Pruning
APPLE AND PEAR
TREES

Extension Service
Institute of Agricultural Sciences
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Pruning
APPLE AND PEAR TREES

By

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The ability to prune fruit trees is not a gift. It comes from experience coupled with an interest in working with them. In their own way they tell whether past treatment has been good or bad. He who wishes to prune, then, need only observe fruit trees well.

The experienced pruner over a period of years has observed the way trees respond to various kinds of treatment and has learned to choose and apply the kind of pruning needed. He sees the tree not only as it is before him, but as it will be in 2, 3, 4 or more years hence. As he works he applies long-established, fundamental principles of pruning.

The so-called pruning of young trees is intended to develop tree structure. By skillfully selecting certain branches for the framework and by removing others, the pruner builds the foundation for long-lived trees strong enough to carry heavy crops. With young trees, developing structure is the first concern; producing fruit is secondary. Because the first few years are a training period during which the growth of the tree is directed according to a chosen form or pattern, cutting young trees may well be called training rather than pruning. In the training process the sooner a sturdy bearing tree is produced, the better.

It is natural for fruit trees to develop according to rather definite patterns. Most fruit trees, when allowed to develop naturally, are low and spreading. Fortunately, this tendency to be low and spreading fits into our general plan of fruit production. There are occasional exceptions, of course, but high trees usually are the result of poor tree spacing, light crops, or faulty training. The more we recognize the natural tendencies and use them, the more simple and effective training becomes. It is better to work with, rather than against, tree nature.

Pruning delays bearing but even though we may want to do away with all cutting on young trees, it is impossible to do so. Nor is it possible to make a general statement as to how much to cut. Trees allowed to grow unpruned for the first 5 years or more come into production one to several years earlier.

* The authors wish to acknowledge the able assistance of the many who read the manuscript editorially and especially those fruit growers of whose trees photographs are included.
than comparable trees pruned moderately each year for the same period. Because of this retarding influence, light pruning is the general practice with young trees. The resulting weight of early production spreads the branches before they become too stiff for spreading. It is evident then that from the standpoint of delaying production and retarding growth, pruning young trees may be overdone. The self-training that comes from early fruiting and normal rapid growth may easily be disastrously postponed or thwarted by too much cutting. This cutting may not only delay bearing 2 or 3 years, but it may, by stiffening upright branches, keep them from ever settling into position. And fully as important is the reduced bearing area that is felt for many years.

**PRUNING TOOLS**

Good tools may not guarantee a good job, but poor tools invite a poor job. Few things about pruning lighten the work more than does having the right tools in good condition. They are the first step toward good pruning. A lopper, a saw, and a pole pruner are almost essential. For small trees a pair of hand shears is desirable, and with bearing trees some operators save considerable climbing by using a pole saw. There are many makes of good pruning tools. Being hand tools, they must be light and strong—the lighter the better as long as they are strong.

The little folding pruning saw is ideal for pruning as practiced in Washington orchards. It can be carried in the pocket when not in use. With fairly large teeth and cutting on the pull stroke as it does, it cuts fast.

Fully as important as having the right tools is keeping them sharp and in good working condition. An occasional drop of oil on the lopper bearing and a pocket whetstone to touch up the blade pay big dividends. Few things are more exasperating than using a lopper that tears. If it cannot be tightened so that it makes clean cuts and works freely, it is no longer a fit pruning tool. A saw with a few long teeth is almost as bad.

Pruners frequently abuse tools thoughtlessly. Using the lopper on branches too large is a common abuse. A more serious one that is almost unforgivable is allowing dirt or sand to get into the bearing. An appropriate rule is: "Never allow the cutting end of the lopper to touch the ground."

**TIME OF PRUNING**

There is a lot of virtue in the old saying, "Prune whenever your knife is sharp." At least it may be better to prune when you can than not at all. But assuming that you can prune when it is best for the tree, there are two times for doing it. The right time for at least 99 per cent of pruning is the dormant period.

**Dormant Pruning**

Pruning stimulates cell activity in the immediate area of the cut. With strictly dormant trees the stimulation does not take place until growth starts the next spring. With partially dormant trees it takes place immediately to
some extent. The wood of the pruned tree is then less dormant than it would have been without the pruning or had the pruning been delayed until the tree was fully dormant. Tissue thus stimulated into growth is susceptible to winter injury much the same as any other growing tissue in the same state of growth. It is for this reason that “die back” often occurs in the area of pruning wounds and that it occurs more frequently on early pruning than on late pruning. Obviously, the way to avoid such “die back” is to prune only when the trees are dormant.

In central and eastern Washington it is reasonably safe to start about January 1 during most seasons, but it is safer to wait until February 1. In western Washington there is little danger from starting in early December.

Delaying pruning until the buds swell doesn’t hurt the tree but there is nothing to be gained by delay except in the case of frost hazard. Leaves, blossoms, and even buds make it harder to see the tree and thus interfere with pruning. Couple this handicap with the fact that it is better to get the pruning done early enough to dispose of the brush before the spring rush, and it is evident that only on rare occasions should pruning be delayed past the dormant season.

Summer Pruning

Pruning in general is dwarfing but summer pruning is doubly so. Summer-pruned trees with the resulting reduced leaf area make less root growth than trees not summer pruned. The net result is that the tree as a whole makes less growth than it would have had the pruning been done in the dormant period. The final result is that fruiting capacity is less because the tree is smaller.

The dwarfing influence of summer pruning is most pronounced in early summer when the tree is completing its extension growth; it becomes progressively less after this period and may actually be insignificant 2 to 3 weeks before leaf fall.

The Young Tree

Cut back or head the young tree at setting time. Heading stimulates the development of lateral branches in the area immediately below and determines the height of the tree head. Without attempting to suggest here the specific heights for the various kinds of trees, we offer suggestions to be used in determining the best height.

Trees headed low usually become established faster than those headed high. It is also true that with high heading the resulting greater exposure to wind is a factor. High heading does not necessarily mean that it is easier to cultivate close to the tree, because the way branches are trained later is of more importance than the height of heading. A low-headed tree with branches trained upward, for example, is more accessible than a high-headed tree with drooping branches.
DELAYED HEADING WIDENS ANGLES

In general, wide angles are strong; the supporting tissue continues to develop within as well as outside the crotch. Narrow angles, on the other hand, are weak. The supporting tissue in the crotch practically ceases to develop when the two branches form a tight wedge. With some varieties of fruit trees the leaders frequently form narrow crotches with the trunk. This tendency is pronounced in the Delicious apple, and can be partially overcome by delaying heading until the shoots are 2 or 3 inches long. Hormones produced in the terminals of the shoots, particularly the central one, widen the angles. Very tall trees, however, must be headed at setting time and again later when the shoots are an inch long; otherwise, new shoots arise only in the area to be removed later and in turn exert little or no hormone influence lower, where the leaders ultimately arise. The procedure for a tall tree is to be headed at 30 inches finally, then, is to head in at 36 inches at setting time and at 30 inches when the shoots are 2 or 3 inches long.

THE NUMBER OF LEADERS

Opinions regarding the ideal number of leaders vary widely among fruit growers. The lower extreme goes as low as two and the upper as high as eight or more. It is quite significant that of the sound trees over 40 years old now standing in Washington, most of them have no more than three leaders (Fig. 1). We need only observe bearing trees with more than three leaders.

FIGURE 1. Tree heads. A.—A Delicious apple tree with three well-attached leaders. With no surplus branches there will never be any occasion for making a dangerous wound in the tree head. B.—A three-leader Delicious apple tree in which the leaders were established early. Note that even though the tree is approximately 40 years old the leaders are not crowding each other.
C.—Winesap apple tree head. A narrow crotch led to the development of the crack shown here. The tree can no longer carry a crop without special bracing.

Eliminating weak crotches when the tree is young, even at the expense of delaying bearing a year or two, is better than trying to remedy the results of weak crotches in later years.

D.—A Winesap apple tree showing the result of a tree head with weak crotches. Faulty training is costly.

E.—A two-leader Rome Beauty apple tree head with a narrow crotch. There is no sign of breakage yet but the fact that the supporting tissue on the inside of the crotch can no longer develop normally is sure to lead to splitting here. At this late date, it is difficult to remove one branch but with permanent trees there is no alternative.

F.—A weak crotch in a young Golden Delicious tree. Note that although the crotch has not yet started to split, there is little room for the branches to expand on the inside. Extreme pressure and subsequent wedging is inevitable.

