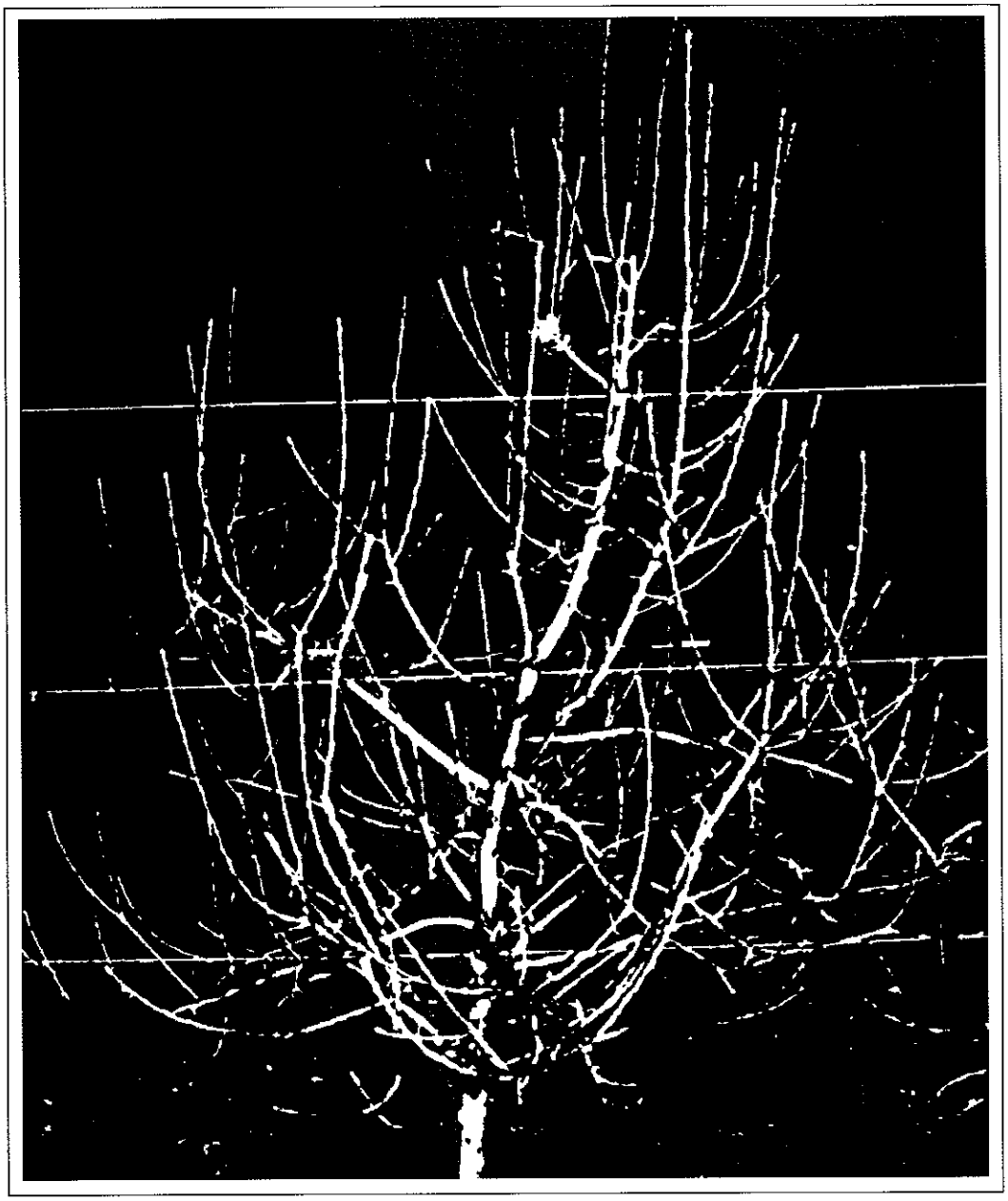
TRAINING APPLE TREES

IN COMMERCIAL ORCHARDS



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Training Apple Trees in Commercial Orchards

R.L. Stebbins

This publication describes the most important concepts in training apple trees. It's designed to help experienced trainers improve their training skills.

Base your judgments about limb positioning or pruning for training in any particular tree on its current condition relative to your desired objectives.

This publication provides information about the advantages and disadvantages of various training systems and how to accomplish certain objectives.

You should recognize that there are several ways to train trees successfully, but they all require an understanding of the characteristics of tree growth. Training that ignores these characteristics may result in broken trees, low yield, excessively tall trees, and reduced fruit size and quality.

This publication first discusses a few facts about tree response (understanding this is basic to all training), defines terms used in training, and then describes the principal systems used for tree training.

Tools for training and pruning

Proper tree training involves cutting into small wood with hand shears. About the third or fourth season, long-handled pruning shears, often called *loppers*, are useful in reaching the higher limbs and in removing large wood. Don't use power mowers or gang saws to train apple trees. The cuts made by such equipment will be too numerous and often too large. Frequent sharpening of pruning tools makes the work faster and easier.

You may need a ladder for the work. Since ladder falls are the most frequent and costly source of injury in orchards, make sure that:

1. you have a *good* ladder,
2. it's the right size for the tree, and
3. you know how to set it properly.

Tree response

These basic facts about tree response apply no matter what training system you follow:

1. Pruning a young, nonbearing tree always delays the onset of production and reduces the quantity of fruit produced in the early years. Training by limb positioning with little pruning leads to increased early production by leaving more potential fruiting wood. Branches tied toward the horizontal are often more fruitful than if left upright.
2. Pruning stimulates growth near the cut; however, the net effect of pruning is to reduce the overall size of the tree and the relative size of the pruned limb. Thus, pruning results in longer shoots, but less total growth.
3. *Apical dominance* is the term used to describe the influence the terminal (or "apical") bud exerts on the growth beneath. It influences the number of buds forming shoots, the lengths of the shoots formed, and their angles with the limb they emerge from (figure 1).
4. The roots also influence the growth habit of the top. Restricting the roots, whether by drip irrigation into an otherwise dry soil, or by allowing only a limited amount of soil for the root zone, increases branching, flower formation and fruit set in young apple trees.

