has been propagated upon a specific size-controlled rootstock that produces a mature tree somewhat smaller than a standard tree and somewhat larger than a dwarf tree. Rootstocks most often used for this purpose are Mailing (M) 7; Mailing Merton (MM) 106 and 111.

Shoot—Long vegetative growth produced from a dormant bud that possesses leaves. Generally, the growth during a current season or, in the dormant season, growth developed the previous season.

Spreader—A short piece of wood or metal used in insert between a lateral branch and the main trunk of a young tree for the purpose of producing a wider growth habit of the scaffold.

Spur—Short, thick growth upon which flowers and fruits are borne, typically on most apple, apricot, cherry, plum, and pear trees.

Spur-type tree—Most often used in reference to recent mutations of certain apple cultivars that produce fruiting spurs early in the life of the tree and more abundantly per foot of branch growth.

Standard tree—Commonly refers to a tree that has been propagated by grafting or budding a cultivar on a seedling rootstock.

Stone fruit—A specifIc type of fruit classifled according to structure. Refers primarily to peaches, plums, apricots, cherries, and similar fruits with a stony layer around the seed.

Sucker—Rapidly growing shoots arising from the base of the tree.

Thin wood—Refers to branches of rather small diameter in relation to overall length. These usually develop in the more shaded portions of a tree and from the lower sides of larger branches and are generally unfruitful or produce small, poorly colored fruits.

Thinning out—Refers to removal of shoots or branches in a portion of the tree, or throughout the tree or other plant, for purposes of permitting greater light and spray penetration into all areas of the plant.

Water sprouts—A term applied to vigorous, succulent shoots arising indiscriminately and generally on the larger branches of a tree. They are often produced in large numbers just below a pruning cut.

Whip—A single, unbranched shoot that has developed from budding or grafting a cultivar on a rootstock and grown] year in a nursery row.

Wound—The cut surface remaining on the plant where a branch has been removed by pruning. It may also refer to any other open surface on the plant.

Wound dressing—A proprietary compound especially made for treating cut surfaces on plants for purposes of reducing the drying of the exposed plant tissues and protecting the open areas from invasion by infectious organisms.

Revised by Paul A. Domoto, associate professor of horticulture, from Pruning and Training Fruit Trees, a publication of the Ohio State University Cooperative Extension Service.

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