G.—A very strong crotch on a young Golden Delicious tree. Note that the secondary branch forms practically a 90-degree angle with the main branch.
leaders to be convinced that with only three there are no vacant areas around
the tree. The greater ease in maintaining fruiting wood in the lower area of
the tree that comes from keeping the structural branches to a minimum
deserves consideration also.

Keeping the number to three, by providing space for the leaders, favors
the development of a tree head with well-attached leaders. The danger of
producing a weak head increases as the number of leaders increases above
three. But keeping the leaders from crowding is no guarantee of a strong
head; it is also necessary to avoid weak crotches (Fig. 1). When leaders
are being selected, a fairly safe rule to follow is to eliminate weak crotches
as they appear. Almost without exception, a weak-angled branch is not suit­
able for a leader.

Avoiding crowding structural branches and avoiding weak angles in
the tree head are essential. There is no substitute for either. These objectives
are so vital that success in tree training may well be measured by the extent
to which they are accomplished.

TREE FORM

There are several patterns for training. Among those in common use
in Washington are the open center and the delayed open center. In addition
to these, there is the central leader. Obviously the pattern must be chosen
relatively early in the life of the tree. Experience in training young trees
teaches that adhering to a certain pattern too rigidly is neither desirable nor
profitable. The tree trainer in general may be assured of success if, as he
directs the tree growth according to his chosen pattern, he considers tree
training as a case of assisting tree nature rather than remolding it.

The Central Leader Tree

In trees trained in this pattern there is a central leader. As the name
implies, the central leader is in the center of the tree. It dominates all other
branches and persists for the life of the tree. The lower part of the central
leader is the tree trunk and it extends to the top of the tree. Side branches
arise from the central leader, usually in great numbers and at wide angles
with it. The trunk space from which they arise is almost unlimited. With
careful training which eliminates surplus side branches, the scaffold branches
can be spaced a foot or more apart. Unfortunately, this training is sometimes
neglected.

The roomy scaffolding and the wide angles at which the scaffold
branches arise from the trunk are two distinct advantages of the central
leader tree. They go far in developing strong trees.

Notwithstanding the resulting sturdiness, the central leader tree has
several bad features. With some varieties the tree grows too tall and quite
frequently the center becomes cluttered with surplus structural branches.
Because of these objectionable features, this pattern is rarely used in Wash­
ington.
FIGURE 2. Diagrammatic sketches of an apple tree before and after pruning for the first 4 years. Note (1) that surplus branches not wanted for permanent branches were retained during most of this training period; (2) that there are three leaders, all of which are present the second year in the orchard; (3) that the central leader of the very young tree eventually settles into the position of a framework branch. It is not headed.
The Open Center Tree

The name open center describes this pattern very accurately. The young tree, headed at setting time, produces several leaders originating from the headed trunk. These leaders spread and form an open center. They all originate within a space of 8 to 12 inches and are present at least by the end of the first growing season. Crowded into such limited space, they often develop a weakness which sometimes leads to splitting. This weakness, which may be overcome by tying and careful pruning, is the chief objection to this pattern. In spite of its weakness, this pattern is considered quite satisfactory with peaches, apricots, prunes, and plums in Washington.

Delayed Open Center

The delayed open center pattern is the result of an attempt to combine the openness of an open center and the strength of a central leader. The young tree headed at setting time as usual grows with a central leader for the first season or two. As soon as the leader produces side branches, 1 year with most stone fruits and 2 years with apples and pears, the leader is headed to a strong side branch—the higher the better. The heading here occurs later than in the true open center tree, hence the name delayed open center.

In practice with apple trees as grown in central Washington particularly, it has been found unnecessary to head the central leader to a side branch. Without heading, the central leader settles into the position of one of the framework branches. It may be necessary however to nip it slightly to keep it from outgrowing the other leaders.

This pattern is satisfactory for fruit trees generally and is particularly so for apple, pear, and sweet cherry trees. Its greater strength is a distinct advantage over the open center pattern.

The Apple Tree

The life of an apple tree depends very much upon its structure. A tree with well-spaced framework branches and strong angles throughout may live 50 years or more; whereas a tree with crowded branches and weak angles may break down at 25 years. Many of the strong trees in bearing orchards today have been trained virtually to the delayed open center pattern. The presence of these trees is being interpreted as a recommendation for the use of this pattern in training apple trees.

Pruning at Setting Time

Assume that the tree is 1 year old. The conventional heading height is approximately 36 inches. Delayed heading, as described on page 6, is suggested for large trees, particularly those of varieties such as Delicious, which are inclined to produce narrow-angled branches.
THE FIRST DORMANT PRUNING

The average tree produces three to six branches during the first growing season. By the time of the first dormant pruning these range from 6 to 24 or more inches long (Fig. 3). Use the top one to extend the trunk and head it at about 24 inches. Heading it here forces branching low enough so that some of the resulting branches can be selected for leaders. If the total growth is less than 24 inches, no heading except removing the tip is necessary.

FIGURE 3. A Golden Delicious apple tree headed at about 18 inches when set. The tree is 1 year old (one year from setting). A.—before pruning. Note the numerous branches and the good terminal growth. B.—after pruning. The two large branches on the right are good leader material. Of these, the lower one is preferable. It matches the one 4 or 5 inches higher on the left.

These two, the upper left one and the lower right one on the pruned tree, are close together but their angles are good and they are on nearly opposite sides of the trunk. These for the lower leaders, and the central leader for the top one, make three. The central leader thus becomes one of the three framework branches. Note that of those remaining, only the top leader was headed and with it heading was very slight. The other two leaders were not long enough to require heading nor was it necessary to head the surplus branches to avoid interference with the selected leaders.
FIGURE 4. Two-year-old Delicious apple tree (two years from setting). A.—before pruning. Note the bend where the tree was headed at setting time and also the place a little higher on the trunk where it was headed last year. Most of the angles are poor. The tree was headed low at setting time. Note how many of the crotches are poor, as is commonly true of Delicious trees. B.—after pruning. Note that all but the leaders were eliminated and the two remaining branches form wide angles with the trunk. As the central leader takes the position of a framework leader, the three leaders dissect a circle in approximately three equal parts.

To eliminate weak crotchcs required the removal of five branches. This was heavy pruning and required some thought about the danger of semi-girdling the top leader. The pruning would have been less had the training been adequate the year before. Note that the three remaining branches selected for leaders are well spaced. Of these, only the top one was headed very slightly. The pruning was severe but maintaining the narrow angled branches even temporarily might have hindered the development of the leaders.
Spacing the leaders, which is one of the most important jobs of tree training, starts with the first dormant pruning. In general, the farther apart the leaders are on the trunk, the better. The statement has been made that they should not be closer than 8 inches. Eight inches is a good distance and farther is better, but spacing them around the trunk uniformly so that none is directly over another is fully as important as spacing them up and down on the trunk. If the spacing around the tree is well done, the 8 inches might be reduced.

Start the spacing by selecting the lowest strong lateral above 12 inches from the ground that forms a wide angle with the trunk. This lateral becomes the bottom leader. Some tree trainers consider it very improper to use laterals lower than about 24 inches. The angle that the lateral forms with the trunk is much more important than its height above ground. A properly attached lateral 12 to 18 inches from the ground can be trained into a very satisfactory leader.

If the spacing around the tree is well done, the 8 inches might be reduced.

If there is a strong lateral 8 to 12 inches higher on the trunk and approximately one-third the distance around it from the first leader, use it as a second leader. Otherwise, wait until next year to select both the second and third leaders.

The selected leaders must dominate all other branches except the trunk. Head only those that are longer than 24 inches and head them at about 24 inches. In practice most of this heading consists simply of removing the tips (Fig. 3B). Heading forces branching in the area of the cut and keeps the long laterals from becoming too limber. Head other laterals only as much as necessary to keep them subordinate to the leaders.

You must not only select well-spaced leaders with good angles but you must also direct the growth of the leaders. For the next growing season the central leader or trunk is a leader in every sense. Keep it dominant over all other branches. Next in rank are the selected leaders, which are only slightly smaller as a result of having been headed somewhat more severely as necessary. All other branches are subordinate to these. Retain as many of them as possible temporarily for the leaf area they provide. Maintaining this leaf area means more rapid growth and earlier production.

THE SECOND DORMANT PRUNING

It is now time to suppress the central leader and to complete the selection of the leaders. Pick out a lateral as high up on the central leader as possible and remove the central leader just above this point. This branch becomes the top leader, and if two were selected last year, it is the final one. Otherwise, a third one must be selected at this time also. Allowing the central leader to become one of the scaffolds without heading to a side branch as pointed out earlier is a modification from the standard delayed open center pattern.