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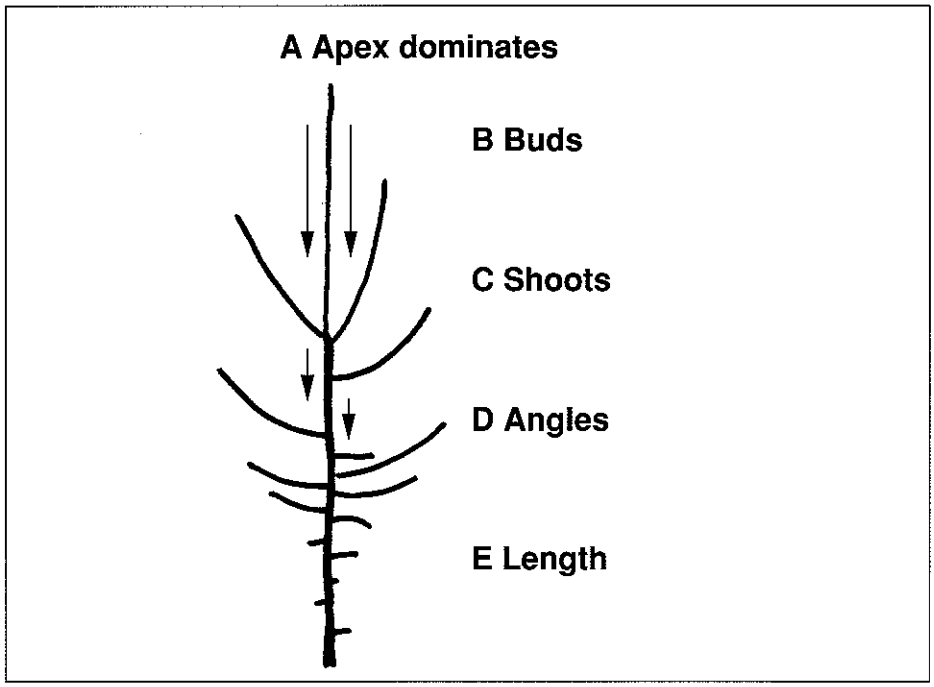


Figure 1.—Apical dominance is the term used to describe the influence the terminal (or "apical") bud exerts on the growth beneath.

5. The overall shape of the tree influences productive efficiency and fruit quality by affecting light distribution throughout the tree (figure 2). Light distribution is more even in a conically-shaped tree than in one that's broader across the top than at the base.

Effects of limb spreading

1. The unspread upright limb produces the longest shoots near its apex (figure 3).
2. Moderate limb spreading, 30 to 60° from vertical, reduces the vigor of shoots near the apex while increasing the number of shoots formed and the length of those farther away from the apex.
3. Wide spreading exaggerates this difference in the position of long shoots, but it may reduce the total number of shoots formed. The requirement for spreading and the degree of response varies considerably with variety and with rootstock. Spreading limbs excessively or when the tree is too young will require heavy pruning to remove upright shoots.
4. Spreading lower limbs reduces their vigor and increases growth of the central leader.
5. Spreading limbs tends to change the locations of flower buds, but it doesn't increase (and it may decrease) the total number of flower buds formed when compared with unspread, unpruned trees.
6. Trees trained by spreading, but little pruning, will set more flowers and fruit than trees trained by pruning alone. Spread trees may end up with more flower buds than nonspread ones because there may be fewer removed while pruning for training.

Two basic cuts

Heading back means cutting off part of a shoot or branch. *Thinning out* means taking out the entire branch or shoot back to a larger branch or to the trunk.

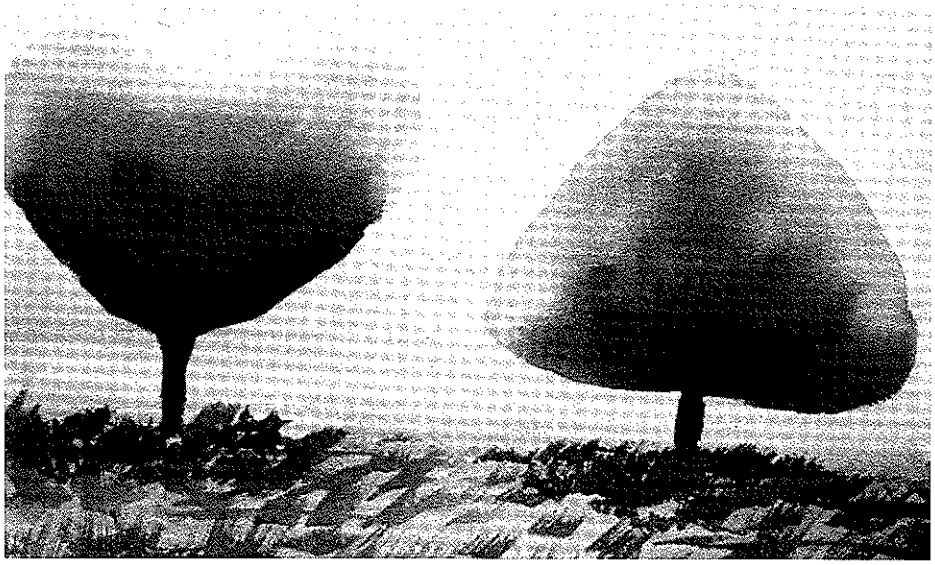


Figure 2.—Tree shapes.

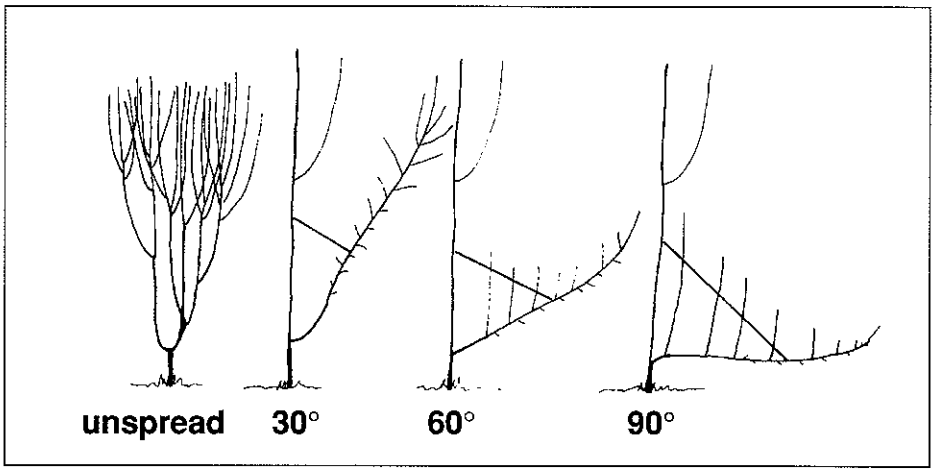


Figure 3.—The effect of limb spreading.

