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Michigan State University Extension Service
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By ROY E. MARSHALL, H. A. CARDINELL,
and H. D. HOOTMAN



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Pruning Young Fruit Trees

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Aside from fire blight, poor soil drainage, and winter injury, the length of life of apple trees in reasonably well-sprayed orchards in Michigan is affected more by the spacing of the main limbs and the angles formed by these main limbs with the tree trunk than by any other factors. Many years before a tree's collapse, its usefulness may be impaired by poor limb spacing and weak angles. In avoiding this trouble, forethought is infinitely more valuable than remedial measures, which are often virtually impossible.

Experimental evidence has displaced many of the opinions formerly held as to the proper pruning for young trees. In particular it has been demonstrated that the vigorous growth which follows heavy pruning is largely devoted to replacing what was taken away, and the net gain is much less than if no pruning had been done. Utilization of nitrogenous fertilizers promotes vigorous growth and, at the same time, permits the retention of what has already been attained. Indeed, "the pendulum" has swung so far that apostles of no pruning are likely to overlook the very real need of utilizing pruning to direct growth into such channels that a sound framework will be developed.

This bulletin presents experimental evidence and observation gathered in Michigan on several varieties which are more or less common in the orchards of the state.

SPRAYING THE YOUNG ORCHARD

One of the very important factors associated with proper growth of young trees is that of maintaining healthy foliage throughout each growing season. Trees will not grow vigorously unless they have abundant foliage that can function properly. If some of the leaves are permitted to drop or if parts of leaves are injured by insects, diseases, or poor spraying practices, the growth of the trees will be stunted proportionately. Timely and thorough spraying with the right materials is therefore fully as important as pruning in developing the young orchard. Directions for spraying are provided in Michigan Extension Bulletin 154, "The Spraying Calendar."

EFFECT OF PRUNING ON GROWTH AND YIELD

The general effects of pruning are indicated in an experiment carried on at the Graham Horticultural Experiment Station at Grand

Rapids. The trees used in this experiment were planted in the spring of 1919. They were all pruned in a similar manner at the time of planting. From 1920 until 1928, groups of nine trees of each of the five varieties were subjected to three pruning treatments: (1) no pruning, (2) light pruning, and (3) moderately severe to heavy pruning.

This was in no sense a tree training experiment. Each spring the heavily pruned trees were thinned sufficiently to avoid closely parallel, crowding and crossing branches and there was enough thinning and heading to prevent the development of sharp-angled crotches. In fact a cut was made wherever there seemed to be a legitimate excuse for making it. As the trees became older, less heading was done. This treatment would not be regarded as severe by many growers because it was for the most part confined to an annual thinning out of the shoots produced during the preceding season.

The treatment for the lightly pruned trees was intermediate between no pruning and the so-called heavy pruning. During the first few years of the experiment, the amount (weight) of wood removed was about half that cut from the heavily pruned trees. As these trees became older larger branches were removed, and, finally, because of

Table 1. The effect of severity of pruning on size and yield of apple trees. Growth measurements made at nine years from planting. Yields are totals per tree for the nine-year period.

Variety and Pruning Treatment	Average Size of Trees			Yield per Tree (bu.)
	Trunk circumference (inches)	Tree spread (feet)	Tree height (feet)	
DUCHESS:				
None	14.2	13.8	16.3	2.9
Light	13.7	13.3	17.0	1.7
Heavy	12.2	11.4	15.5	1.1
GRIMES:				
None	15.3	15.3	16.8	4.4
Light	15.1	14.8	16.4	4.9
Heavy	15.6	16.3	16.0	3.1
BALDWIN:				
None	17.7	17.6	15.6	1.8
Light	17.6	16.5	16.2	0.5
Heavy	16.7	15.4	14.6	0.4
STAYMAN:				
None	16.8	20.9	17.4	3.7
Light	16.4	19.7	17.2	2.8
Heavy	15.0	18.5	16.5	1.8
NORTHERN SPY:				
None	17.3	14.9	17.9	0
Light	15.7	12.4	16.6	0
Heavy	14.1	11.4	15.4	0
AVERAGE OF ALL VARIETIES:				
None	16.3	16.5	16.8	2.6
Light	15.7	15.3	16.7	2.0
Heavy	14.7	14.6	15.6	1.3

density and larger size, the prunings from the lightly pruned trees weighed more in some instances than those from the heavily pruned ones. The pruning was, nevertheless, light in proportion to the size and density of the trees.

The records for tree size (Table 1) were made in the spring of 1928, and the yields are totals per tree from the time the trees came into bearing up to and including the season of 1927.

Of the five varieties listed in Table 1, Duchess, Stayman, and Northern Spy trees were materially dwarfed by pruning, and the dwarfing was proportional to the severity of the pruning treatment. This is well brought out in Figs. 1-4, showing 10-year-old Northern Spy trees pruned each year in varying amounts. The heavily pruned Baldwin trees were noticeably smaller than unpruned ones, but light pruning



Fig. 1. A ten-year-old Northern Spy tree that has not been pruned except for a reduction of top at time of planting. Compare size with the trees shown in Figures 2 and 3.

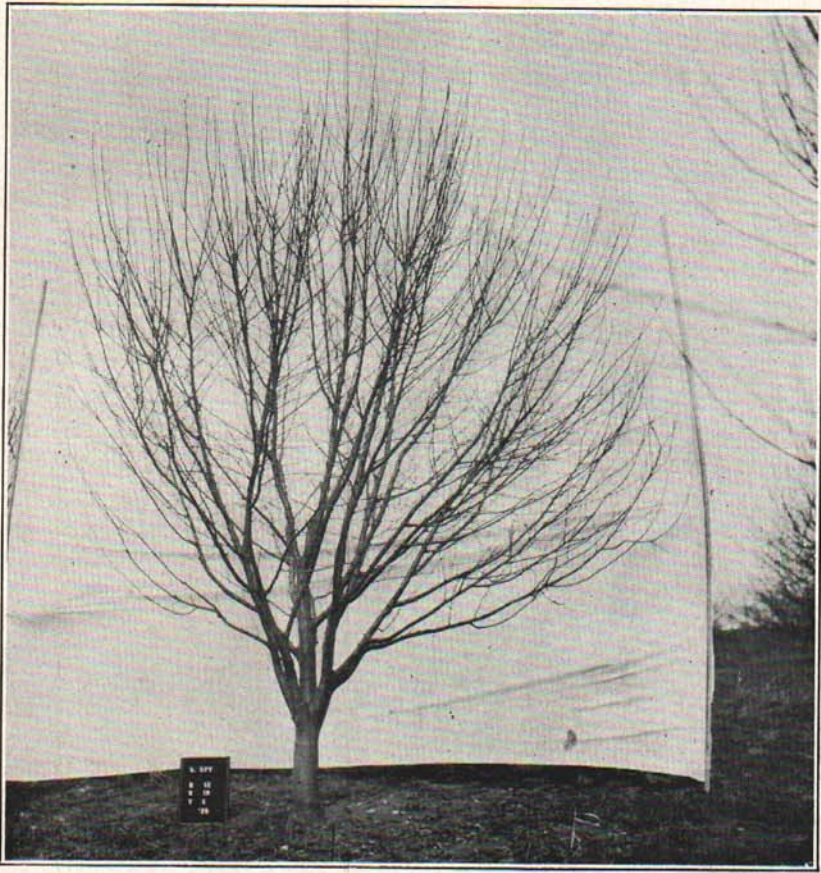


Fig. 2. A ten-year-old Northern Spy tree that has had light annual pruning. Compare with trees shown in Figures 1 and 4. This tree has not been "trained" and is not shown for the purpose of illustrating an ideal framework.

did not result in trees appreciably smaller at the end of nine years. On the other hand, pruning has had no considerable effect on the size of Grimes trees at nine years of age. The Northern Spy trees had not come into bearing and showed the greatest differences in size because of treatments. The portions of the unpruned trees above the point of origin of the lower branches were approximately twice as large as those of the heavily pruned ones. The averages for the five varieties show that the tree trunks of the unpruned trees were about 11 per cent larger at nine years of age than those of the heavily pruned trees. Furthermore, the average unpruned tree had about a 13-per cent greater spread and was 8 per cent taller than the average heavily pruned one.

All of the varieties except Baldwin and Northern Spy produced

some apples during the sixth season in the orchard. Pruning did not delay the time of first fruit production, but the unpruned trees yielded much more fruit than either of the pruned lots during the first several years of fruiting. The yields were inversely proportional to the severity of the pruning treatments, except in the case of Grimes. On the average the unpruned trees at nine years of age yielded twice as much fruit as those heavily pruned and the yield of the lightly pruned trees was intermediate between those of the other two treatments.

In general, pruning of young trees may be expected to result in some dwarfing, and this reduction in size will probably be proportionate to the severity of the pruning. Some varieties, however, such as Grimes, may apparently be pruned moderately without materially reducing either size of tree or yield of fruit during the early life of the orchard.

Mention should be made of the fact that pruning temporarily stimulates growth. This stimulative effect lasts until balance between root and top is re-established. For the most part, this growth stimulation is

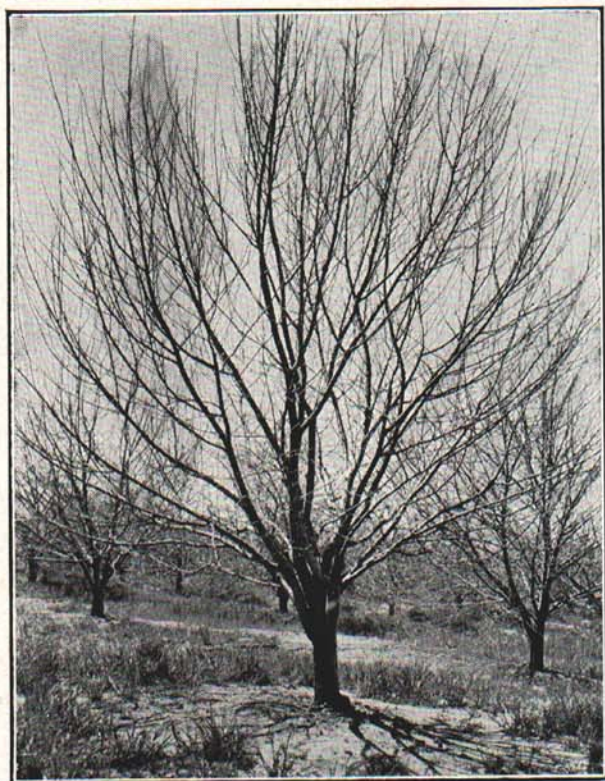


Fig. 3. Same tree as shown in Fig. 2 at 15 years. Very poor crotch formation resulting from failure to space scaffold branches properly. A good tree otherwise.