There are now three leaders (Figs. 4, 5, and 6). Some of them are 1 year old and others are 2 years old. Maintain these as leaders. Do not allow secondary branches on any leader to compete with it for leadership. Strong leader-
ship favors the development of well-attached secondary branches. Allowing the leader to form twins or triplets is likely to result in a structural weakness at the junction; nor can you develop secondary branches on the inside of close twin and triplet branches. A few main branches with good distribution of side branches are more valuable than many pole-like branches.

FIGURE 5. Two-year-old Winesap apple trees (two years from setting).
A.—A tree in which one leader was selected during the first dormant pruning. All other branches except the central leader were removed at that time. Removing all but these branches is heavy pruning but note that the lower leader is now well established and that its angle is very good.

For the second leader we go to one of the three branches on the left; the upper one is excellent and we can leave the lower two as surplus branches to be eliminated later. With the two lower leaders selected, we have only to use the central leader as the third.

B.—A tree in which three leaders were selected during the first dormant pruning. All three leaders are now well established. The second dormant pruning consisted mainly of removing surplus branches on the front side of the top leader to encourage it to grow in the direction midway between the other two leaders. The narrow angle on the leader on the left was overlooked. The weaker of the two twin branches should have been removed.

Note that in both cases the central leader becomes a framework branch.
FIGURE 6. A 2-year-old Delicious apple tree. A.—before pruning. Note the narrow angles in the area of the heading at setting time. Unfortunately, these involve the largest branches on the tree. They are stronger than the branches with good angles. B.—after pruning. The first step in selecting leaders is to eliminate poor crotches. The pruning here consisted of eliminating three weak crotches. There is still at least one more on the left with a poor angle. It was left to avoid excessive pruning but special attention will be needed in future years to keep it and other surplus branches from hindering the development of the permanent framework branches.

Of the remaining branches, the third one from the bottom on the left is suitable for the bottom leader. For the second leader we go to the top branch on the right side. With these two as the lower ones and the central leader as the top one, we have three leaders. With as many surplus branches as we have left, we must guard the leaders and keep them dominant. Note that the top and bottom leaders were headed slightly.
THE THIRD DORMANT PRUNING

When the leaders have all been selected, we need only to keep them growing uniformly (Fig. 7). It may be necessary to hold the 2-year-old leaders with their secondary branches back somewhat. Do so by thinning out some of the secondary branches, particularly those close to the trunk. Head the 2-year-old leaders only in the case of more than 24 inches of terminal growth.

Our chief concern with the 3-year-old tree is to see that the leaders develop uniformly. Our only means of doing so is to retard the growth of those that are too vigorous. It is here that we use the dwarfing influence of pruning. With the apple, the top leader requires special attention to keep it from dominating the others. Pruning more than necessary at this time of course dwarfs the tree and delays bearing unnecessarily.

FIGURE 7. A 3-year-old Delicious apple tree. A.—before pruning. There is a slight wind coming from the right front. Note the abundance of leader material. There was practically no pruning during the first 2 years. The bottom branch is in the right position for a leader but it is low. One of the two directly above it is preferable. B.—after pruning. The bottom branch was removed to keep it from crowding the branch above it. We then have two strong branches on this side of the tree—the bottom one to be selected as a leader and the top one as a temporary branch. Leaving a temporary branch on the wind side until the tree starts bearing is particularly desirable.

For the top leader we go to the top main branch on the left of the trunk. For the second leader we look to the right side of the trunk and select the second branch from the top. We then end up with the three leaders definitely selected and with a fairly large surplus branch.
Skill in using the dwarfing influence of pruning comes from practice. We need only keep in mind that removing any branch whatsoever is dwarfing and that the greater the pruning, the greater the dwarfing. It is helpful to know that the dwarfing influence is most pronounced in the area of the cut. With this in mind, prune primarily on those branches needing dwarfing.

The inexperienced tree trainer may be confused in deciding what branches to remove. The answer is not mysterious. With the apple tree we seldom head permanent leaders much. Heading is necessary in the case of annual terminal growth of more than 24 inches. Occasionally secondary branches arising from leaders must be headed slightly to keep them subordinate to their leaders. And occasionally some of the temporary branches being maintained for leaf area must be headed to keep them from interfering with permanent branches. Others of the temporary branches, particularly

![Figure 8](image-url)

**FIGURE 8.** A 4-year-old Delicious apple tree. A.—before pruning. The tree was headed at setting time and allowed to grow with no further pruning until the time this picture was taken. There is no lack of leader material and the angles for the most part are good. Unfortunately, some of the large low branches are too low. B.—after pruning. For the first leader, starting from the bottom we go to the bottom branch on the left of the trunk. For the second one we go to the third branch on the right. This leaves us the next large branch going up or the central leader for the third leader. The close proximity of the large branch to the second leader forces us to choose the central leader, which promises to settle midway between the other two leaders. With these selected, we have only to remove surplus branches enough to keep them from hurting the leaders. Note that when this is done, the total spread of the tree has not been decreased. Note also that no branches were headed and that many small branches were left. Note also that the central leader was not eliminated.
FIGURE 9. A 5-year-old Winesap apple tree. A.—before pruning. There was some leader selection during the second and third dormant prunings but there are still several surplus branches. Some of these are now major branches which must be eliminated. Maintaining these up to now increased the growth of the tree, but keeping them longer will jeopardize the ultimate structure of the tree. The large framework branches have already produced many substantial side branches. The permanent framework branches must be protected from surplus branches.

Besides the central leader there are three major branches on the left of the trunk and two on the right. The lower branch on the left is directly below the top one. Both cannot be retained and the lower one, if retained, will require special training to keep it from becoming too low.

The middle branch on the left is really larger than it appears in the picture. It can be used as a leader, should we decide to use four leaders, or it can be retained as a surplus branch for 2 or 3 years. The latter is preferable.

On the right of the trunk the difficult decision is between the central leader and the large branch immediately below it. Both are good leader material but we must eliminate one. Removing the central leader would be unnecessarily severe cutting because it is much the larger branch. Evidence is, therefore, in favor of removing the lower branch.

B.—after pruning. The lowest branch on the left was removed, leaving the one above as a leader. To have retained it longer would have injured some of the laterals on the branch above. But more serious, the bottom branch would have "boxed in" the leader above and kept it from spreading. The second large branch on the right was removed also. It was crowding laterals on the branch above which makes our top leader. For the middle leader we go to the lower branch on the right background. It is well attached and in good position.

Note that removing two large branches made up most of the pruning. Removing them was heavy pruning. Note especially that the total spread of the tree was not reduced and that there was no heading.
those in the area of the tree head, must be removed completely. Leave as many small branches as possible, however, even though doing so makes the tree look bushy.

In addition to directing the growth of the permanent branches, you should eliminate weak crotches as they appear. They never make suitable permanent branches.

THE FOURTH DORMANT PRUNING

We are now reaching the stage where some attention must be given to spacing the secondary branches on the leader. These dare not arise too near the tree head because of limited space here. A fairly good rule to follow is to space the closest one at least 16 inches from the trunk.

We must also continue to keep the leaders growing uniformly during this fourth dormant pruning. Nor dare we overlook the removal of weak crotches as they appear. Beginning about this time or a little later semisucker branches appear on the upper surface of the leader. Take these out as they appear, even though there may be a temptation to leave them for later renewals.

THE FIFTH TO TENTH DORMANT PRUNINGS

The tree is now beginning to bear (Figs. 9 and 10). Surplus branches left for early fruit are pretty well loaded with fruit spurs. Encourage this early production by continuing light pruning, but always keep the permanent structural branches in mind. Don't cut a permanent branch to keep from crowding a temporary branch. Take out the temporary branch.

As the young trees come into bearing, the burden of producing fruit becomes progressively greater. The vigor of the young tree is high, but as production increases, vigor decreases. Do not allow it to drop too low. Keep it, as measured by terminal growth and fruit size, at the desired level by regulating pruning and fertilizing.