Heading back

Heading back, especially into 1-year-old wood, stimulates branching, stiffens limbs, or prevents fruit set on the ends of shoots (figure 4). It reduces the number of flower buds formed.

Thinning out

Thinning out improves light penetration, redirects limbs, and shortens branches (figure 5). All pruning reduces flower bud formation, but thinning reduces it less than heading does.

Shoots that form a narrow angle with the trunk of a young tree will become main limbs with narrow angles. Narrow crotches include bark, are weak and split easily, and are more susceptible to cold injury. Winter ice forming in narrow crotches expands and may split the trunk.

Avoid narrow crotches by selecting shoots that form wide angles, such as 45 to 60° with the trunk or other branches, or by artificially spreading the young shoots as they form.

When to prune for training

Late spring and early summer is a good time to direct growth into shoots that will make desirable branches and eliminate those that will compete with the leader.

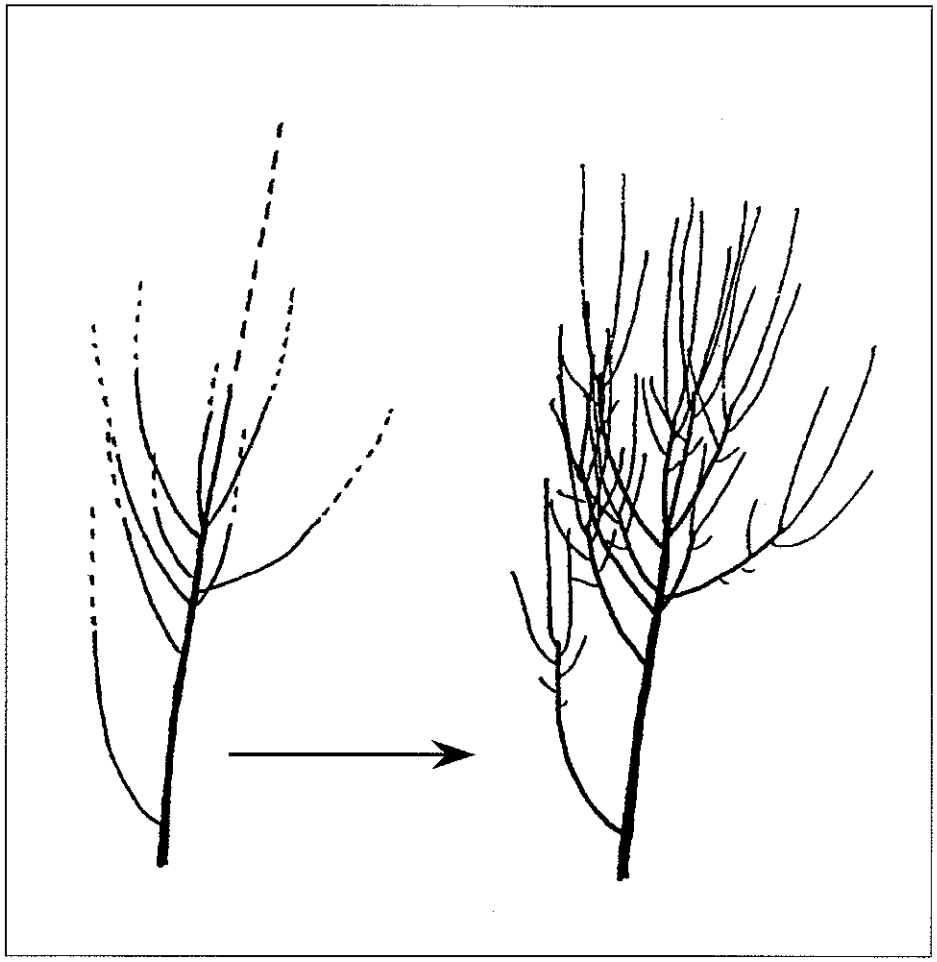


Figure 4.—Heading increases branching.

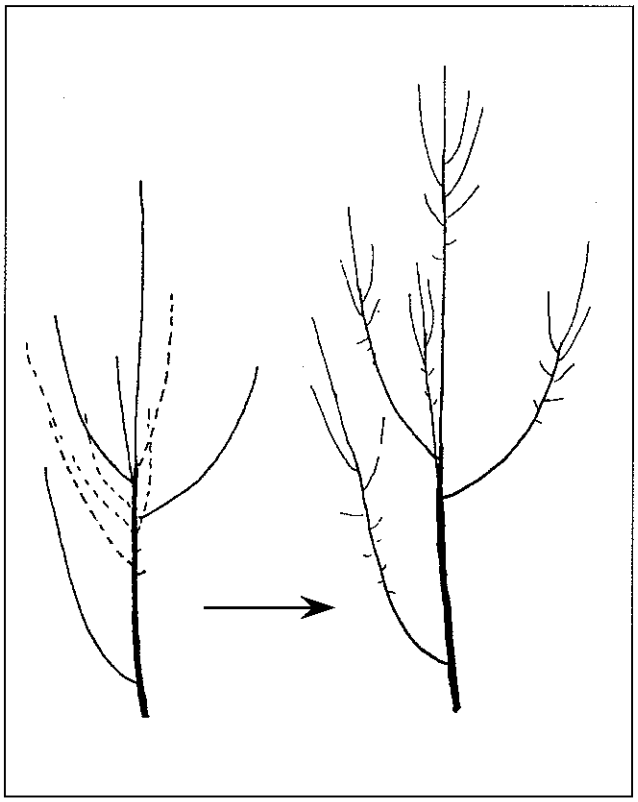


Figure 5.—Thinning limits branching.

Fall or early winter pruning can increase the susceptibility of trees to damage in a sudden freeze within 2 weeks after they're pruned.

In districts with mild winters, you may begin pruning for training as soon as the leaves fall. In the colder districts, wait until after January 1 to reduce the risk of damage to pruned trees from extreme cold.

Growth and fruiting habit

Different varieties of apple, or the same variety grown on a different rootstock, respond somewhat differently to training. To become a masterful trainer, you must prune and carefully observe the results on the same trees for several years.

Growth habit refers to the overall growth pattern of the tree and includes:

- carriage—stiff upright to weeping;
- crotch angles—narrow to wide;
- branching—many to sparse;
- location of branches—start of a year's growth and/or bourse shoots; and
- the presence and degree of "blind wood."

A *bourse shoot* is one that originates from the enlarged portion of stem that bears a fruit (figure 6 on page 6).

The degree of branching of young trees may vary with climate, with less frequent branching in hot climates than in cool ones. Although there's no scientific evidence about this point, it's strongly suggested by reports of observations of branching in different climates.