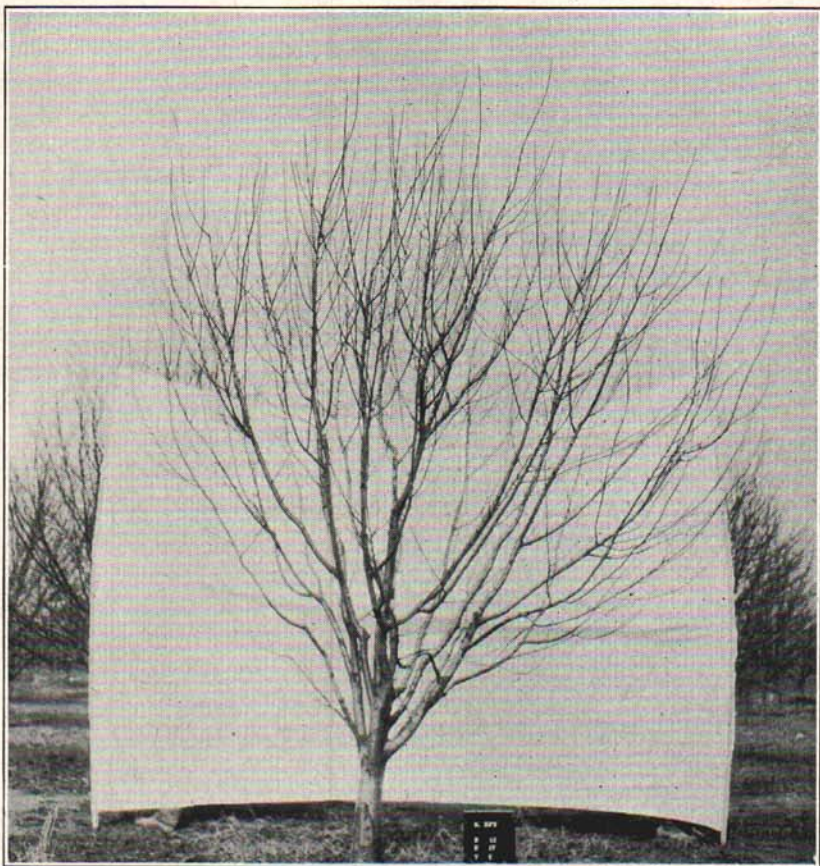


Fig. 4. A ten-year-old Northern Spy tree that has had comparatively heavy annual pruning from the time it was planted in the orchard. Compare with trees shown in Figures 1 and 2.

evident in the immediate vicinity of the pruning cut. In reality, however, the tree is dwarfed in proportion to the severity of the pruning treatment because the new growth produced by the pruned tree is not enough greater than that produced by the unpruned tree to compensate for what is removed in pruning.

PRUNING OF YOUNG TREES ESSENTIAL

Despite the fact that pruning results, at least temporarily, in some reduction in tree size and bearing capacity, it must be regarded as an essential orchard practice because there is no other practicable method of developing a strong framework that will support the bearing portions of the mature tree in later years. Weaknesses which are likely to develop in untrained or improperly trained trees and methods of avoid-

ing these weaknesses are discussed in the following pages. The grower, however, should constantly bear in mind that every pruning cut will tend to limit tree size and early fruit production. Therefore, the amount of pruning afforded young trees should be only such as is absolutely essential to the development of a strong framework. No other objective can be obtained by pruning the average tree during its first five seasons in the orchard. As soon as the framework is satisfactorily established, pruning may be discontinued until the tree comes into full crop production, except perhaps for a limited amount of shaping incident to the correction of wayward growing tendencies. In case of doubt as to the proper treatment, it is always preferable to underprune rather than overprune.

PRUNING THE NURSERY TREE AT PLANTING TIME

When a fruit tree is dug from the nursery, a large part of the absorbing root system is left in the soil. This destroys the balance between top and root and, unless the top is pruned at planting time to reduce what would otherwise be a relatively large leaf bearing surface the leaves may require more moisture than the greatly reduced root system can supply. The result may be the loss of the tree, owing to drying out.

Survival of newly planted trees and the amount of growth made during the first season in the orchard are often proportional to the severity of the pruning treatment. Specific treatments for trees of each of the several species commonly grown in Michigan are discussed in other portions of this bulletin.

HEADING BACK VERSUS THINNING

Thinning or thinning out refers to the removal of an entire branch or shoot. Heading or cutting back refers to the removal of the terminal portion of a branch or shoot. Those two kinds of pruning are followed by different types of growth response. When a tree or branch is thinned, the principal growth is from the terminal buds that remain, though of course there is some growth from lateral buds. Thinning encourages the development of a more permanent and extensive fruiting system.

When a shoot is headed or cut back, several lateral buds immediately below the cut usually develop into shoots. This result in a more dense top than characterizes thinned trees. Heading, however, must be practiced to some extent in the young orchard to force out new growth at desired points. When shoots longer than 20 inches are left in the young tree, legginess and lack of compactness is likely to result.

Cutting a branch back to a lateral or side shoot results in the formation of fewer shoots than heading to a bud. This kind of pruning can sometimes be made to serve some of the objects of heading without resulting in a dense top. It might be more or less accurately called thinning back, as it is a pruning more or less intermediate in kind and in response between typical thinning out and typical heading back.

HOW TO PREVENT WEAK CROTCHES

Two branches of the same size originating from virtually the same point will usually give rise to about the same amount of new growth. When two such branches are permitted to develop in such a way as to form a Y or sharp angle, a weak crotch is formed unless steps are taken to strengthen it (Fig. 5). This is due to the tendency to de-



*Fig. 5. Divided leadership too often results in a ruined tree.
A sharp angled crotch usually results in a weak union.*

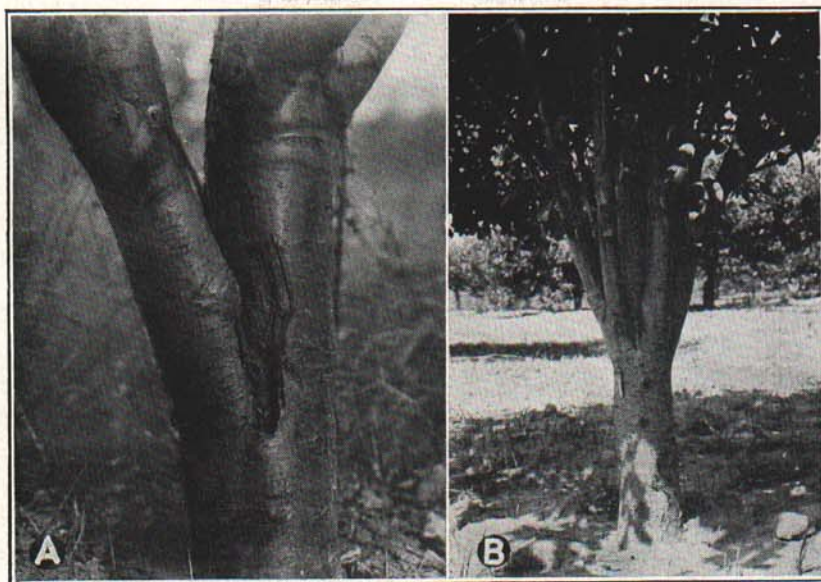


Fig. 6. (A)—A narrow angle between a main branch and the trunk may induce winter injury in the most vital part of a limb system.

(B)—An untrained Northern Spy tree. The main lateral branches are likely to girdle or choke out the leader.

velop layers of bark between the two branches instead of bridge wood. Sharp-angled crotches of this type are almost certain to split under the strain of heavy crops of fruit or heavy winds. Wide-angled crotches are stronger and seldom break (Fig. 10).

Heading back or shortening one of the two will dwarf that branch so that it becomes a lateral or side branch of the one that is pruned less severely.

WHERE TO MAKE THE CUTS

The pruning cuts made in removing a limb or in cutting a leader back to a lateral or side branch should always be made as close to the branch to be saved as possible. Close cuts heal more rapidly than those in which stubs are left. The shears should be used in such a way that the cutting edge is next to the parent branch or the one that is to be saved, and, with limbs more than a half inch in diameter, a saw is preferable.

When shoots are cut back, it makes little difference whether the cut is made very close to a bud or some little distance above it. If the cut is made close to a bud, the shoot developing from it will grow more nearly in line with the direction of growth of the parent branch than will be the case where a short stub is left, but this is of little practical

importance except possibly with trees one and two years old. Some advantage in desired spread may be gained when pruning horizontal branches by cutting shoots back to outside buds or even to upright buds.

WHEN TO PRUNE

Young trees should be pruned in late winter or early spring. The cut surfaces are less likely to dry then than when pruning is done in the fall or early winter. When pruning is delayed until the bark loosens, tearing of the bark is likely to retard the healing of the wounds for several years. Under Michigan conditions nothing is gained by pruning young trees during the summer. Furthermore, summer pruning usually results in further dwarfing of the trees.

TYPES OR STYLES OF TRAINING FOR YOUNG TREES

Several different types or styles of training for young trees have been employed in recent years. The most satisfactory type is that which, through experience and investigation, has proved to combine necessary strength of framework and openness. The basic principles of this type of training, with some modifications, are now being practiced in nearly all of the important fruit-producing districts in America. It is generally referred to as the "modified leader" or "leader" system.

A properly developed modified leader tree is one with a central trunk or axis, along which a number of main lateral or scaffold branches arise. These scaffold branches are as evenly and symmetrically spaced along and around this central leader as is practicable for the species, the variety, and the individual tree. It is not a "two-" or "three-story" tree nor is it a tree with a leader like that of some coniferous species.