As the tree approaches 10 years, it approaches good production and takes on the growth habits of a bearing tree. It soon reaches the rate of growth that should be maintained throughout its life. As production increases, it becomes necessary to add some growth stimulus if this state of vigor is to be maintained. Part of the stimulus may come from removing surplus branches. And it may be necessary to open up the tree somewhat at this time to encourage color development and to maintain fruiting wood in the inside of the tree. It is during this period that it may be necessary to step up the amount of pruning.
FIGURE 10. A 5-year-old Winesap apple tree in which there was considerable leader selection during previous years and in which secondary branches are now established. UPPER.—before pruning. Note the scars showing the removal of surplus branches in previous years has produced three large leaders—the bottom branch on the right, the largest branch on the left, and the central leader. The surplus branch in the foreground can be retained for a year or two without injuring the leaders in this area. The central leader, which already is settling into position for the third leader, has two secondary branches. These both may be retained permanently, although it is quite likely that one will be removed after 3 or 4 years. This tree, compared with the one shown in Figure 9, shows the advantage of selecting leaders earlier.

LOWER.—after pruning. This year the pruning was very light, consisting of the removal of a fairly large branch on the left and one on the right. Note that there was no heading.
THE ELEVENTH TO FIFTEENTH PRUNINGS

The tree is in rather good production at this time. It is not uncommon for trees 10 to 15 years old to yield ten to fifteen packed boxes. Watch the vigor carefully and keep it at the right level. Pruning is but a minor source of growth stimulus; use it along with fertilization to keep growth up and production high.

As the tree comes into full production, the development of the leaders must be continued. If, because of the overproduction or underfertilization and underpruning, they stop growing, expansion growth stops also. Retarding the growth in this way in turn retards the time at which the tree reaches full size and full production. Allowing the tree to overbear, therefore, is poor economy both from the standpoint of production and tree structure. One important objective of pruning at this time, then, is to keep the leaders extending their growth and to keep them from settling out of position. This pruning consists mainly of thinning the laterals near the tips of the leaders to keep them in good vigor and in position.

RENEWING FRUITING BRANCHES

A fruiting branch starts out as a fast-growing vegetative shoot and then it becomes a dormant twig. As a rule, the resulting dormant twig, particularly on the young tree, has no fruit buds or spurs the first year. Never having felt the weight of fruit, its position is vertical rather than slanting or horizontal. This vertical position is not necessarily objectionable but merely indicates that the twig has not yet fruited. During the second year the twig produces laterals and develops into a branch, but the upright position persists for a year or so until the branch starts bearing. A few fruits at this stage, while the branch is still supple, tend to pull it from a vertical to a slanting position. A little weight at this time is more effective than much later. As production increases, the position of the branch changes from vertical to horizontal (Fig. 11). The greater the production, the faster the change.

Eventually the branch settles beyond the horizontal into a drooping position. To be drooping is a sign of old age and the longer it can be postponed, the better. The best method of postponing it is to thin off twigs, branches, spurs, and fruit.

It is more or less normal for fruiting branches on the outside of the tree to eventually reach a drooping position. Whether or not they should be maintained after reaching this position depends upon their vigor. Drooping branches with vigorous fruiting wood are capable of producing first-class fruit and of course should be maintained. To keep them in production their small branches must be thinned carefully.

When drooping branches do reach the stage when they must be renewed, there are several things to keep in mind. First of all, pruning will not take the place of fertilization. Assuming that fertilization is adequate, you must then look to pruning. If the branch is boxed in, it may be necessary

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FIGURE 11. A.—a drooping apple tree leader with renewals in production. Note the weak wood on that part of the leader beyond the point at which the top renewal originates. The two renewals have devitalized this wood to the point where it is of little value. The leader went out of production too soon. The rapid devitalization may have been due, first, to low tree vigor, and, second, to the fact that renewals were started too soon. Renewals originating on the sides of the branch are less dwarfing than those originating on top of it.

The renewal in this instance originates too low on the leader. It should have originated at the bend. Here it would have renewed the drooping wood at the end of the leader without so completely choking out fruiting wood on the structural part of the leader. With the renewal farther out, there would have been good fruiting wood throughout the leader similar to that in evidence lower down. As the branch now stands, there is not much to do but to eliminate that wood beyond the point where the top renewal originates. Of this fruited-out wood, the lower branches may be retained for a year or so but the upper one, which is part of the original leader itself, had as well be eliminated now. The stub on the upper side of the drooping part of the leader suggests that there might have been some good fruiting wood here. Normally the wood on the top is preferable to that on the bottom.

B.—apple tree with wood in various stages. The upright wood is in its prime. Retain as much of it as possible. The hanging wood on the lower side of the main branch is past its prime. Much of it is still good wood but do most of your pruning here.

to remove competing branches completely. And occasionally the drooping branch eventually must be shortened. In doing so, it is better to cut it back to a fairly strong branch rather than to simply clip off the end, unless you intend shortly to eliminate it. It goes without saying that some small branch thinning goes hand in hand with the shortening.

Vigorous twigs frequently appear on structural branches. They usually appear on the upper surface and anywhere from the tree head out to where the branches are 2 inches or less in diameter. Particularly on the inner part of the tree, they tend to grow skyward until they reach the top of the tree. For this reason they are commonly called risers. When necessary, these risers may be used to renew leaders or laterals if selected and handled properly.
FIGURE 12. Drooping Delicious apple tree leader bearing several "risers.” UPPER. — before pruning. Note the denseness because of the numerous risers and the presence of secondary branches on the risers generally. Note also the amount and type of growth beneath the leader. The large riser originating at the bend of the leader is ideal for a renewal.

LOWER. — after pruning. As complicated as pruning may have seemed upon first sight, most of it was accomplished by making the three saw cuts shown by the arrows. There was some thinning with the lopper, and more will be necessary next year. Removing the large riser was a "must." Note especially that none of the remaining risers were headed. The renewal was left rather heavy in the top to force it to settle into position as soon as possible.
Those originating on the sides are preferable to those on top. Renewing should not be started until the parent branch is drooping severely. The renewal should then originate at the base of the bend, usually about 6 to 8 feet from the trunk (Figs. 11 and 12). If too far out, the resulting branch becomes too high; if too close, it seldom develops into a smooth continuation of the branch being renewed.

It is unwise to permit numerous branches to develop on the upper surface of the leader or lateral with the idea that they may eventually be used for renewals. It is better to allow possibly two of them to develop on a branch needing renewal. It is, of course, necessary to foresee the need for renewing, several years in advance. These branches, if left when not needed, develop into risers, which eventually dwarf either the parent leader or the lateral. The riser is in a key position to hog the sap flow that, otherwise, goes to the leader. Because of its advantageous position, it can dwarf out the leader in 3 or 4 years, especially if the riser originates from the top rather than the side. It is because of this danger that these potential renewals should be left only when needed.

Seeing that the renewal originates in the bend of the branch to be renewed is only the first step in developing a renewal. It dare not be shaded into weak and slender growth. And as it develops side branches, it must be trained to settle toward the outside of the tree. This training consists of removing some of the inside branches (Fig. 13). Occasionally it is advisable to pull it out artificially and tie it. Risers allowed to become stiff before fruiting, can still be encouraged to bend outward by artificial spreading. Very rarely, if ever, is it advisable to head the renewal.

**PRUNING DIFFERENT VARIETIES**

Varieties differ in growth and fruiting habits. These variations demand different kinds of pruning. The pruning for spreading trees, for example, is not the same as that for upright trees. And pruning those that bear almost entirely on spurs differs from pruning those that bear terminally and laterally on new growth. The biennial bearing habit also is a factor to be considered when pruning varieties with this tendency. The fact that with some varieties, but not with others, color is an important factor of grade, must be taken into consideration also.

*Delicious and Winesap.* Trees of these varieties are fairly open with a spread of as much as 40 feet (Fig. 14). With reasonable training during the first 15 years, the leaders form a steep-sided funnel with the center pretty well filled with secondary wood. There are two things to be accomplished by pruning the bearing tree. One is to single out fruiting wood and expose it to light and air. This singling out, which is accomplished by thinning secondary and smaller branches, encourages color and the development of good fruiting wood. The other is to thin out old spur wood. These varieties are inclined to produce too many spurs. These surplus spurs must be thinned as soon as they show signs of weakness. Weak spurs are usually on
FIGURE 13. Stiff Delicious apple tree “riser” before and after tying. A.—
before pruning and tying. Stiff risers settle into position readily when en­
couraged to do so by tying. Note the two large risers and the several small
ones. Note also that the large riser on the right originates at the base of the
bend of the leader and that this riser bears several good secondary branches.
It is good renewal material because of its location and because of its fine
secondary branches. Note that the leader is drooping, which is an indication
that a renewal should be started. Note also how many risers there are and
the amount and type of wood underneath the leader.