Fruiting habit refers to the overall pattern of fruiting and includes:

- fruiting on the ends of long or short shoots,
- age of spurs that produce most of the crop, and
- production close to the trunk or rapidly evolving toward the extremities of scaffold limbs.

Most apple varieties can be classified as one of the following types according to growth and fruiting habit.

Spur types

These are characterized by Starkrimson Delicious. Spur-type trees tend to be stiff-upright with narrow crotches and sparse branching (figure 7). They branch little at the start of a year's growth, and have few or no bourse shoots. Fruiting occurs on numerous short spurs, which are long-lived. The zone of fruiting tends to remain close to the trunk. Tree vigor is strong low in the tree.

Semispur types

The semispur types, such as Braeburn, have a much greater tendency to branch, yet the lower part of the tree remains most vigorous (figure 8). They have few, if any, bourse shoots, and little or no blind wood.

Middle type

This type is characterized by ("standard") Golden Delicious. These varieties tend to be spreading with wide crotches and frequent branching both at the start of a year's growth and as bourse shoots (figure 9). They bear on spurs and shoots that are generally 1 to 3 years of age.

Sometimes they also bear laterally on last year's shoots, but these fruits are generally small. The fruiting zone tends to move rapidly away from the trunk to the outside of the tree.

Tip bearers

Characterized by Rome Beauty and Granny Smith, tip bearers tend to have upright main scaffold limbs with narrow crotches and frequent branching (figure 10). They bear much of the crop on the ends of the previous year's shoots.

There's a strong tendency for the lower half of the shoots to be without leaves or fruit—that is, "bare" or "blind," especially if the tree is vigorous. There's a strong tendency for the fruiting wood to move toward the extremities of the branches, with tree spreading as a result.

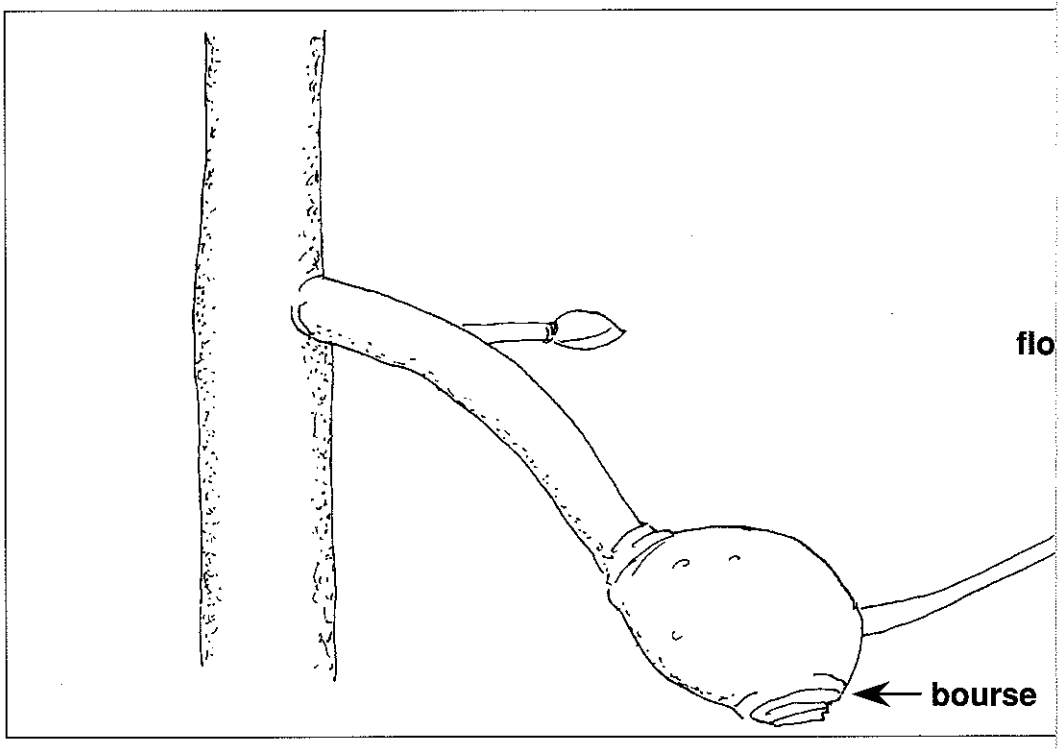
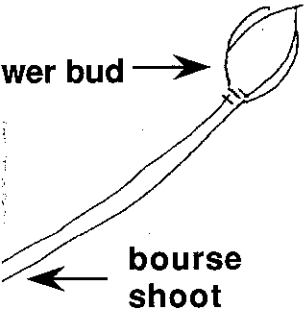


Figure 6.—A bourse shoot.

Figure 7.—A spur-type tree.



When to train

Training directs growth into a well-designed tree structure. To avoid heavy cutting, which would reduce early yields, do most of your training in the first two or three seasons, when you use only a few small cuts.

Newly-planted trees

Unsupported trees must be headed at planting time so that the lower trunk and branches will be strong enough to resist wind. Supported trees are often headed at planting, either to stimulate formation of shoots lower on the central leader and/or to develop a stronger lower tier of limbs.

With an unheaded central leader, the desired tree height may be reached sooner than if the tree is headed, but the branches may not be at desired points and may be too far apart. Heading increases the need to spread limbs to develop wider crotches, and to remove shoots with narrow angles.

Low heading, about 24 inches or lower, stimulates fewer but longer shoots on unbranched whips. Heading higher than 24 inches usually results in more but shorter shoots. Figure 11 shows low vs. high heading.

Delayed heading—after the terminal shoot bud has opened but before much growth has been made—produces framework shoots with wider angles than a single heading cut at planting time.

Feathers

If the nursery stocks arrive with unbroken branches, called *feathers*, some of these can be used to develop a lower whorl of limbs, provided they aren't too low or too high.

Feathers are sometimes headed to develop branches and spurs closer to the central leader, and to avoid areas of blind wood. However, if left unheaded, the feathers tend to spread wider under the weight of leaves and the first fruits.

Under some conditions (injured nursery stock, infrequent irrigation, or other stresses) feathered trees may not grow well.

Remove all feathers closer to the ground than 18 inches. If there are plenty of feathers, you may want to remove all below 24 inches. The presence of very low branches greatly complicates mowing and chemical weed control.