Modified leader trees have well-formed crotches, are low and spreading, and have a moderate number of main lateral or scaffold branches. The crotches are strong because they develop at wide angles with the leader, and wide-angled branches form strong shoulders. The trees are low and spreading because the lower branches of the trees are allowed to grow more and are therefore longer than the higher ones.

The writers recommend the leader or modified leader type of training for most of the tree fruits grown in Michigan. The methods employed in developing this general type of tree will differ, however, with the different species. It is therefore necessary to discuss each kind separately. The training of the apple tree will be discussed in more or less detail, and then such differences as seem essential for the proper

development of trees of other kinds will be presented. Consequently, the grower of pears, peaches, cherries, or plums is urged to study the principles involved in pruning the apple before referring to the section which deals with the practices for the particular kind of fruit in which he is interested.

Two rather distinct methods of attaining the leader type of apple tree are described. The first is the method that has been employed by many Michigan orchardists for nearly 20 years. If two-year-old nursery trees are planted, this method involves lighter pruning than the second method at the time of planting but heavier pruning in subsequent years. If one-year-old whips are planted, the second method makes less pruning necessary throughout the training period. The second method usually results in better spacing of framework branches, but some of these branches are likely to be too upright in direction of growth. Each method will result in well-built trees if directions are followed carefully.

Since spacing along and around the central axis is determined in the first method by pruning and in the second method by a combination of disbudding and pruning, the first will be designated as the "pruning" method and the second as the "disbudding" method.

TRAINING APPLE TREES BY PRUNING

In the development of the modified leader apple tree by the pruning method, the grower should have in mind a tree in which one to three, usually two, permanent scaffold branches are selected each year for three or possibly four years. The lowest of these branches should be 26 to 30 inches from the ground and the others should be distributed along the trunk so there is an average of at least 6 inches between their points of origin. Furthermore, one branch should not be directly above or directly opposite another. Balance between these several branches is necessary to develop them properly as main or scaffold branches. Those are the ideals that the grower should remember when pruning young apple trees. The writers realize fully that the ideal can be realized seldom because trees just do not grow ideally from the standpoint of the grower.

The grower may buy one-year branchless trees or two-year ones from the nurseryman. For the purpose of this discussion, it will be assumed that the trees are the one-year whips. If the trees are two years old the grower will use the methods described for the one-year-old orchard trees. Unless otherwise stated, the ages used in this bulletin will be from time of setting in the orchard.

PRUNING AT PLANTING TIME—After the one-year-old nursery tree is planted, it should be cut back at 35 to 40 inches above the

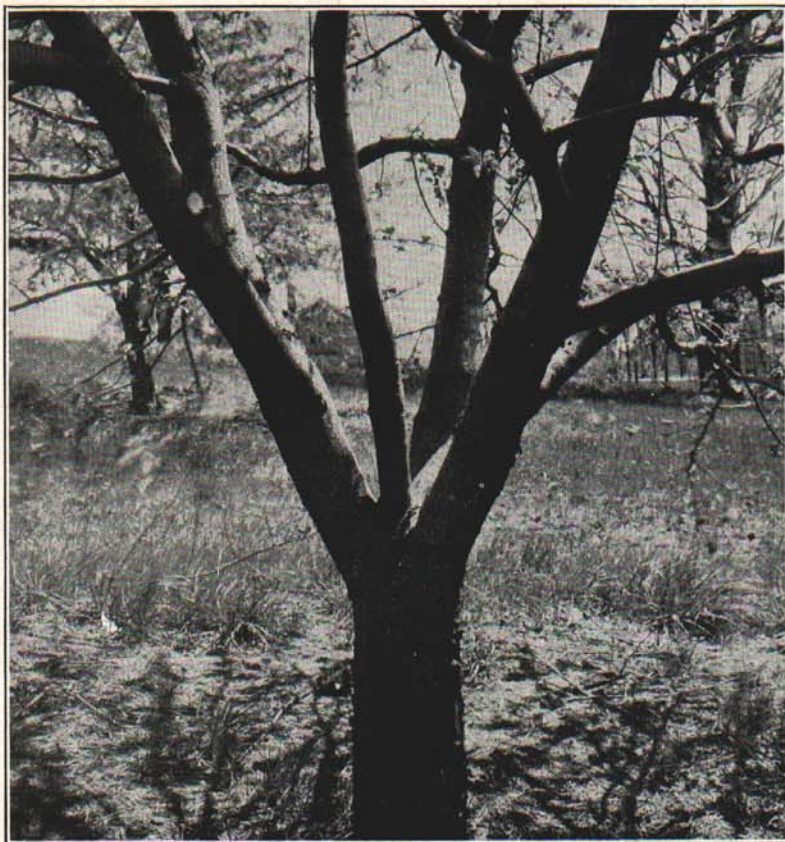


Fig. 7. The leader arising from the center of this tree is gradually being starved or choked out by the outer branches. The leader might have been maintained had the outward growing branches been spaced along it.

ground. The lowest scaffold branch will then develop 6 to 10 inches below the point of heading, or 26 to 32 inches above the ground. Any side branches that the newly planted yearling tree may have developed in the nursery should be removed if they are too low or have a tendency to develop crotches with sharp angles. This pruning at planting time serves a double purpose: (1) It tends to balance the top with the nursery pruned root system, and (2) it determines the height of the head of the tree.

PRUNING THE ONE-YEAR-OLD TREE—During the first season of growth in the orchard, the branchless tree referred to in the preceding paragraph will develop several shoots. One or two growing from the top-most buds will generally grow nearly upright and usually

will attain a height a few inches greater than the others. Shoots farther back from the tip will generally arise at wider angles from the tree trunk (Figs. 9 and 10). The number of new shoots produced varies considerably with varieties. Thus Northern Spy will produce several shoots while Stayman usually develops very few shoots.

When the tree is pruned in the following dormant period, one of the shoots that grew from the tip buds of the tree should be retained as the leader or central axis from which scaffold branches will be saved a year later. Along with it, one or two of the lateral shoots should be kept as permanent scaffold branches (Figs. 9 and 10). Care should be exercised in their selection. As previously stated, the lowest one should originate 26 to 32 inches above the ground. None should be saved that form angles of less than 45 degrees with the tree trunk or central leader. This usually means that shoots developing from buds near the tip, except the one saved as a leader, must be removed (Fig.

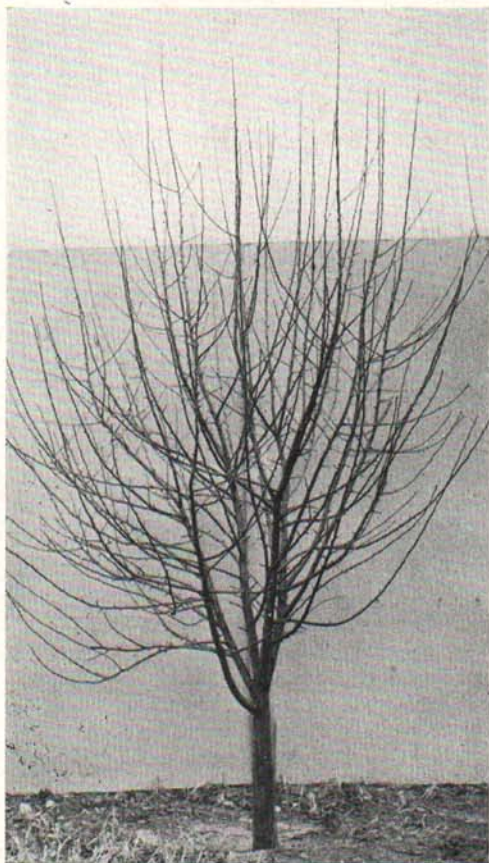


Fig. 8. A four-year-old Delicious apple tree that has had no pruning. It has made excellent growth and should come into bearing early but it is likely to be short-lived because of narrow crotches and too many main branches originating at a common point. This may lead to such conditions as are illustrated in Figs. 5, 6 and 7. Compare with Figs. 14 and 17.

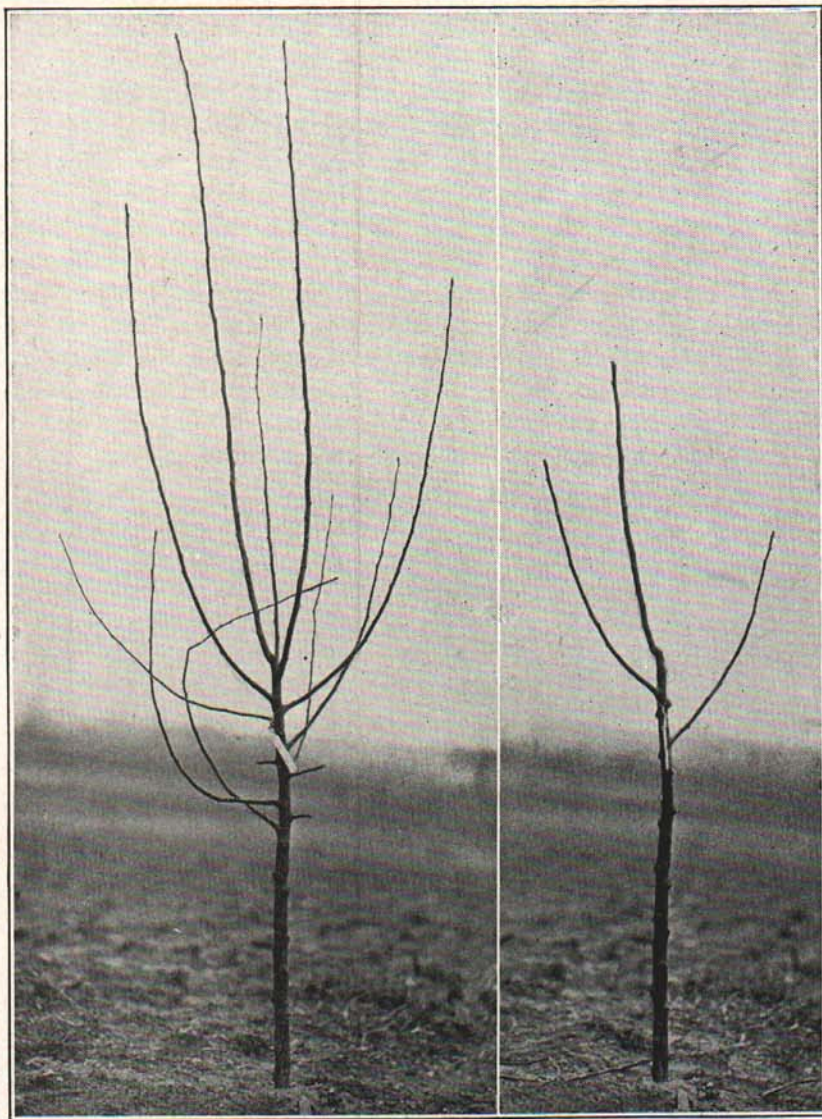


Fig. 9. Development of the leader type of tree by pruning. A vigorous McIntosh tree before and after pruning. Only three of ten shoots were saved. One of the vigorous upright ones was selected for the leader and the other two as the lowest main lateral or scaffold branches. A greater number of scaffold branches were not selected because the lowest ones were too close to the ground and two of the higher ones formed sharp angles that might develop weak crotches. Even then the two scaffold branches selected originate closer to each other than is desirable.