B.—after pruning and tying. Thinning the riser is now necessary from the
standpoint of crop, both immediate and future, and from the standpoint of
structure. To postpone thinning longer will dwarf out the leader too soon
and it will destroy the secondary branches on the riser that is to be the re­
newal. The renewal was stiff and upright before tying. Fortunately, it leaned
slightly outward and the laterals for the most part were on the outside. It
doubtless would have settled into position without tying eventually; but had
it leaned the other way, tying would have been necessary.

Number 14 wire was tied to a surplus lateral near the tip of the riser
and to a small branch on the leader. Note that the pulling was not severe.
Once the renewal is made to lean in the right direction, the weight of the
branch itself and the resulting fruit induce further bending.

the underside of branches and on pendant wood. Individual spur thinning is
not a general practice although it is sometimes worth while as a means of
minimizing fruit thinning. It is faster to remove heavily spurred small
branches than to remove individual spurs.

In shaded areas of these varieties long branches barren of side shoots
sometimes develop. These often remain barren for 3 or 4 years but can be
brought into production by exposing them to light, unless they are too
slender.

Jonathan. This variety is inclined to overset. Pruning is not a correction
for oversetting except as a fair amount of spur and twig thinning reduces
the number of clusters. With red varieties, such as Jonathan, providing exposure to light is an important objective of pruning, and distributing the pruning over the entire tree usually aids materially in accomplishing it. How much thinning to do to expose the branches depends upon the density of the tree to start with. Furthermore, providing sunlight to all branches without inviting sunscald is the key to renewing and maintaining fruiting wood. Occasionally it is necessary to thin out old spur wood in old trees. Sometimes drooping wood must be taken care of too.

**Rome Beauty.** The fact that the Rome Beauty tree produces much of its fruit on the tips of branches necessitates a special type of pruning. The outer branches are inclined to overlap after a few years of production. This overlapping when too intense eventually destroys the fruiting wood in the shaded areas. Take out the weaker of the outer branches and do some branch thinning on those that remain.

The problem of developing and maintaining fruiting wood throughout the inside of the tree is as difficult with Rome as with any other variety. It can be accomplished only by doing enough pruning to expose the tree to light reasonably well and by distributing this pruning over the entire tree. This practice tends to favor good color development, which is an item with this variety also. Rome usually develops good fruit size without special pruning to increase size.

**Yellow Newtown.** This variety, like Jonathan, oversets. Here again, some spur and branch thinning to limit the number of clusters is in order. Yellow Newton also has a tendency to bear biennially. There is little hope of overcoming alternate bearing by pruning, but pruning may soften the tendency and make such practices as good thinning more effective. With trees in partial off bearing, it is customary to save as many blooming spurs as possible during the off year and to remove a fair share of them during the on year. This is accomplished by removing spurs and fair-sized branches during the on year but only fair-sized branches during the off year. Although color is not a factor, keeping the tree fairly open means better quality. And here again, distributing the pruning over the entire tree is a good practice.

**Golden Delicious.** This variety is inclined to bear biennially. It is also inclined to overset and will stand spur and twig thinning to reduce the number of clusters. This variety has the serious fault of developing large structural branches that remain stiff and unyielding as the tree comes into

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**FIGURE 14.** (See page 26.) A mature Winesap tree producing forty packed boxes regularly. **UPPER.**—before pruning. The number of structural branches has been reduced to four. Pruning of previous years consisted mainly of thinning and not heading. Note especially that there is an abundance of good fruiting wood in the lower part of the tree, as well as in the other parts. Note also that the tree is dense and that the density is fairly uniform throughout the tree.

**LOWER.**—after pruning. The pruning shown here was moderate in amount and the tree responded with a normal crop of good-sized, well-colored fruit. Pruning consisted mainly of thinning. Note that none of the upright branches were headed. Note also that the density of the pruned tree is uniform throughout the tree. The resulting exposure to sunlight is most desirable.

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FIGURE 15—C

C.—leaders of bearing Golden Delicious tree showing natural tendency for branches, even when bearing, to remain upright. The tree as shown here is 18 years old and is in good production. Note that the leaders are still upright. With most other apple varieties these leaders would have been drooping. Golden Delicious wood is stiff and brittle. It lacks the spring of other wood. Instead of bending under extreme loads, it breaks.

full bearing. When these branches load with fruit, they sometimes snap off instead of gradually settling into position. They usually form good angles with the trunk, however, which, at least to some extent, favors spreading them artificially before they become too stiff. Artificial spreading seems to be about the only means of spreading them.

Even the slightest rubbing scars the fruit. It, therefore, is doubly necessary to keep the tree fairly open. Keeping it open with fruiting wood well spaced protects the apples from rubbing and provides the exposure to light necessary for fine finish and quality.

Yellow Transparent. Size rather than maturity determines the time of harvesting this variety. The sooner the fruit reaches marketable size, the better. Firmness is a secondary factor. The extent to which pruning may be used in developing size, therefore, is greater than with most other varieties.

FIGURE 15. A.—sweet cherry tree showing the influence of early spreading. Spreading was first started 3 years before this picture was taken. The pulling was rather severe as indicated by the occasional sharp bend. Very severe pulling stimulates the development of shoots at the bend, which is undesirable. Note that in recent years the ties were raised; otherwise, the branches would have curved upward again. Note also that as a result of spreading, this tree at 6 years is as wide as it is tall. Without spreading it would have been at least one-third taller than wide. The ties can soon come off. The weight of each leader with its fruit will tend to pull it down.

B.—a 5-year-old Bing cherry tree after spreading. The leaders of this tree have never been headed. The ties were made to adjacent trees. Note how perfectly the non-headed leaders spread.
D. — five-year-old Golden Delicious tree before spreading. Note that the leaders are still upright even though they have not been headed and the tree is in production. Note that before spreading, the width of the tree is about half its height.

E. — the 5-year-old Golden Delicious tree shown in C (after spreading). Pieces of props are shown as spreading braces. Note that the large branch on the left is stiffer than the one on the right at the other end of the brace. The brace was placed higher on the stiffer branch in order to equalize the spread.

The fact that it is a yellow variety, with which color is not a factor, means even greater freedom in this respect. Quite naturally, rather heavy pruning with a fairly high nitrogen level is the desired practice. This condition automatically means a constant renewal of fruiting wood without too much effort.

Yellow Transparent has the bad fault of bearing biennially. But keeping the nitrogen level high and pruning as much as you can without inducing fire blight tends to overcome this trouble. With almost no limit to the amount of pruning that may be done, the usual pruning suggested for biennial varieties can be used effectively.

The rigid leaders respond to artificial spreading as the tree comes into bearing. The uprightness of the leaders while the tree is young may cause concern about the tree becoming too tall. Do not head the leaders but rather increase the weight on the outside by removing twigs and small branches from the inside.
The Bearing Tree

Anyone can walk up to a tree and cut off a few branches but it takes a smart man to prune the right amount. Knowing how much to prune comes from experience and from the ability to gauge the vigor of the tree as indicated by terminal growth, bark color, fruit size, etc. Generally, the greater the vigor, the lighter the pruning. Vigorous trees are capable of bearing a heavy crop, and the only way to permit them to do so is to retain fruiting wood for it.

Vigor is measured primarily by the annual terminal growth. Because terminal growth is usually greater on the top than on the side of the tree, it is advisable, when measuring the vigor, to use neither the top nor the side but an average of the two. The size of the fruit, of course, is an indicator also, and reddish bark usually indicates low vigor. Such symptoms as fruit size come only from having a record of past performance of the tree, which is essential to good pruning.

It is impossible in a general statement to specify the desired terminal growth for all trees under all conditions. The best we can do is to suggest amounts for various kinds of trees, with the understanding that each pruner will adjust his pruning to his local conditions. The terminal growth your trees make when they bear good average crops of fruit of the right size is about what you want. The approximate amounts suggested here may help you to determine how much your tree should grow if you do not already know.

<table>
<thead>
<tr>
<th>Tree</th>
<th>Desired Terminal Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apples</td>
<td>8-16 inches</td>
</tr>
<tr>
<td>Pear</td>
<td>12-18 inches</td>
</tr>
</tbody>
</table>

Trees making more than these amounts of growth are too vigorous. Their pruning must be lightened. Trees growing less, on the other hand, are weak, and with them heavy pruning along with more fertilization is in order. Pruning, of course, is by no means the only method of overcoming weak trees. Fertilizing and fruit thinning may be even more effective and should go hand in hand with pruning.