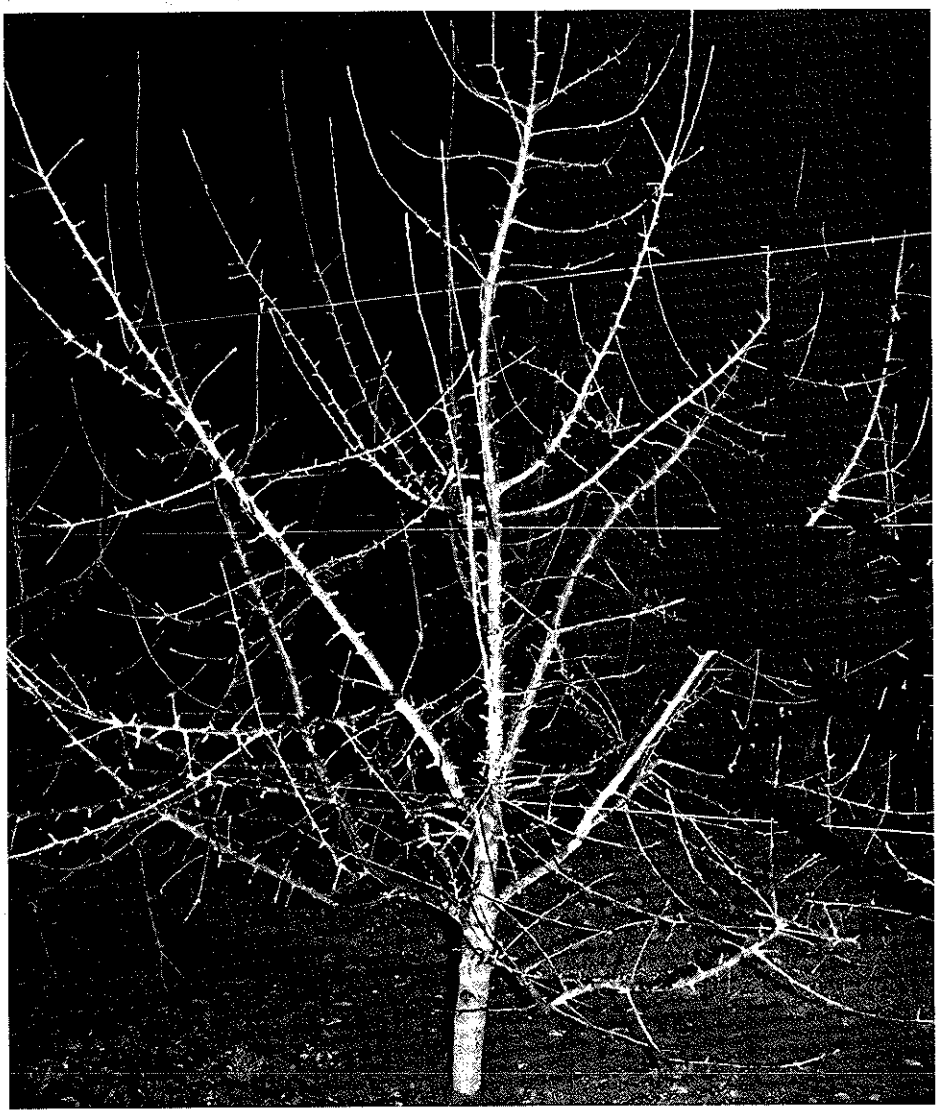


Figure 8.—A semispur-type tree.

Kinds of training

There are three general kinds of training used for apple trees: central leader (or axis), modified central leader, and multiple leader (or vase).

For dwarf and semidwarf trees, central leader is by far the most commonly used system. However, there are many variations of central leader training that relate to the overall orchard system, rootstock, and variety.

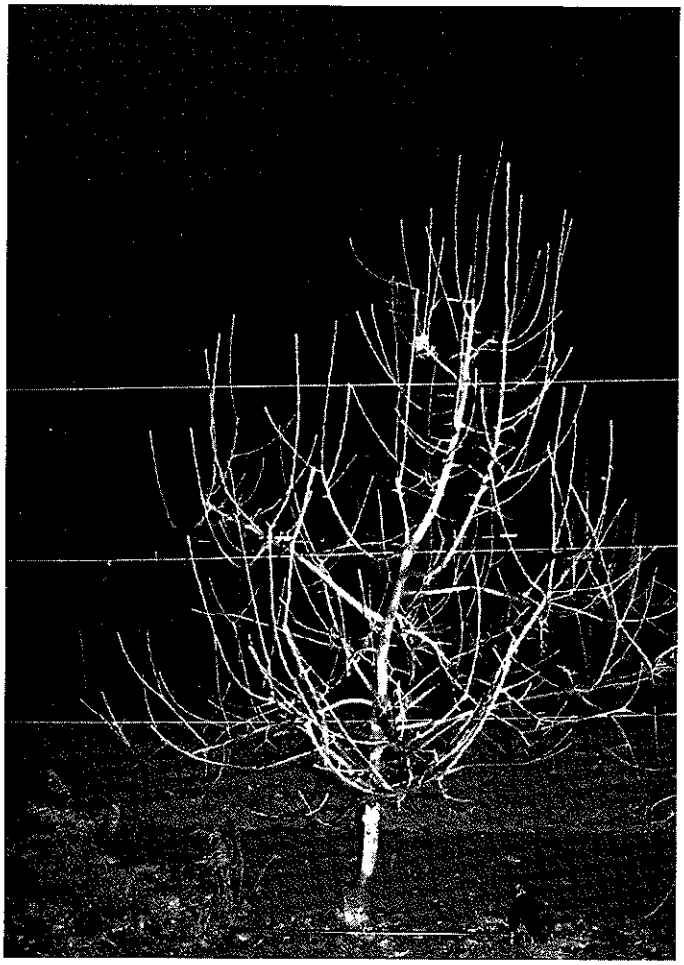


Figure 9.—A middle-type tree

Figure 10.—A tip-bearing tree

The French "axis" (axe central) and the "slender spindle" system are two specific kinds of central-leader training that are beyond the scope of this publication.

Training to a central leader

Use central-leader training (figure 12) in apple orchards with tree spacings 8 to 12 feet or closer in the rows and 14 to 18 feet between rows, where tree height is confined to not more than 12 feet. It's difficult to position a ladder to gain access to the tops of central-leader-trained trees that are more than 12 feet tall.

Because of a tendency for strong apical dominance, it's easy to train most varieties of apple to a central leader, provided you follow certain rules.

First spring. First, head the central leader. Establish the dominant position of the central leader by removing competing shoots in spring or early summer while they're still very small. This is called "guarding the leader" and results in greater net growth of young trees than more severe dormant season training.

If you don't guard the leader, your tree will have two or more competing leaders.