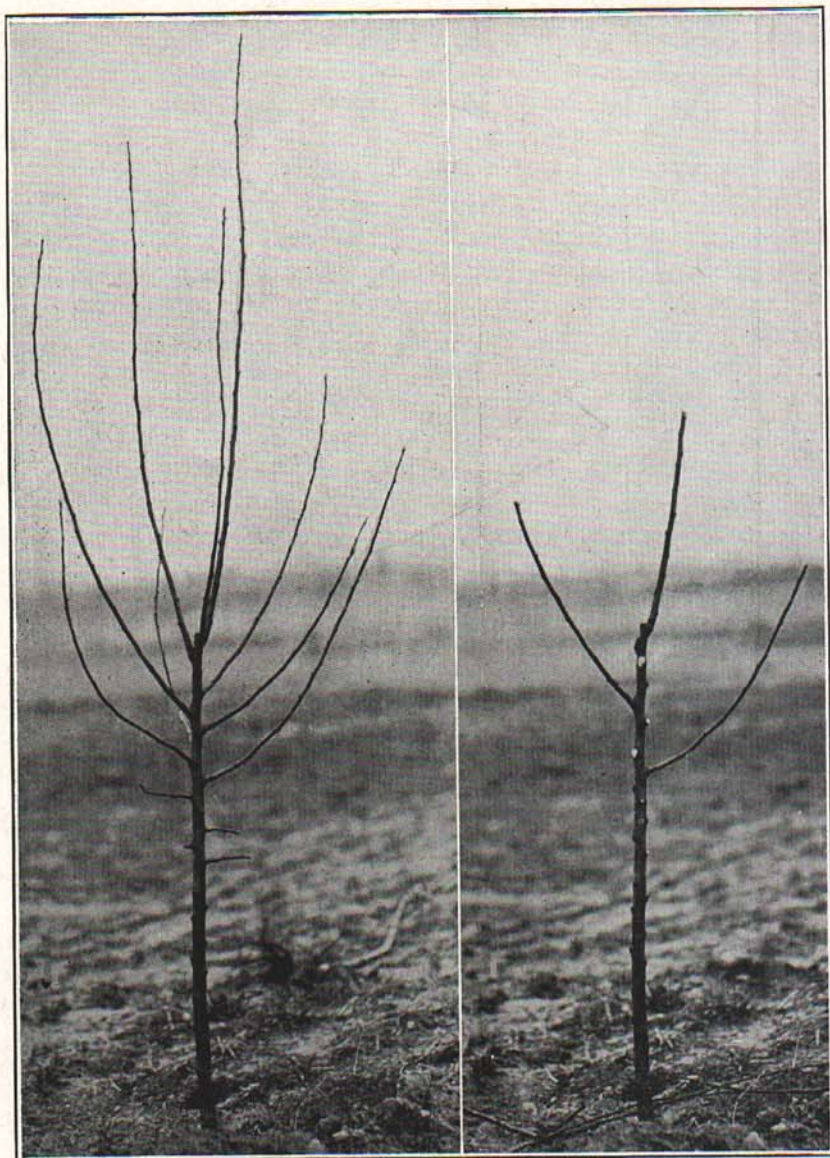


Fig. 10. Development of the leader type of tree by pruning. Two wide angled laterals are selected to form the lower scaffold branches with as much space between their points of origin as is possible. The leader is left a little longer than the lateral shoots. In this case the leader should have been left a trifle longer.

10), and, frequently, the lower limbs are comparatively weak and must give way to a higher limb which is larger and more vigorous. Furthermore, if a second scaffold branch is saved it should not originate close to the point of origin of the other and should be at least one-fourth of the way around the trunk from the first one. These requirements sometimes place such restrictions upon the selection of a second scaffold branch that only one can be saved at this pruning.

A mistake very commonly made by growers in an endeavor to save two or three scaffold or main lateral branches each year is that of allowing two branches to develop opposite or nearly opposite each other, or to save three shoots originating from adjacent buds. This situation is likely to lead to more or less girdling or choking of the leader and finally the leader may be completely outgrown by scaffold branches (Figs. 6B and 7). Proper spacing of the scaffold branches along the central axis avoids this difficulty and permits the balanced development of all scaffold branches of the tree.

In case of some varieties, the branches that have been selected to begin the framework of the tree must be headed at such points as will

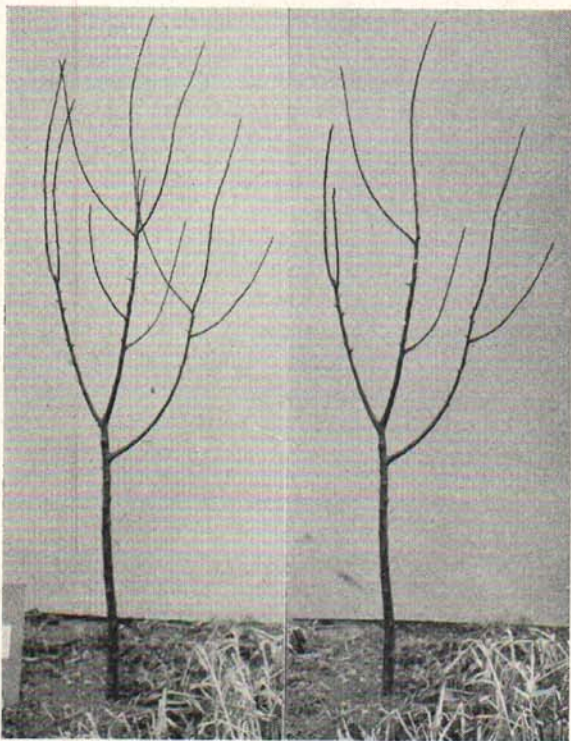


Fig. 11. Development of the leader tree by pruning. A Fameuse tree before and after pruning one year after planting in the orchard. The third and fourth frame-work branches have been selected. This tree offered a better selection of branches than is usually possible.

provide secondary branches at desirable locations and maintain the proper relationship or balance between limbs.

The leader should not be left longer than 18 to 22 inches or a "two-story" tree and legginess may result. Heading the leader much shorter results in either a crowded framework or the saving of too few scaffold branches the following year.

Furthermore, the scaffold branches should not be headed shorter than 18 inches long or rebranching will occur too close to the tree trunk. These scaffold branches must never be left longer than the leader unless the points of origin are low or the shoot growth is weak.

The ideal place to cut back the leader is approximately 18 inches from its point of origin. The lateral or scaffold branches should be cut so that they are 4 to 6 inches shorter or lower than the tip of the leader when the former are held in an upright position (Fig. 9). Greater

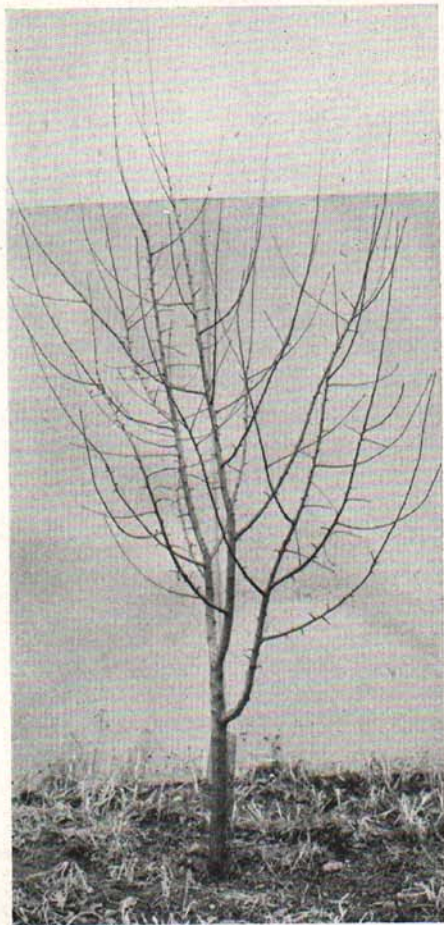
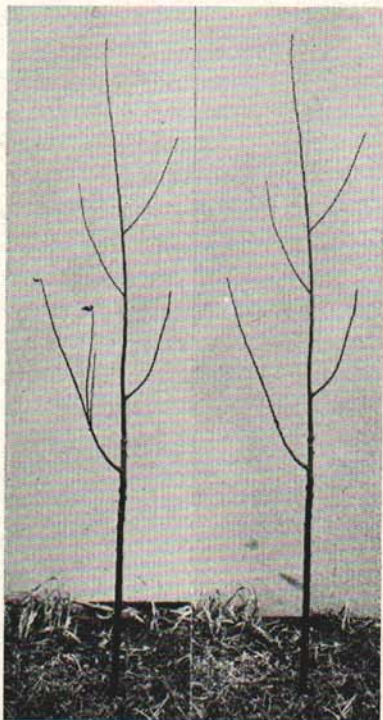


Fig. 12. Development of the leader tree by pruning. A three-year-old McIntosh after very light pruning. One scaffold branch is nearly as large as the leader and might have been pruned more severely in an attempt to keep the main lateral branches in better balance.