The degree of pruning is commonly expressed as light, moderate, and heavy. Light pruning usually consists of thinning out small wood and spurs. Heavy pruning takes out larger wood also. In almost any orchard section the amount of pruning during a season varies from orchard to orchard. Notwithstanding the variations that are pronounced during some seasons, moderate pruning is still the established practice.

PRUNING FOR CONVENIENCE

The more accessible a tree is for picking, spraying, and thinning, the less these operations cost. With this in mind, an orchard averaging forty-five boxes per tree is not necessarily more profitable than one averaging forty...
boxes. Well-planned pruning over a period of years, by making the tree convenient, can reduce the cost of all ladder operations. Opening up ladder spaces, for example, reduces the number of sets, and lowering tall branches increases the percentage of ground and low-ladder work. Pruning of this sort simplifies spraying in about the same proportion, and for the most part need not reduce production.

FIGURE 16. A Delicious apple tree in which wind is a serious factor in pruning. The orchard is producing light crops. The view in upper pictures is perpendicular to, rather than parallel with, the direction of the wind. UPPER LEFT.—before pruning. Note that the tree is very dense. Note also that most of the branches are to the right of a line extending upward from the trunk. UPPER RIGHT.—after pruning. Most of the pruning this year was on the leeward side of the tree. Pruning on the windward side was held to an absolute minimum. Note also that there was no heading this year.

The view shown in lower pictures is parallel with the direction of the wind. LOWER LEFT.—before pruning. Note that the tree is very dense and that the density of the tree in this view is fairly uniform throughout the tree. LOWER RIGHT.—after pruning. Note that the appearance is similar to that of a tree in an area in which wind is not a factor. The density of the tree is fairly uniform from top to bottom and no branches were headed.
PRUNING TREES IN WINDY AREAS

The wind complicates pruning in some areas. It is not practical to force the tree into the wind by pruning, but reducing the pruning to an absolute minimum until the tree starts bearing hastens the time when the fruit load helps to pull the branches into position (Fig. 16). As the tree loads up, most branches settle into position surprisingly well, especially when aided in extreme cases by tying.

Do not try to do away with pruning entirely but prune mainly on the leeward side. Without some pruning here, the branches become very thick and the tree becomes completely overbalanced. Opening up alleys through the tree parallel with the direction of the wind relieves the pressure from the wind by allowing it to pass through.

LOWER TALL TREES

Many apple and sweet cherry trees in Washington are objectionably tall. Before attempting to lower them, consider the reasons for their being tall (Fig. 17). If the height is the result of crowding, the most logical procedure is to do some tree spacing. Or if, because of poor pollination, the trees have never felt the spreading influence of a fruit load, pollinizers may be needed. As a rule, trees in good bearing and with necessary space are low and spreading unless they have been abused.

Nevertheless, for one reason or another there are trees so tall that it is impossible or impractical to handle them as they are. We then have no choice. We must remove those branches which are out of reach. Such removals are major operations and should be considered so.

Most tall trees can be lowered without radical cutting. In each tree there are usually one to three large branches that are responsible for most of the undesirable height. These can usually be cut to fairly major lateral branches. When large branches are removed, other pruning should be lighter than usual in order to avoid overpruning. The practice of leveling tall trees to within reach from a 12-foot ladder or any other height, in contrast to selecting out the tallest branches, fails to use the art of pruning in a way that takes advantage of the natural growth habits of the tree. By cutting everything to a given height, small upright branches in the top, instead of being allowed to bear and settle into position, are cut and stiffened.

Tree Spacing

It may not seem economical to remove half the trees in a crowded orchard, but it has been proven experimentally that production equaling that at the time of removal can be restored within 2 to 5 years. Undue height resulting from crowding seriously interferes with orchard operations. This handicap, coupled with inevitable reduction in the percentage of extra fancy fruit, can make the difference between a first-class orchard and a mediocre orchard. Allowing a first-class orchard in need of tree spacing to grow in-
definitely without it is disastrous. Unfortunately, with a crowded orchard we sometimes do not recognize what is happening until the orchard is injured.

The Square Plan. The trees form squares which increase in size as you remove filler trees. You can stop with one tree removal or you can make two, depending upon the space your trees need; after each, the trees are in squares.

This plan is preferable to all others. With it the trees interfere as little as possible with necessary field operations. The so-called objection of fitting a round tree in a square space is of little significance.

Table 1. Number of trees at various planting distances before and after tree removal. (Square Plan).

<table>
<thead>
<tr>
<th>Distance in feet between trees</th>
<th>Trees per acre</th>
<th>Distance in feet between trees</th>
<th>Trees per acre</th>
<th>Distance in feet between trees</th>
<th>Trees per acre</th>
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<tbody>
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<td>45.2</td>
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</table>

FIGURE 17. Trees contrasting the natural shape and spread with the effects of crowding. UPPER.—a Bing cherry tree standing by itself. Even sweet cherry trees are low and spreading. This tree consistently produces 800 to 1,200 pounds. The highest fruit can be picked from a 20-foot ladder but most of it can be reached from a 12-foot ladder. Note the number of low branches and that the tree is wider than it is tall.

LOWER (p. 34).—a Bing cherry tree that has not been crowded. The spread is approximately 60 feet. This tree frequently produces 2,000 pounds of cherries. Harvesting inevitably requires the use of tall ladders for the top fruit. It may not be economical to allow trees to reach this size but this tree shows how even sweet cherry trees will spread when permitted to do so.
The **Hexagonal Plan.** The trees form hexagons with a tree in the center of each. This plan permits 15 per cent more trees per acre than the square plan but this feature is sometimes overrated; with almost any plan the tree roots soon fully occupy the soil. The trees interfere seriously with field operations and it sometimes is difficult to end up with the right spacing.

### Table 2. Number of trees at various planting distances before and after tree removal.

<table>
<thead>
<tr>
<th>Distance in feet between rows</th>
<th>Original stand Trees per acre</th>
<th>After first removal Trees per acre</th>
<th>After second removal Trees per acre</th>
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<tr>
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<td>49</td>
<td>33</td>
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</tbody>
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### PRUNING NEGLECTED TREES

The average neglected tree is a thicket of crowded, twisted, and overlapping branches (Fig. 18). The fruit is small and the crops are irregular. The length of the annual terminal growth is an inch or two which is only a part of what it should be. But fortunately, the trunk of many such trees is sound and the general framework is good. These as a rule can be brought into good production at little cost.

The first job in rejuvenating a neglected tree is to prune it. The amount of pruning needed depends, of course, upon the condition of the tree. As a rule, it is better to take 2 or 3 years to bring it back than to try to do it in 1 year. Too much pruning produces a wilderness of water sprouts.
Bing cherry tree in a crowded orchard. Production is low and picking requires the use of tall ladders. Very little fruit can be picked from a 12-foot ladder. Failure to tree space 10 years ago has been costly.

Quite naturally broken and diseased branches come out first, and if there are weak crotches these must come out too.

In most cases the pruning involved in (1) taking out diseased and broken branches, (2) remedying weak crotches, and (3) taking out tall branches is as much as should be done the first year. If the tree still seems too thick, take out some small branches in the thick areas. Generally most of the detailed pruning should come in later years.

**TREATMENT OF PRUNING WOUNDS**

Removing a large branch from a tree is always a major operation to be seriously questioned because of the danger of decay entering through
FIGURE 18. A Gravenstein apple tree. UPPER.—before pruning. Here we have the result of allowing a tree to grow naturally. The spread is 1 1/2 times the height. Production has been moderate to light because of poor pollination. Even so, note how low and spreading the tree is. The body of the tree is sound and there has been enough early training to reduce the structural branches to a reasonable amount. Note the density of the tree. The need for providing greater exposure to light, particularly to the inside of the tree, has become progressively greater in recent years.

LOWER.—after pruning. A few saw cuts removing branches from 1 to 3 inches in diameter opened up the tree enough to provide reasonably good light exposure throughout the tree. Detailed pruning to eliminate small branches will come later. Note especially that the lower branches were not removed. These will almost touch the ground at harvest time. Note also that the density of the tree after pruning is uniform throughout the tree and that there was no heading.
FIGURE 19. A Bartlett pear tree. UPPER.—before pruning. The lack of both training and pruning is evident. There are too many large structural branches and the tree is tall even though it has never been crowded. Fortunately, the trunk is sound and the wood throughout the tree is alive. Note especially the spread of the tree and the presence of low fruiting branches.