Varieties differ widely in their tendency to branch and to form wide crotch angles naturally:

- Varieties with narrow angles should be spread with toothpicks or spring-type clothespins when the shoots are 5 to 8 inches long, during the growing season.
- Varieties with very sparse branching require delayed heading on the leader and laterals to increase the number of shoots formed.
- Varieties that branch profusely on the central leader require extensive shoot thinning to develop a strong central leader.

When you develop a central-leader tree, any branch that's too thick relative to the leader will compete with it, destroying the balance and symmetry of the tree.

Therefore, *when a lateral on the leader is more than ½ the thickness of the leader (where it's attached), remove it* (see figure 13 on Page 10).

There's a temptation to keep too-strong limbs in order to get early fruiting, but this can be a trap, especially in sparse-branching varieties. Remove those too-strong limbs in the dormant season, or when you see them in spring or summer.

First dormant pruning. If you were able to select a basic set of limbs (first whorl) at the right height using feathers from the nursery, and if you guarded the leader diligently during the spring and summer, there should be little to do in the first dormant season.

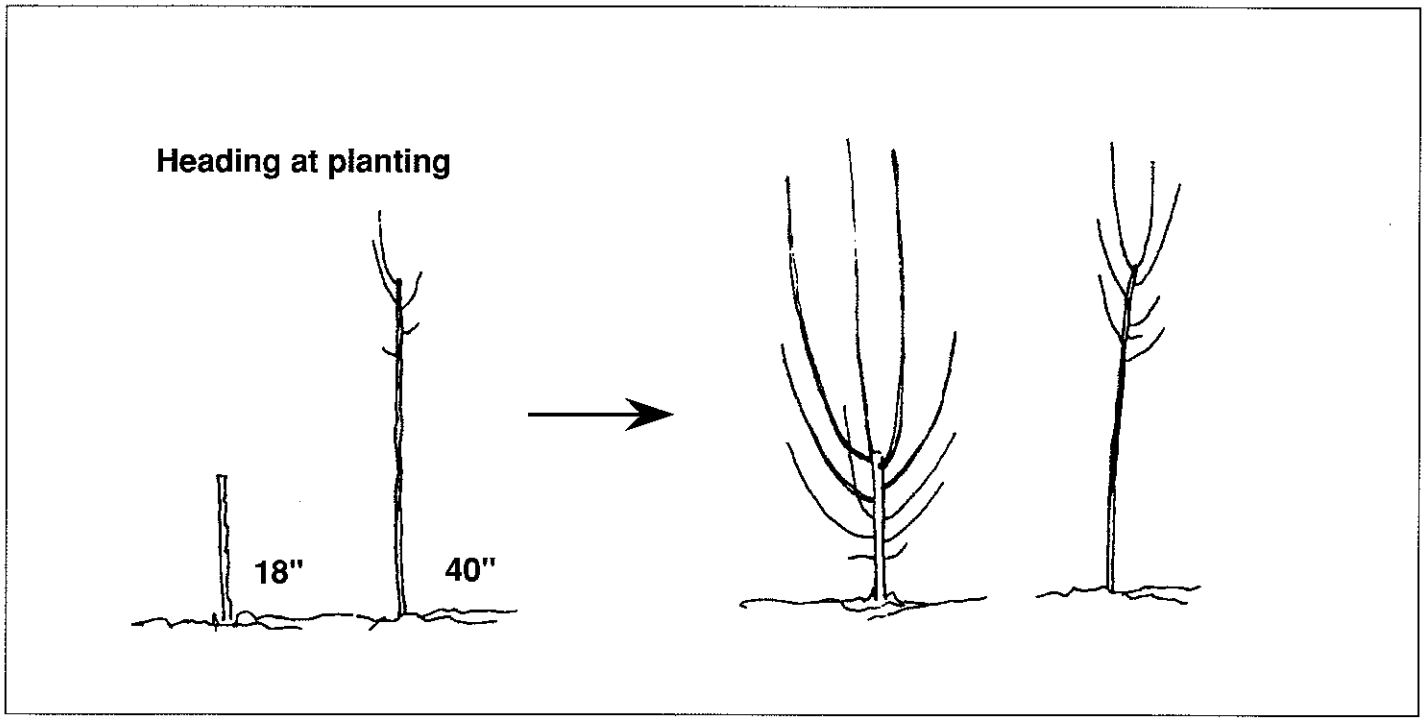
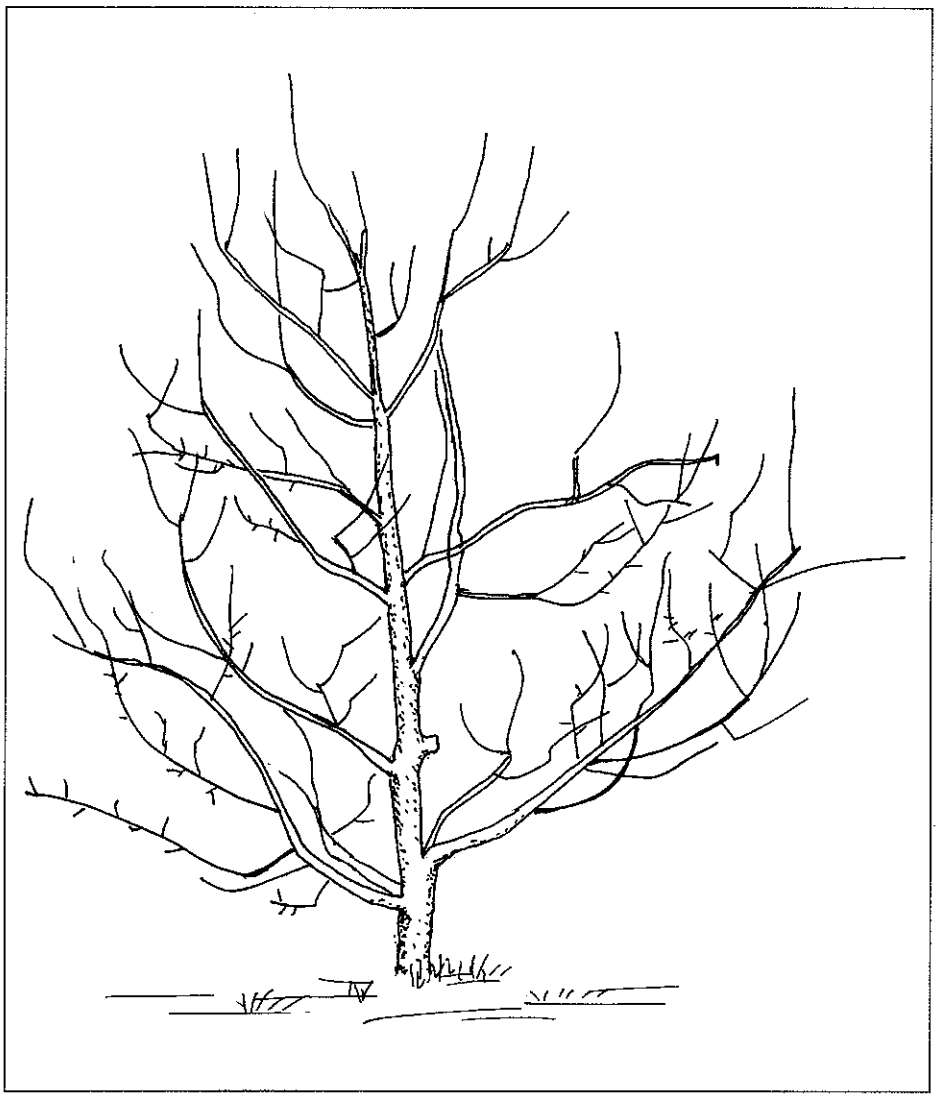