Fig. 13. Development of the leader tree by disbudding to solitary buds. At the time this two-year-old Fameuse tree was planted one year earlier, it was pruned to a whip and all the lateral buds were rubbed off except four which grew into the lateral branches shown in the photographs. Good spacing of scaffold branches resulted, and very little pruning was necessary at the time these pictures were taken.



difference between the length of the leader and the scaffold branches is likely to result in the leader outgrowing the latter and finally the lateral branches may cease to be actual scaffold branches. If the laterals are left longer than the leader, they are likely to outgrow it and the goal in training is defeated. This proper balance between the leader and the scaffold branches is very important in the successful development of modified leader trees (Figs. 18-19).

It is not uncommon for the tree to produce less than 18 inches of growth during the first season in the orchard. In such cases, no tipping or heading back is desirable.

PRUNING THE TWO-YEAR-OLD TREE—During the second season in the orchard, a growth response similar to that of the first season will probably be obtained from each of the two to four branches. When the tree is pruned the following spring, at two years from planting, the leader is treated in a manner similar to that of the previous year. The shoot developed from the topmost bud of the leader should be selected to continue as the leader. It is not necessary to head back the leader unless it has made a growth of more than 2 feet. Then two or possibly three of the shoots which developed from the leader

or central axis are selected as additional permanent scaffold branches. Strength of crotches and distribution along and around the central axis or leader must again determine which of the several shoots will be saved as the scaffold branches for the permanent framework. Those should be headed if the average level of their tips when placed in upright positions is less than 4 to 6 inches below that of the tip of the leader. Heading back at this pruning, however, is often necessary with the top-most laterals.

The branches that were saved to form permanent scaffold limbs the previous year will have rebranched, forming secondary shoots or branches. The secondary shoot developing from the end bud should usually be saved to form the midrib or assume the leadership of the scaffold branch. There should be a leader for each scaffold branch. Not more than two or three additional secondary branches should be saved. Heading back is not necessary unless they are longer than the leader or midrib branch of the scaffold. It is often better to remove these longer laterals and thereby provide wider spacing along the midrib branch. With some varieties, however, a tipping of the leader may be advisable to increase the number of shoots formed the succeeding season. In other words, each scaffold branch is pruned much as though it were a young tree of that age. These several points are well illustrated in Fig. 20, which shows a two-year-old pear tree of rather spreading habit, before and after pruning.

This is an important period of tree training and mistakes made at this time are not easily rectified. The several parts of the tree should be in balance after pruning. If the lower scaffold branches are left too long, they will outgrow the upper portions of the tree. The more common mistake, however, is to leave them too short in relation to the upper portions, resulting in dwarfing and finally in their elimination as scaffold branches, in which case a high-headed tree eventually results.

In many orchards, shape of the trees is likely to be influenced by prevailing winds. Such trees should be pruned less on the windward than on the leeward side. Precaution should be taken to save the branches growing near the horizontal plane rather than the upright ones. Cutting to outside buds on the windward side and to inside or topmost buds on the leeward will also aid in developing a balanced tree, though the weight of fruit in later years will gradually pull the limb into the wind and downward.

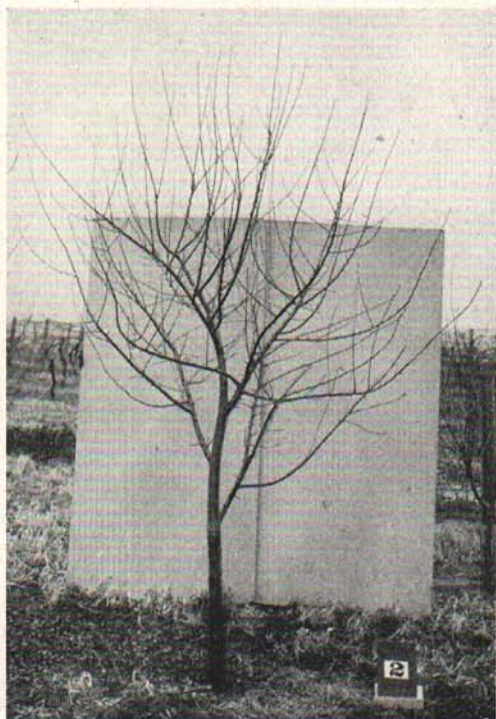
Short growths that may develop in the interior portion of the tree should be saved, except that spurs developing along the central leader and on laterals near the leader should be removed to prevent fire blight gaining entrance to the trunk of susceptible varieties. If these shoots

develop into vigorous branches that tend to make the center of the tree thick and brushy, they can be removed a year later.

PRUNING THE THREE-YEAR-OLD TREE—Additional scaffold branches may usually be chosen after the tree has completed three seasons of growth. The method of selection is similar to that previously described. With spreading varieties, such as McIntosh and Rhode Island Greening, it is sometimes difficult or almost impossible to develop new scaffold limbs after the first two or three years. It is unlikely that heading back will be necessary unless here and there a branch has outgrown its neighbors. Furthermore, the relative amount of thinning should be less than that of the previous years. Occasionally an entire limb may be removed in favor of a better one that could not be anticipated when the former was chosen.

Pruning at this time is largely done to encourage the formation of additional branches and to prevent the tree from becoming unbalanced. The grower should particularly make certain that the lower scaffold branches are maintained in a strongly vegetative condition. The pruning should be heavier on the side of the tree away from the prevailing winds. Any tendency to develop weak crotches must be corrected. Short growths and fruit spurs should be saved. When opposite branch-

Fig. 14. Development of the leader tree by disbudding to solitary buds. A four-year-old Delicious tree that has just received a very light pruning. Note the distribution of scaffold branches along and around the leader. This method of training encourages the development of sharper crotch angles than is desirable for some varieties.



ing on the trunk or along the bases of main framework branches has developed, the poorer branch should be removed. Remember that time of fruit production, yields, and size of trees are largely determined by the amount of pruning practiced at this time.

PRUNING THE FOURTH AND SUCCEEDING YEARS—A sufficient number of scaffold branches should have been selected to form the permanent framework of the tree previous to this time so that it is unnecessary to encourage the further development of the leader. It is seldom necessary to suppress or remove the leader, because most commercial varieties do not naturally carry a leader longer than five or six years. The only pruning necessary is that which is done to keep the established scaffold branches properly balanced with one another, allowing none to outgrow the others, and to remove the water-sprouts and an occasional crowding or crossing branch. The grower should also destroy narrow-angled crotches on the scaffold branches in favor of newer, wider-angled limbs. Heading-back is very seldom necessary.

During the ensuing years, the grower should make only such pruning cuts as seem absolutely essential to maintain the proper balance

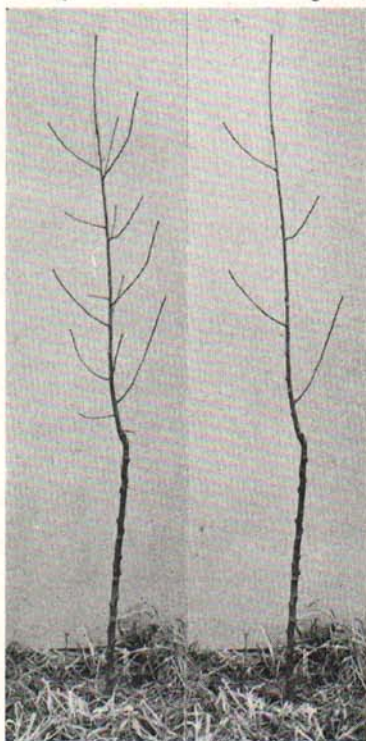


Fig. 15. Development of the leader tree by disbudding to groups of buds at each of four levels. At the time this two-year-old nursery tree of the Turley variety was planted in the orchard one year before these pictures were taken, four sets or groups of buds were saved at intervals of approximately eight inches along the leader. Other buds were removed. The picture on the left shows the growth response during the first year in the orchard. Individual shoots did not make as much growth as those shown in Fig. 13 but considerable choice is possible in the selection of framework branches having wide angle crotches. The picture on the right shows the framework or scaffold branches selected.

between different parts of the tree. In fact, many trees should not be touched with pruning tools from their third or fourth season in the orchard until after they have come into bearing. Too little pruning is preferable to overpruning after the main framework has been established. Remember that pruning of the young tree is only for the purpose of developing a strong framework.

TRAINING APPLE TREES BY DISBUDDING

The method described in the preceding paragraphs involves a greater amount of pruning, and consequent dwarfing, than some growers like. Furthermore, despite painstaking efforts, many of the trees will have spacings of 2 to 4 inches between adjacent origins of scaffold branches saved in one season and perhaps 16 inches between points of origin of adjacent branches in separate years. The disbudding method overcomes these difficulties though it, too, has faults that will be evident in the following discussion.

Training by disbudding was devised for one-year-old nursery trees or whips by the Pennsylvania and Illinois agricultural experiment stations, but the writers have used it successfully with two-year trees during the past four years. When this method is used with two-year-

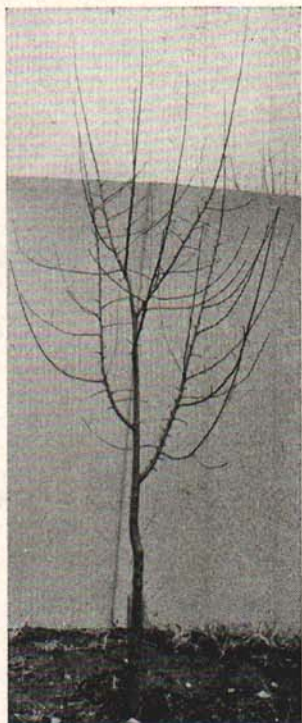


Fig. 16. A three-year-old McIntosh tree (after pruning) trained as illustrated in Fig. 15.

old nursery trees, all second-year growths should be removed except one vertical vigorous shoot which is saved to form the central axis or leader. This results in a long whip-like tree comparable in appearance to a very vigorous one-year-old nursery tree or whip, and subsequent treatments for the trees are very similar (Figs. 13 to 17).

At the time the trees are planted, or preferably a few days later when the buds will have started visible activity, all buds are removed from the whip-like tree except those at the levels where scaffold branches are to originate. The lowest lateral or scaffold branch should be 26 to 30 inches from the ground, and the other scaffold branches should originate at intervals of approximately 8 inches along the central axis.