LOWER.—after pruning. The first part of the pruning was to take out one large surplus branch. The cut was made flush with the remaining branch. The removal of this branch reduced the height of the tree and opened up the tree without greatly reducing its capacity. Note that the largest remaining leader was headed to a substantial lateral. Note also that smaller branches, primarily those 3 and 4 years old, were headed also. This heading will invigorate the weakened spurs and aid in fruit thinning. Note that there has been considerable heading. With apple and cherry trees, this amount is seldom advisable.

To provide necessary exposure to light, it was necessary to do considerable thinning also. The thinning was confined primarily to branches 1 to 2 inches in diameter. Further thinning will be necessary in future years, but at present there is about as much exposure to light as can be provided at one time. Quite naturally broken and diseased branches come out first, and if there are weak crotches these must come out too.

In most neglected trees there are several fairly large branches that can be spared. They may be excessively tall or they may be crowded. Sawing these out is fast pruning and removing them “singles out” the remaining branches for need exposure to sunlight and air. Their removal also simplifies spraying and by providing ladder spaces may simplify thinning and harvesting.
the resulting wound. Although large cuts are most undesirable, at times it is impossible to avoid them. Make wounds that heal as rapidly as possible and protect them from checking and moisture during the healing period (Fig. 21). It is reasonable to expect that carefully applied waterproofed material may furnish protection against decay. Obviously the need for protection is greatest in humid areas, although there is considerable evidence of loss in arid areas because of wound decay.

Wound dressing must be durable and nontoxic to living tissue. In addition to such materials as asphalt-water emulsion, white house paint, filtrated

FIGURE 21. Pruning wounds. A.—large wound on a Bing cherry tree. Healing on the lower side was slow because the stub was longer on this side. To have made the cut closer on this side would have meant faster healing but somewhat greater danger from breakage. This sort of cut is dangerous because the remaining branch must support considerable strain. Leaving a 2-foot stub and keeping it alive for several years until the remaining branch adjusts to the loss of the branch lessens the danger from such cuts.

B.—two good pruning wounds on a Delicious apple tree. They were made close and both are healing rapidly.

FIGURE 20. Montmorency cherry tree. UPPER.—before pruning. Thinning is most apparent. Note the height and spread. Note also that the original leader has been virtually choked out.

LOWER (p. 40).—after pruning. Twisting and crowding branches were removed first. After removing these, the tree was still too dense. Branches ranging from $\frac{3}{4}$ inch to 3 inches in diameter were then taken out. Most of the pruning was with a saw; only rarely was the lopper used. Note that there was no heading. Note also that the height and spread have not been changed and that the low branches have been maintained. One large leader going toward the center on the right was removed. Note that the cut was not made flush with the remaining branch. To have cut it flush would have endangered the remaining branch. The stub will be removed with a flush cut 2 or 3 years hence.
C.—a dangerous pruning wound. Healing tissue has not yet started to cover the wound. Instead, the bark at the edge of the wound has started to die and slough away. For rapid healing it would have been necessary to make the cut dangerously close. Devastating decay is inevitable.

D.—wound cavity resulting from a large pruning wound. The way to avoid such tragedy is to reduce the number of leaders to three while the tree is young and to avoid large cuts whenever possible.
E.—a large pruning wound being covered with a pruning-wound dressing.

asphalt paint, Bordeaux paint, and copper resin, there are commercial pruning wound dressings that possess most of the desirable requirements.

Although conclusive scientific evidence indicating the best time for applying the dressing is not available, the best time seems to be when the wound is dry. On this basis, wounds made during the dormant period may be coated in May or June, if not earlier. The extent to which one should go in painting small wounds is a question but it is not considered practical to cover wounds less than 1 inch in diameter.

Wound dressings are effective only to the extent they keep out moisture and rot organisms. They must not only cover the wound but they must also stick to the surface of the wound to keep moisture out. It, therefore, is necessary not only to see that the wound is completely covered at the time of the original application but later also.

**ROOT PRUNING**

Approximately half to three-fourths of the roots are cut off as the young tree is dug from the nursery row. No further reduction is necessary. It is generally believed, however, that cutting root ends torn in digging stimulates better root growth at these points. Removing broken roots by making smooth cuts at the breaks is thought to stimulate more rapid and better healing also.
The tree obtains its plant nutrients and water through its roots. With established trees it would seem then that from the standpoint of fruit production and tree growth, the larger the root system, the better; and that to reduce the root system by root pruning must defeat the purpose of such practices as fertilizing and watering. Such is the case and on this basis root pruning is of practical value only when it is desired to keep trees small. With overvegetative trees it may stimulate fruit bud formation, but because it is difficult to administer the right amount of restraint, root pruning may induce alternate bearing by setting an excessively heavy crop. Couple this hazard with the fact that the resulting tree is smaller and you readily see that root pruning has no place in practical fruit production, except with trees being transplanted.

There are instances where shrubs in particular are inclined to grow too large. It is here that root pruning has a place. The mechanics of the operation necessarily depend upon the circumstances and the ingenuity of the gardener. The pruning may be done by inserting a spade to the depth of the blade in a continuous circle around the plant. How large to make the circle of course depends upon the size of the plant and the amount of root pruning desired.

**RELATION OF PRUNING TO BIENNIAL BEARING**

Pruning, along with fertilization and thinning, determines whether or not the tree bears regularly. Pruning is by no means the only factor but it has a definite influence for or against biennial bearing, depending upon the character of the pruning.

The kind and amount of pruning for trees bearing biennially should vary with the off and on years. On-year pruning should consist of detailed small cuts designed to remove old spur wood and thin the crop. Such pruning, which is essentially a thinning process, reduces thinning costs. Off-year pruning, on the other hand, should consist mainly of saw cuts to space laterals without eliminating spurs any more than necessary.

**MAINTAINING TREE STRUCTURE**

Most bearing trees in Washington have too many leaders. Removing surplus branches is a major operation that must be thought out carefully in order to avoid weakening the tree head. Making the cut flush with the remaining branch may cause breakage at this point, which in some cases can be avoided by leaving a stub 12 to 18 inches long to be cut off with a flush cut 3 or 4 years later. Dwarfing the stub in this way, but keeping the stub alive, reduces the size of the wound in relation to the remaining branch.

**PROPPING USUALLY NECESSARY**

It generally is more economical to prop when necessary than to attempt to eliminate propping by pruning. Propping may be minimized, however, by reducing the number of structural branches. Branches allowed to grow without crowding develop diameter enough to withstand considerable strain; whereas crowded branches grow less in diameter and require extra propping.
The Pear Tree

The delayed open center pattern as described for apples is satisfactory for pears. But with pear trees it is necessary to head the central leader to a side branch rather than allowing it to settle into the position of a scaffold branch.

The usual heading height for strong trees at setting time is about 30 inches. Weak trees are headed lower.

FIGURE 22. A 3-year-old Bartlett pear tree. A.—before pruning. The tree was headed at setting time. The first dormant pruning consisted of some leader selection but very little heading. Note the 2-year-old wood resulting from the light pruning. This tree at 3 years has a sprinkling of fruit buds. The annual terminal growth of the past season was approximately 18 inches. Note the reduced number of structural branches.

B.—after pruning. The third dormant pruning as shown here was moderate to heavy. It consisted of thinning and heading. Note that a strong branch was maintained at the tip of each leader. This branch, which was headed, serves to keep the leaders dominant. Note also that these were reduced to one per leader; otherwise, this would have marked the beginning of twin branches. The one on the lower leader on the right should have been left longer. In fact, this entire leader should have been left heavier. Note especially that there are numerous small branches which were not headed at all.
Delayed heading as described on page 6 offers some advantage over heading at setting time. As soon as growth is well started in the early summer, all except the three leaders may be removed or the headed tree may be allowed to go without any summer training. Selecting the leaders during the first growing season simplifies the first dormant pruning.

**THE FIRST DORMANT PRUNING**

Without leader selection during the first summer, the usual procedure for selecting the leaders during the first and second dormant periods as described for apples is used for pears. But there is more heading with pears than with apples.