Figure 11.—Low vs. high heading



1. Continue to select branches for the lowest set, if needed.
2. Head the leader of all unsupported trees and of supported trees if required by the system (spindle bush, central axis, etc.). On semi-dwarf trees, the second whorl of limbs should be at least 3 feet above the first. Head above where the second whorl of limbs should be.
3. Remove any laterals that are too thick relative to the leader.
4. Remove or spread any laterals that are too upright.
5. Remove any vertical suckers.

Figure 12.—A tree trained to a central leader

Second spring and summer. Continue to spread or weight limbs as required, remove too-thick laterals, and guard the leader. Where you need a limb but no shoot is available to form one, score through the bark with a knife (but not into the wood) above a bud, going ⅔ of the distance around the bud (figure 14).

Do this at budbreak. Often, but not always, a new shoot will form from that bud. Thin the ends of scaffold branches to a single shoot.

Second dormant season. Continue to follow the instructions for the first dormant season, but emphasize developing a second whorl of limbs about 3 feet above the first whorl for semidwarf trees, and closer for fully-dwarf trees.

Figure 13.—A limb with a diameter more than ½ of the central leader should be removed. The highest limb on the right is too thick and should be removed.

The longer the limbs must spread between trees, the further they must be apart on the leader if light is to reach the center of the tree.

Timing for developing the second whorl depends on tree vigor. Trying to develop a second whorl too early is a common mistake; it will come in time.

Remove branches that arise directly over others on the leader, unless they're 1½ to 2 feet apart, farther for semidwarf trees.

By the end of the second dormant season, most training should be completed—or you should have set a pattern to follow from there on.

Third and later years. If the upper portions of the unsupported central leader are allowed to fruit in the early years, the tree will easily bend out of shape and won't make a satisfactory amount of growth. Don't allow fruiting on 1-year-old wood.

Solve the fruiting problem by removing the fruit or by supplying artificial support for the central leader. Choose whichever method is economically better for you.

It's difficult to develop a well-balanced, free-standing, central-leader tree on a windy site. Using an artificial support to hold the tree into the wind may enable development of the tree without excessive pruning. Tie the trunk and, as the tree grows larger, tie some limbs into the wind. Supplement this effort by pruning to buds that are pointing into the wind.

Training to a modified leader

The idea of this system is to develop a strong basic tree structure by starting with central-leader training but finishing with a multiple-leader tree.

A temporary central leader helps obtain wide-angled crotches both by the hormonal influence and by affording a place to insert spreaders. It helps you select the main scaffold limbs, spaced about a foot apart on the trunk, which also contribute to tree strength.

The modified leader system is used primarily for apple trees whose ultimate height will be 14 feet or taller, with an equal or greater spread.

Training to multiple leaders

Multiple-leader training is best for large apple trees where central-leader training isn't desired because of fire blight or tree size.

Select 3 to 6 primary scaffold limbs around the trunk and head as required to stimulate branching. They should branch about 2 feet out from the trunk. Space these 8 to 12 inches apart vertically. Head the leaders in the dormant season to cause branching. Don't head secondary branches.

Multiple-leader spur-type apple trees may have 7 to 9 scaffold limbs, which permit the renewal of fruiting wood by removing entire scaffold

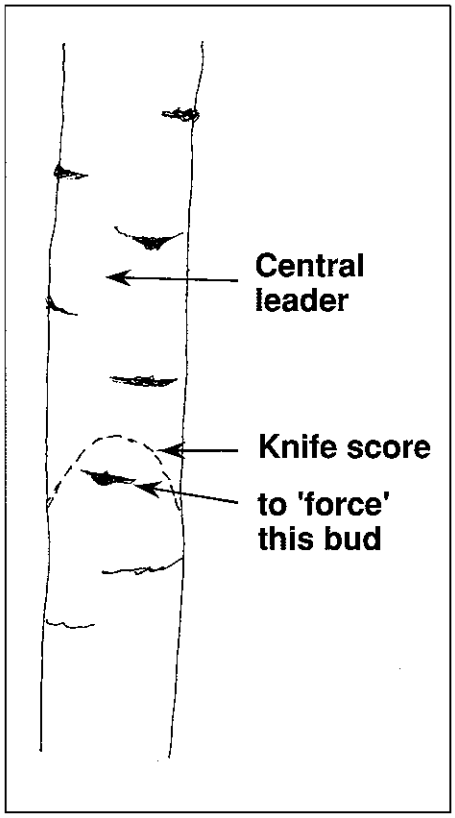


Figure 14.—Scoring to stimulate branch formation

limbs. Select limbs with strong crotches and spread these against one another, or tie the limbs out with strings fastened to clips in the ground. Thin out the ends of the scaffold limbs to a single shoot and head it lightly. The weight of fruit will further spread the tree.

The main purpose of limb spreading in a multiple-leader tree is to obtain strong crotch angles. Excessive spreading will open the center of the tree too much, stimulate unwanted inside growth, and make it difficult to maintain an overall conical tree shape.

Good light penetration depends on conical shape more than openness of center. Avoid equal-sized limbs in secondary scaffolds; they'll interfere with the dominance of the leader. The leader should terminate in a single upright shoot.

Glossary

Apex
The end of a shoot most distant from its base.

Apical dominance
The phenomenon in which the growing shoot tip produces hormones that move toward the roots, influences the number of shoots forming buds, the lengths of the shoots formed, and their angles with the limb they emerge from.