Some investigators advocate leaving one good plump bud at each level along the whip-like tree, (Fig. 13) while others recommend leaving groups of three or four buds at each level where it is desired to have scaffold branches originate (Fig. 15). Where a single bud is left at each 8-inch level, the lowest bud should preferably point toward the southwest and it should be 26 to 30 inches above the ground (Fig. 13). A snapper type clothespin may be fastened to the tree in such a manner as to straddle the desired bud and to point in the direction that a shoot arising from the bud may be expected to grow. Next, select a bud about 8 inches higher and approximately one-fourth of the way around the axis from the first bud (pointing to the northwest or to the southeast). Use another snapper clothespin to protect and indicate probable direction of growth. A third bud is selected 8 inches higher than the second one and it should point in a direction opposite to the first one saved; cover it with a third clothespin. A very vigorous one-year nursery tree or a two-year tree should be tall enough to make possible the selection of a fourth bud pointing in a direction opposite to that of the second bud. Another clothespin is used for it. All buds not protected by clothespins, except the top terminal one, are now removed by means of a sharp knife. The clothespins are then removed. This method will assist in the choice of buds for future limbs and indicate their probable direction of growth.

The method of disbudding just described is simple. Care must be taken to try to select strong buds that are reasonably certain to grow. Even with such care in selection of buds, 5 to 10 per cent of them may not grow into shoots. This means that 15 to 30 per cent of the trees may not have shoots developing from all four selected buds and that the resulting tree may not be well balanced. Furthermore, the branches originating from the lower buds of some varieties may be too vertical in habit. Generally, these points are overcome by the time the trees reach bearing age.



Fig. 17. A four-year-old Delicious tree, trained as illustrated in Fig. 13. Note that the main lateral or scaffold branches originate from the central leader at rather uniform intervals. Also, note the very few twigs on the ground removed just before this picture was taken.

The objections just mentioned may be overcome by saving groups of three or four consecutive buds at each height where a scaffold or framework branch is desired (Fig. 15). The lowest group of buds should be 26 to 28 inches above the ground, and the intervals between groups should be about 8 inches when measured from the middle of one group to the middle of the next. All other buds are removed with a sharp knife. The whip-like tree may be headed back very slightly or preferably left without heading.

In the case of one-year nursery trees that are less than $4\frac{1}{2}$ feet tall, it is not advisable to attempt to save four sets or groups of buds—indeed, two groups may be the limit on some one-year trees.

During the first growing season, shoots that arise below the height for the first scaffold or framework branch may be removed soon after they begin development. In the case of solitary disbudding, shoots growing from nodes where buds were not fully removed and shoots growing from adventitious buds may be removed, unless the framework branch grows from the approximate location of a selected bud that failed to grow. Otherwise, no summer pruning is done.

After the trees disbudded to solitary buds have been in the orchard one year, it may be necessary to remove branches growing from nodes other than those selected at planting time (Fig. 13). Occasionally, one of these branches may be better than one growing from the selected node and may be substituted for the poorer one.

If group disbudding was done at planting time, one branch is selected at each level or height at the beginning of the second season



Fig. 18. Good scaffold branch spacing in a six-year-old Delicious apple tree.

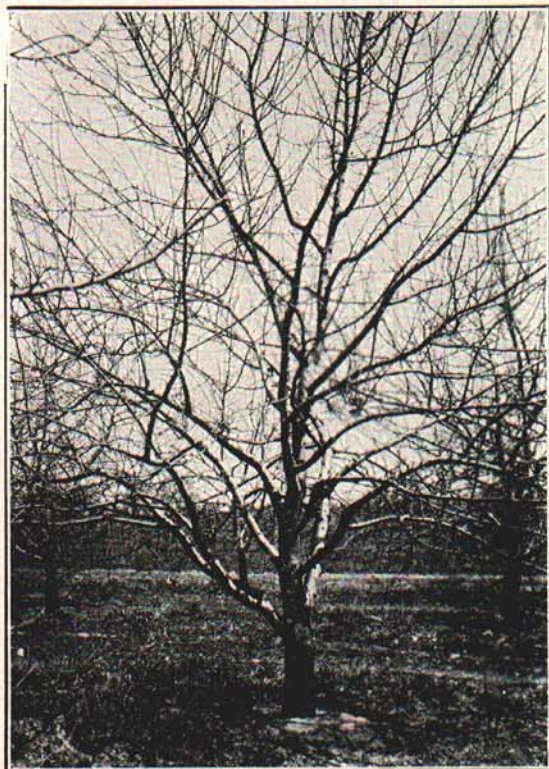


Fig. 19. A 12-year-old Delicious tree with good spacing of scaffold branches. Note that the oldest (lowest) scaffold branches have been kept in proper balance with the rest of the tree. Same tree as shown in Fig. 18.

for the permanent framework (Fig. 15). The choice from each group of branches should be based on direction of growth and the vigor of branch, so as to form a well-balanced tree, as indicated by the amount of growth made, and on the angle formed between the central axis and the lateral branch (30- to 45-degree angles are desirable). Other lateral branches are removed unless they are short horizontal laterals that are not likely to compete seriously with the branches selected to form the framework. Leaving a few of these short laterals encourages better growth (less dwarfing) of the tree. It is seldom necessary to head back the branches selected to form framework branches.

In case small one-year nursery trees were planted and only two or three groups of buds were left at that time, it may be necessary to select higher laterals at the beginning of the third season in the orchard to complete the framework (see section on "Training Apple Trees by Pruning," page 13). Otherwise, the pruning at the beginning of the third and subsequent seasons should be as little as possible and the treatment should be similar to that described for trees trained by pruning under the sub-heading, "Pruning for the Fourth and Succeeding years," page 23 (Figs. 14, 16, and 17).

PRUNING THE PEAR TREE

The young pear tree should generally be trained and pruned in a manner similar to that recommended for the apple. Pear trees show a strong tendency, however, to assume a more upright habit of growth than apple trees. It is therefore advisable to cut to outside buds and to outside semi-horizonal or oblique lateral branches whenever feasible. As with the apple, it is important that proper balance of growth be maintained between the leader and the scaffold branches. The grower should aim to avoid sharp-angled crotches throughout the tree, though experience shows that pear crotches are somewhat less subject to splitting than those of the apple.

Because of the upright growth habits of some pears, it is a common practice in certain districts to cut back rather severely to prevent the tree from becoming too high. This practice is seldom successful in attaining the end sought, because cutting back is usually followed by

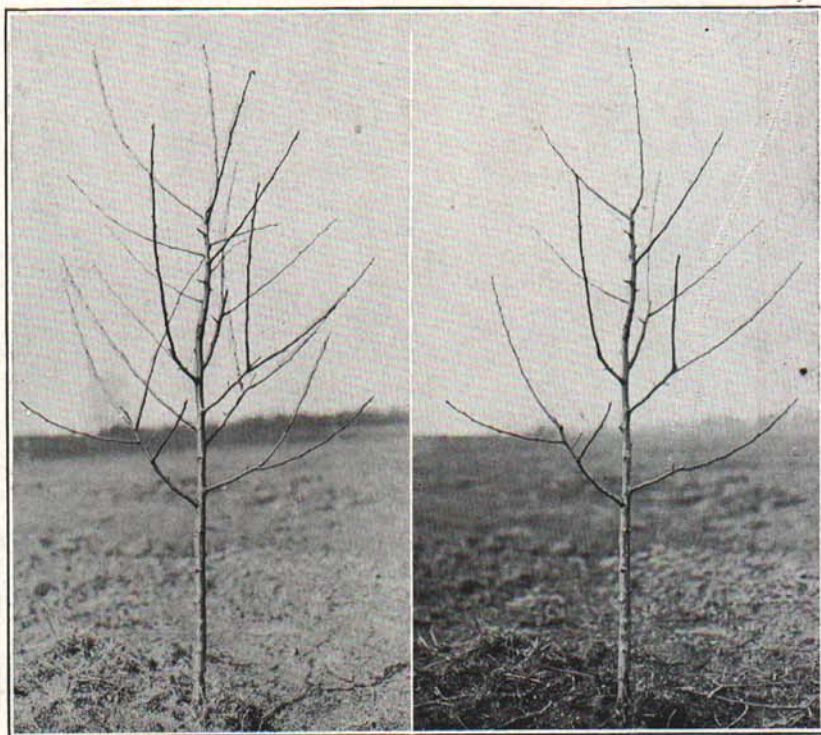


Fig. 20. A two-year-old pear tree with excellent spacing of lateral branches. One or two of these laterals may be eliminated after another one or two season's growth. The full quota of scaffold branches may be obtained in a shorter time with the pear than with the apple.

the growth of a number of nearly upright shoots from points near the place of cutting. The practice merely dwarfs the tree and limits fruit production without resulting in any improvement in spread. Thinning out rather than cutting back should be the type of pruning practiced after the framework is established. Fewer new shoots will develop and spreading with little addition in height will result. The first crops spread the tree naturally, and it is futile to attempt to force spreading by means of severe and unnatural pruning treatments.

For varieties susceptible to fire blight, blossom spurs developing along or within a foot of the central leader should be removed.