![Figure 23. A 5-year-old Bartlett pear tree. A.—before pruning. (The tree was headed rather low at setting time.) Pruning up to the time of this picture consisted mainly of thinning out small branches and a small amount of heading. The thinning was not necessarily directed toward keeping the leaders dominant. Nor did it eliminate surplus structural branches. With five large structural branches present, we must take out at least one large branch. To delay it longer will seriously injure the permanent leaders. B.—after pruning. The central branch in the foreground is boxed in and it fills the center of the tree. The other two large branches on the front side, in comparison, have several strong secondary branches. These are being retained as leaders. Eliminating the central branch frees them of a crowded condition. For the third leader we must go to the large branch in the background. It is really larger than it appears in the picture, and the semi-bench cut of some time ago has not injured it seriously. The fourth and only other large branch is surplus or may be retained as a fourth leader.](image)
FIGURE 24. A 7-year-old Anjou pear tree. A.—before pruning. The tree was headed rather low at setting time. Heading in recent years for the most part was to outside branches. It served to develop spread. The thinning was more or less promiscuous and not necessarily directed toward selected leaders and keeping them dominant. Some leaders have divided so that with some large branches there are now two large branches of equal strength instead of one strong one with good secondary branches. Because pruning up to this time failed to eliminate surplus structural branches, we must now do some further leader selection.

B.—after pruning. As we examine the tree head we see three large branches and three small ones. The large ones are satisfactory for leaders, and to remove any of them would be heavy pruning. They are close together, but as long as the angles are good this is not too serious with pear trees. Taking out the inside branch of the right leader opens up the tree somewhat. This cut, although somewhat benching in nature, is not dangerous, inasmuch as the remaining branch is larger than the branch removed. The leader on the left and in the foreground is puzzling. It was divided when the tree was 2 years old and the resulting two branches have been allowed to grow equally. We now have the job of holding the right one back slightly and developing it into a secondary branch. The other two leaders promise to come along in fine shape but would have been better had the heading been omitted.

The three surplus branches will be taken out gradually in the course of the next 2 or 3 years. Pruning this year included some small branch thinning also, which was directed mainly toward restoring and maintaining the dominance of leaders. Note that there was no heading.
THE SECOND DORMANT PRUNING

Head the uppermost or main branch of each leader at about 24 inches. This branch, of course, is the leader. Allow the others to go unheaded except those that are in a position to dwarf the leader. Heading the leader stiffens it slightly. Take out seriously competing laterals; occasionally it is better to shorten them and leave them temporarily. These temporary branches dare not be confused with the leader, which is headed also but longer. The unheaded branches come into bearing fast and soon settle into a drooping position. The leader then comes into its own and takes the position of a framework branch.

It is now time to select the laterals. The leader, having been headed at 24 inches the year before, has produced by this time several branches 16 to 20 inches from the trunk. Choose one of these on each leader. Those arising from the side of the main branch are preferable to those arising from the top side. In selecting the lateral, give usual consideration to avoiding weak angles. It may be necessary to head the lateral slightly in order to keep it subordinate to the leader. Give constant attention during this period to keeping the leader dominant and to keeping surplus branches from interfering with permanent branches. This does not mean that the tree may not be allowed to become somewhat bushy. The more extra leaf surface you can retain and still keep the permanent branches growing in their proper relationship to each other, the better.

THE THIRD DORMANT PRUNING

Each leader now has one or more laterals; if only one, select another on the opposite side of the main branch and 16 to 20 inches beyond the first one. The laterals headed last year have secondary branches. The 1-year laterals, of course, are whips. Head these only as much as necessary to keep them subordinate to their leader, as was done last year with the laterals that are now 2 years old.

When heading whips or branches, pay particular attention to directing the growth toward the outside of the tree. On the 2-year laterals there are side branches (Fig. 22). Keep these side branches subordinate to their leader by thinning and heading only as much as necessary. Follow the same procedure in keeping the three framework leaders dominant over their laterals. Give some attention also to keeping the three leaders growing uniformly. In general, it is better to hold vigorous branches back by thinning rather than by heading.

By this time we have arising directly from each leader one or two secondary branches, making a total of possibly six secondary branches per tree besides the three leaders (Fig. 23). These are main structural or framework branches. In our 3-year-old tree we now have about as many structural branches as there should be. Down at the tree head, of course, there are only three. Within the next 3 to 6 feet beyond, the number increases to nine.
FIGURE 25. A mature Bartlett pear tree. UPPER.—before pruning. This tree produces approximately forty boxes regularly. Note the mendous spread of the tree which equals its height. There are three main structural branches and some smaller surplus branches that should have been removed earlier. Note especially the new growth in all parts of the tree. Note also the tremendous amount of low fruiting wood.

LOWER. — after pruning. Pruning consisted mainly of thinning small twigs and wood ranging from 1 to 2 inches in diameter. A few but not many of the vigorous twigs were headed. Note how the secondary wood has been singled out for light exposure.
FIGURE 26. A Bartlett pear branch in which pruning consisted mainly of thinning. A. (upper left)—before pruning. Note that of the three large branches the central one is largest. Keeping it dominant retains the other two as well attached secondary branches. Note that these three branches are well exposed to light. As they grow they will not overlap or crowd each other. Note the presence of considerable small twig growth and numerous spurs. Note also the moderate new growth at the ends of the main branches.

B. (upper right)—after pruning. Note first of all that the three large branches were retained in their original relationship to each other. The new growth, both large and small, was thinned considerably. Note that some of the vigorous twigs were headed but that the small ones for the most part were not.

C. (lower)—Bartlett pear branches. The lower one was not headed and is still horizontal. The upper one, headed after it had started drooping, now has knots of new fruiting wood.
FIGURE 27. Bartlett pear tree in which pruning consisted mainly of heading. Note that all of the new growth has been headed. Note also how much wood was removed. Special attention is given to selecting and spacing the wood when this system is used. There is some question as to whether the amount of forcing which follows this sort of pruning is desirable because of resulting blight hazard.
FIGURE 28. A branch from a bearing Bartlett pear tree, in which pruning consisted mainly of heading. UPPER.—before pruning. Last year everything but a whip was removed and it was headed at about 1 foot. Note that it is now loaded with branches ranging from 1 to 3 feet in length. Retaining the whip last year and heading to 1 foot, in contrast to cutting it shorter, increased the amount of structural wood of this branch.

LOWER.—after pruning. Obviously the pruning here consisted of complete and severe heading accompanied by some thinning. Of the two large whips at the end of the main branch, one was removed and the other was headed. Note that it was left longer than other whips on the branch. It might have been left even longer as a means of increasing the capacity of the tree faster. Note that there was considerable thinning as well as heading. Next year the headed whips will be loaded with spurs.
There is little to be gained by further heading. The lighter the pruning from now on, the better. Prune only as much as necessary to eliminate weak crotches and to keep the leaders growing somewhat uniformly (Fig. 24).

**PRUNING BEARING PEAR TREES**

Our chief concern now is to develop and maintain good fruiting wood. As with other fruits, the tree must be kept in good vigor. Trees making an annual terminal growth of 10 to 18 inches are in about the right state of vigor (Fig. 25).

Color, of course, is not a factor, but pruning in a way that exposes the fruiting wood to sunlight and prevents rubbing means better fruit quality. Training and spacing structural branches during early years favors the development of healthy branches. As the tree gets older we need only to keep the larger wood from becoming too dense and to follow up with some detailed pruning. This pruning involves retaining lower branches so that the producing wood extends from 2 to 3 feet from the ground to the top of the tree, rather than from shoulder high to the top of the tree. Quite naturally pruning consists of thinning twigs, branches, and spurs and heading some twigs (Fig. 26). It is necessary to thin out a good many twigs, particularly those in the sap flow areas. Here and elsewhere where the twigs are inclined to develop into objectionably large branches before they form fruit buds, it generally is advisable to remove them and leave the smaller branches. Occasionally where large branches need extension, large twigs may be retained and headed at about 12 inches for this purpose. The small twigs need no heading. Pruning the bearing tree, therefore, consists mainly of twig, spur, and branch thinning with occasional twig heading.

Spurs as a rule are not desirable for more than about 6 years. At this age they begin to show signs of weakness. Spur thinning consists simply of removing the weaker ones and spacing the others for light and renewal.

After about 4 years (Fig. 26), unheaded wood starts drooping. Heading it, by forcing new wood, keeps it in production.

Fortunately, pear trees withstand extremes in pruning (Fig. 27). Extremes within the state vary from no pruning to cutting back every terminal twig. Obviously the latter develops an abnormal condition. Trees so pruned respond with a tremendous growth of succulent wood and greater susceptibility to fire blight. This heavy pruning is thought also to make premature dropping somewhat more critical but has the advantage of producing crops regularly and maintaining a supply of good fruiting wood (Fig. 28).