Blind wood
Portions of branches where no buds open so there are no leaves, shoots, or spurs, are called *blind*. This tendency is a varietal characteristic.

Bourse shoot
A shoot arising from a fruit-bearing spur or shoot.

Central leader
The central limb in the tree from which all other limbs arise and which also forms the highest part of the tree; it's also called *central axis*.

Central axis system
A training system for trees on trellis planted at high densities. Not described in this publication.

Delayed heading
The practice of heading a shoot in spring, shortly after the terminal bud has started to grow. This is done to increase the number of vegetative buds that form shoots, and to obtain shoots with wider angles.

Feathers
The 1-year-old shoots that are found on some trees arriving from the nursery.

Flower bud
In apple, buds that contain flower primordia also contain leaf primordia and could produce up to two shoots.

Heading
Cutting off part of a shoot or branch not at a branching point.

Productive efficiency
The amount of fruit produced relative to the amount of space occupied by the tree. In young trees, it's the yield divided by the cross-sectional area of the trunk.

Pruning
Cutting off parts of the tree.

Rootstock
Apple trees are compound plants, with different genetic makeup in the roots. The selection of rootstock clone greatly affects tree size, bloom, and fruiting.

Scaffold limbs
The woody parts of apple trees can be divided into two kinds: fruiting wood and structural or "scaffold" wood. Fruiting wood is replaced periodically by pruning, but scaffold wood is more or less permanent.

Shoot versus spur
The term *shoot* refers to the past season's growth in winter or a current season's growth in summer.

Spindle bush
A special training system for trees not over 7 to 8 feet tall, usually planted at high densities. Details of this system are not described in this publication.

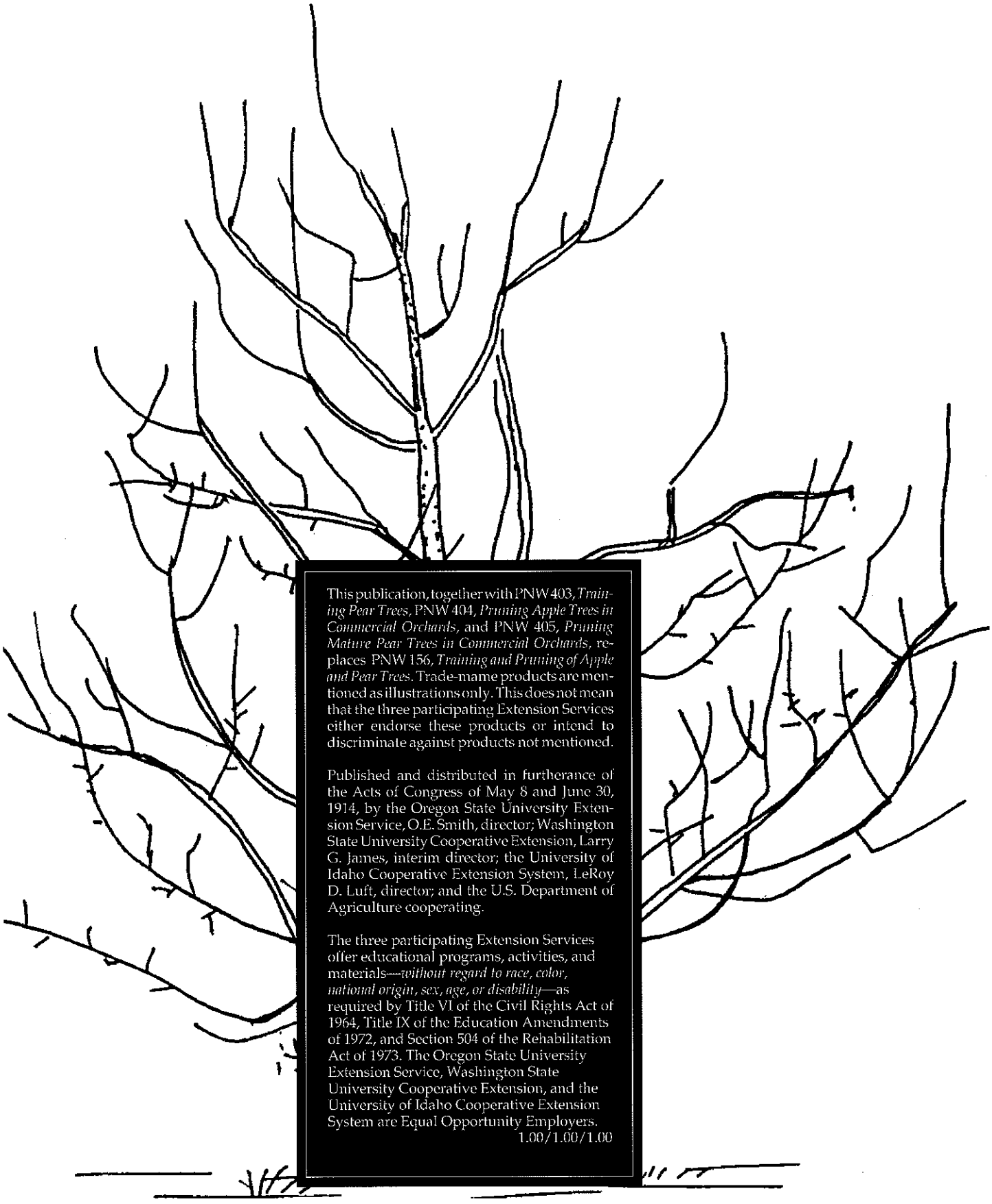
Spur
A very short shoot that usually terminates in a flower bud. A **spur system** is a cluster of spurs that originated from a single shoot.

Sucker
A vigorous, usually vertical, shoot that usually arises from the roots, trunk, or main scaffold branches. Used interchangeably with *water sprout*.

Thinning
Taking out the entire branch or shoot back to a larger branch or to the trunk.

Training
The shaping of a tree to a preconceived configuration through pruning and limb (shoot) positioning.

Water sprout
The same as a sucker, but it *always* arises from the trunk or a main scaffold branch.



This publication, together with PNW 403, *Training Pear Trees*, PNW 404, *Pruning Apple Trees in Commercial Orchards*, and PNW 405, *Pruning Mature Pear Trees in Commercial Orchards*, replaces PNW 156, *Training and Pruning of Apple and Pear Trees*. Trade-name products are mentioned as illustrations only. This does not mean that the three participating Extension Services either endorse these products or intend to discriminate against products not mentioned.

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