PRUNING THE PEACH TREE

The following is a condensation from a portion of Michigan Experiment Station Circular Bulletin 177 by Stanley Johnston, published in March 1941:

The open-center type of tree was accepted by early peach growers, and from three to five scaffold limbs were allowed to develop near

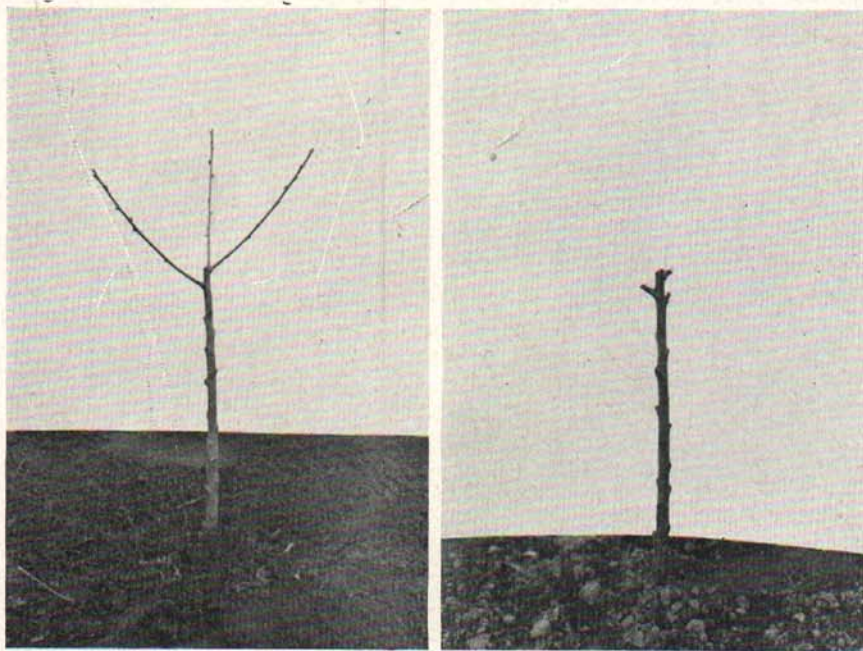
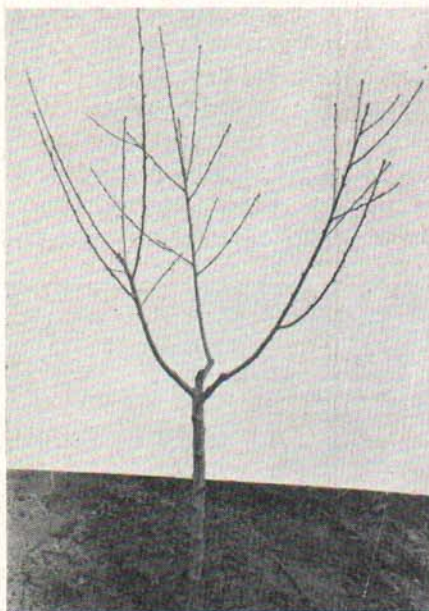


Fig. 21. Trees pruned immediately after planting to be trained by the three-scaffold method. If three suitable branches of equal size can be found close together they can be retained and cut back to 10 or 12 inches in length as shown at the left. Often three branches of sufficient vigor and uniformity cannot be found, especially at a height of 18 to 24 inches. In this case it is best to cut back the branches present to short stubs, being careful not to cut away the basal buds next to the trunk. Shoots developing from these buds can be selected for scaffold branches. (Photo by Stanley Johnston.)

Fig. 22. A one-year-old tree trained by the three-scaffold method. The three scaffold branches grouped closely together should develop a knot-like head of great strength. Pruning should be as light as possible during the first two or three years, but every effort should be made to keep the three scaffolds in balance. This can be done by doing the most pruning on the most vigorous scaffold branches. (Photo by Stanley Johnston.)

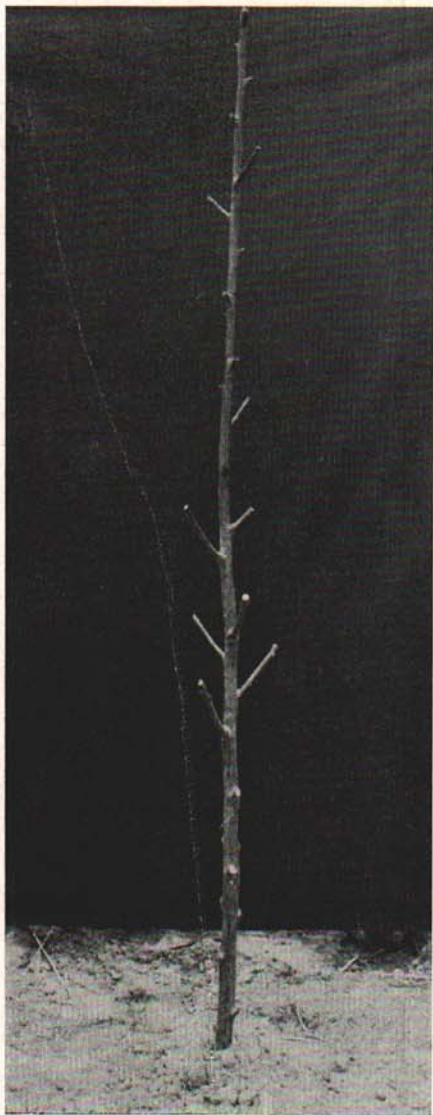


the top of a tree headed at 18 to 30 inches at planting time. In recent years a modification of the central leader type of training was developed. Still later, a modification of the open center method has been developed that is worthy of trial. Essential points of the three systems of training, including the strong and weak features of each, are presented.

OPEN CENTER METHOD—The one-year-old nursery trees should be headed at 18 to 24 inches at planting time (Fig. 21). Three scaffold branches are then selected that are well distributed around the trunk and as near as possible to the place where the tree was headed or cut back. When the branches originate close together, they form a knot-like growth at the head of the tree that will be exceptionally strong. If the scaffold branches are large and uniform in size, they may be left 10 to 12 inches in length, but if they are rather slender and uneven in size, they should be cut off near the trunk, leaving one or two basal buds (Fig. 21). New shoots will develop from these basal buds, and three of these, well distributed around the head of the trunk, may be selected for the main scaffold branches.

These trees should be examined two or three weeks after planting at which time all shoots except those which are to make scaffold branches should be removed so as to direct all growth into those three branches. Light, corrective shoot removal should follow in another two weeks.

A light, corrective pruning will be necessary during the spring of the second season (Fig. 22). Any shoots arising from the trunk other than the three selected to form the main framework should be removed. The three scaffold branches should be brought into balance, if one or two are making a much greater growth than the others, so that they will develop uniform size. By the third year, the structure and shape of the tree should have progressed to the point where virtually no pruning will be needed, unless it is to remove a particularly wayward branch or to keep the tree in balance by subduing an occasional over-vigorous branch.



CENTRAL LEADER METHOD—The central leader type of training must be modified somewhat when applied to the peach because the terminal shoot or leader (above the place of heading) does not grow upright, as is true with the apple, but off to one side at an angle of about 45 degrees. The tree should be headed at 36 to 48 inches at time of planting. Thus, large nursery trees are essential to this method of training. Lateral or secondary branches closer than 18 to 20 inches from the ground should be removed. Laterals between this

Fig. 23. A peach tree pruned immediately after planting to be trained by the central-leader method. The tree has been headed high, about 40 inches from the ground. All of the scaffold branches have been cut back to stubs. Only larger nursery trees can be used successfully for this method of training. (See Fig. 24.) (Photo by Stanley Johnston.)



Fig. 24. A central-leader type peach tree at the end of the first year's growth. Part of the scaffold branches have been removed and two or three more having narrow angles at the point of attachment with the trunk should be removed. (See Fig. 25.) (Photo by Stanley Johnston.)

point and the place where the tree is headed are "spurred back" to one or two buds (Fig. 23). The tree is allowed to grow for one season, though it is suggested that new shoots originating within 18 to 20 inches of the ground be removed early in the growing season so as to encourage greater growth of shoots above this region.

Scaffold or framework branches are selected after one season's growth in the orchard (Fig. 24). Some five or six of the stronger growing shoots that have relatively wide angles at points of attachment with the trunk should be left to form the scaffolds. Some of these may have originated from the stubs left at planting time, some from buds located between the stubs and the leader, and some from nodes that were branchless at time of planting. Obviously, the branches selected for the framework should be spaced as evenly along the trunk and around it as conditions of growth and crotch angles will permit.

Skill and careful attention are required to develop trees properly by this method because of the inclination of the peach tree to form an open center type of tree. Lower scaffold branches sometimes outgrow and shade the upper ones to such an extent that the latter must be removed at some later time, leaving a low-headed open center tree with a large pruning wound in the head. Sometimes the upper scaffold limbs outgrow the lowers, shading them so that their removal becomes necessary, leaving a high-headed tree with large pruning wounds on



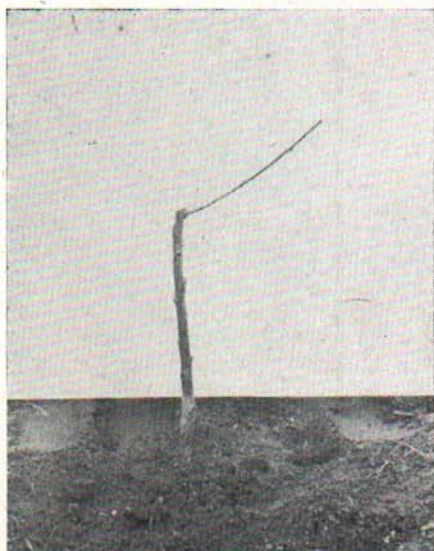
Fig. 25. Narrow-angled crotches do not mature properly in the fall and are therefore subject to winter injury. Note the winter injury in the narrow-angled crotch, lower left, and the absence of it in the two wide-angled crotches above. (Photo by Stanley Johnston.)

the trunk. Thus, some heading back of shoots at the beginning of the second growing season and thinning out to retard growth rates of some scaffolds during the second and third years may be necessary to maintain a proper balance between the several framework branches. Neither the upper nor the lower branches should be allowed to outgrow or dominate the others.

Narrow angles at points of attachment with the trunk frequently do not mature properly, with the result that this area is very susceptible to winter injury (Fig. 25). Such injury permits entrance of borers and peach canker disease, with the result that the tree's life is shortened. Thus, the importance of selecting only wide-angled branches for the framework.

SIDE LEADER METHOD—The first trees of this type were observed by W. W. Teichman in his orchard near Eau Claire, Mich. To train the tree by this method, one branch is selected at the desired height for the head, which is as nearly horizontal in direction of growth as possible, and which has a wide angle at point of attachment with the trunk (Fig. 26). This branch is headed back to 10 or 12 inches in length and all the remaining branches, including the leader, are removed. The selected branch should be on the side opposite prevailing winds, and this should be taken into consideration during the

Fig. 26. A peach tree just planted and pruned to start its training by the side-leader method. One strong lateral branch is selected that is as nearly horizontal as possible. In planting, this branch should be placed opposite the direction of the prevailing wind. Three shoots to be used as scaffold branches are allowed to develop from it the first season. Others should be removed then or the following spring. (Photo by Stanley Johnston.)



planting operation. The force of the prevailing winds blowing against this branch and its secondary branches will aid in keeping the branch in a horizontal position, and the secondary branches will form wide angles with the parent branch or original side leader.

During the first season, three scaffold branches having wide angles are allowed to develop from the side leader (Fig. 27). Others should be removed. During the second and third seasons, the treatment should



Fig. 27. A tree trained by the side-leader method at the end of the first year's growth. Three scaffold branches have been selected on the side-leader. Judging from the position and appearance of these, a strong tree should develop. Care will have to be used to subdue the two lower scaffolds sufficiently to permit the terminal branch to continue as the leader. Otherwise it will gradually be pinched out, leaving a two-scaffold tree. (Photo by Stanley Johnston.)

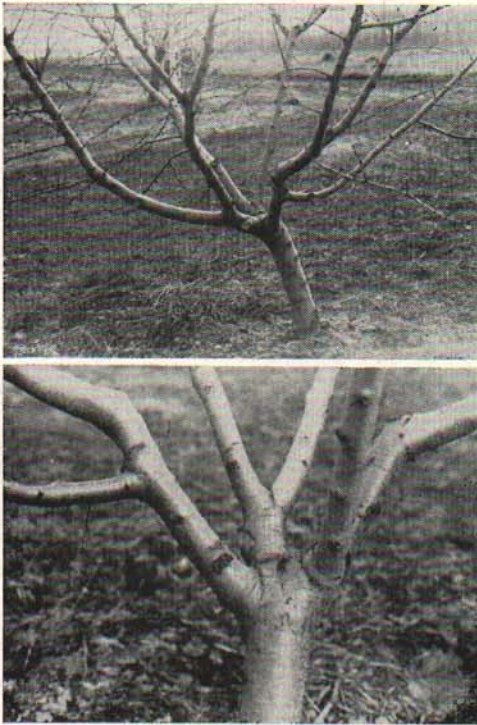


Fig. 28. Two views of the same tree, a four-year-old Halehaven, trained by the side-leader method. The scaffold branches are well spaced and have strongly knit unions with the head of the trunk. (Photo by Stanley Johnston.)

be essentially the same as that suggested for the open center method of training. The terminal scaffold should be maintained as the leader by pruning the other two scaffolds sufficiently to keep them slightly smaller. If this is not done during the first three or four years, the two scaffold branches nearer the trunk will have a tendency to grow faster and dwarf the terminal scaffold, leaving a two scaffold tree. Despite the heavier pruning of the basal branches, the three scaffolds will be of nearly equal size when four or five years old.

The heads formed by this method of training are generally very strong (Fig. 28). Defective unions at point of attachment of the scaffolds with the original side leader are rare.

No attempt is made here to indicate a preference of the three methods of training above described. Excellent trees can be grown, with the proper nursery stock, by a careful workman with any of the three methods.

Only a light, corrective pruning should be given peach trees trained with any of the three methods during the second and third years. The small wood in the center of the tree should be left, because it is on this wood that the first peaches will be produced. This may result in a fairly good crop the third growing season. In the spring of the fourth

year, the small wood in the center of the tree may be removed because it has fulfilled its purpose. It may be necessary to head back the tops lightly to prevent the main branches from becoming too long and limber. If only slight bud-killing has occurred during the winter, it would be advisable to do some wood removal by thinning out crowding or weak branches, thereby reducing the prospective crop of fruit and providing for the production of suitable new wood for the next year's crop.

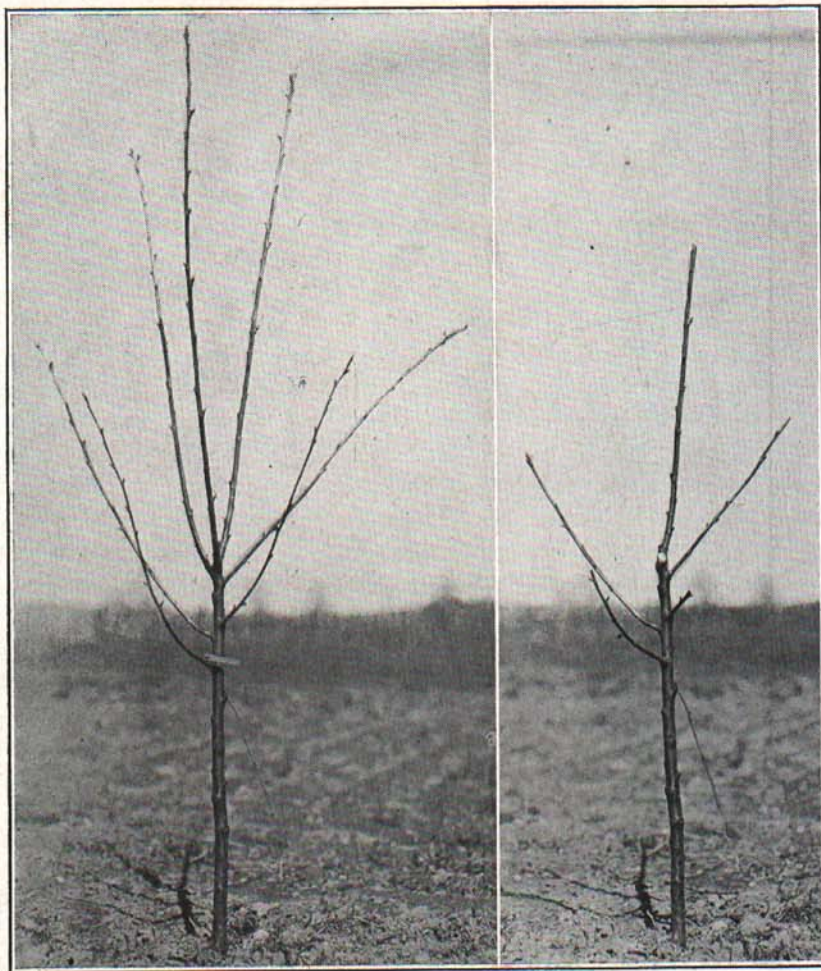


Fig. 29. Attempts to train a sweet cherry tree as one would an apple or pear usually results more or less disastrously because cherry buds are easily killed. The number and location of live buds will determine the length at which lateral branches should be cut.

PRUNING THE SOUR CHERRY TREE

A modified leader type of tree, intermediate between that recommended for the apple and the peach, is the most desirable for the sour cherry tree because it results in a stronger head and less splitting of crotches. The hazards of establishing a young cherry tree are many. Buds that have started to swell at the time of planting are easily injured. Well grown, carefully handled trees that retain most of their buds and whose buds are still dormant may be pruned more severely than trees which have buds injured by rough handling. The amount and kind of pruning of the young cheery tree at planting time should be determined by the number and location of its buds.

The one-year-old nursery tree usually has a number of lateral or side branches. If these lateral branches are low, their removal is generally advisable. However, pruning to a whip is seldom necessary or advisable unless there are a number of strong well-distributed buds on the trunk that will virtually insure a well-balanced top. In such cases, the disbudding method of training, as described for the apple, would appear to be desirable though the writers have not used it. After planting, the tree should be pruned—leaving the leader 8 or 10 inches longer than any of the scaffold branches. More lateral branches may be left than will be required for permanent scaffold branches when the tree is fully established. These scaffold limbs should be cut back to six to eight inches in length if this leaves some buds on each branch (Fig. 29).

One or two years after planting, when the tree has become established, the superfluous scaffold branches can be removed. Three or four wide-angled ones should be saved as permanent scaffolds, with the lowest about 20 inches from the ground. The three or four branches selected should be spaced along the trunk so that they will not tend to girdle or choke the leader and thus keep it from growing as fast as the selected scaffold branches. This is a point of particular importance in training the cherry. Scaffold branches should be selected so that not more than two of them are close together and so that no adjacent ones originate from the central axis directly above another. The pruning at this time will be mostly a thinning out of some of the superfluous branches not required as scaffolds. No heading back is necessary unless the growth has exceeded 20 inches or unless some branch is outgrowing the others. Even in the latter case it is more satisfactory to suppress the stronger growing branches by removing some of the laterals arising from them.

When the sour cherry tree is two years old, it will probably have three or four established scaffold branches. Six or seven of these main



Fig. 30. A sour cherry tree after one year in the orchard. Note that at planting time, the laterals were spurred back. The pruning that has just been done consisted of thinning out the laterals to provide the number and distribution shown. This should develop into a very strong framework.

branches distributed along about 3 feet of central axis or leader are advisable if it is possible to secure them. Therefore, another selection of scaffold branches to complete the framework of the tree is necessary before the tree enters the third season in the orchard. Again, no heading back is necessary except to maintain balance between main branches. There is a tendency for the lower ones to outgrow the upper branches unless proper balance is maintained by slightly heavier pruning of the lower ones. This pruning need not necessarily be heading back because any kind of pruning that removes part of the potential leaf system will produce the desired results. Some of the crowding, secondary branches may also be removed at this time.

After the tree is three or possibly four years old, little pruning is advisable. The framework is presumably established and pruning must be designed to maintain the proper balance between the scaffold branches. The leader should not be allowed to grow faster than the scaffolds, in fact, it becomes a main or scaffold branch rather than a leader after the full number of permanent lateral branches are selected.

PRUNING THE SWEET CHERRY TREE

The young sweet cherry tree should be trained in much the same manner as the apple, except that less heading and perhaps more thinning out are advisable. The shoots should not be headed unless the growth of a portion of the tree is likely to destroy balance between parts and the problem cannot be satisfactorily handled by thinning.

PRUNING THE PLUMS

The type of training recommended for the apple tree is in general satisfactory for the European plums. This group includes such varieties as Arch Duke, Grand Duke, Monarch, Bradshaw, Green Gage, Italian, Gueii, and others. The trees may, however, be headed so that the lowest scaffold branch is about 20 inches from the ground. In general, a less severe pruning should be practiced than with the apple. Heavy heading back usually results in long upright growths and a high and dense top; hence heading back, when advisable, should be light.

Varieties of Japanese plums such as Burbank have growth habits similar to those of the peach and the type of training described for the peach is recommended for them. Some of these Japanese varieties, such as Burbank, are comparatively "rangy" growers, and more or less corrective pruning is necessary in order to develop and maintain a well-shaped top.