PRUNING FRUIT TREES

BY WENDELL PADDOCK

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Pruning Fruit Trees.

By Wendell Paddock.

Handling Young Trees:—The writer has been impressed, when visiting the various fruit districts of the state, by the lack of knowledge on the part of many growers of the requirements of young trees. No doubt a large majority of our fruit growers come to the state with no experience in the business and so have everything to learn, and surely no part of orchard management is more important than to start the young trees just right. On this depends not only the future usefulness of the orchard but in many instances large numbers of young trees fail to live through the first season for the simple reason that the trees were not properly started. In several instances the Experiment Station has been asked to investigate the cause of the dying of newly planted trees, and on visiting the orchard it was found that the trees were planted just as they had been received from the nursery. No doubt some of them had been injured somewhat by exposure and improper care but with the best of treatment it is difficult for the mutilated root system of a transplanted tree to establish itself and at the same time support a vigorous or overgrown top.

It is not generally realized that when a tree is taken from the nursery row, a large portion of the root system is left in the ground. The balance between the roots and the top is thus destroyed and obviously a part of the top should be removed. Practically all of the elements which nourish and build up a tree, save one, are taken from the soil by the roots in liquid form. This material is carried in the cell sap mostly through the outer sap wood to the leaves. Here the crude food is changed by the influence of the sun light and the green substance of the leaves to a form that can be readily assimilated by the plant. This will illustrate, briefly, how important the roots are to a plant. Much of this elaborated food may be stored in the cells, especially in the fall, to be drawn upon at any time that the roots fail to supply the requisite amount. In transplanting, the nursery tree is often deprived of one-half or more of its roots, and not only must it become established in the soil but it must produce a large number of new roots before much new food can be supplied. In the meantime the leaves begin to push out
and the reserve food and moisture may all be used before the root system is in a condition to supply more.

Is it any wonder, then, that the failure to cut back the tops of newly planted trees results in the death of many of them? This is especially true in Colorado as the dry air and intense sunshine cause the young trees to dry out rapidly.

It is also true that many nurserymen, as well as fruit growers, are careless in handling trees before they are planted. Not infrequently the roots are exposed for hours to the drying action of wind and sun. One must take the chances of such treatment from the nurserymen but after the trees have been received by the grower there is no excuse for neglect in this respect. The trees should be heeled in deeply at once in damp soil and when planting the work should be so arranged that the roots of each tree shall be exposed to the air for the shortest possible time.

All bruised and torn roots should be carefully removed, leaving smoothly cut ends which will readily heal; if this is not done decay is apt to set in which may seriously injure the tree. Long straggling roots may well be shortened and if a tangled mass of fine roots are present they should be shortened and thinned. Some successful growers also insist that where large spreading roots occur a slanting cut should be made so that the cut surface may rest flat upon the ground.

It would seem to be almost superfluous to insist on the importance of having all nursery stock inspected by the County Inspectors, yet there are a few who try each year to evade the law in this respect. There are several insect pests and plant diseases, which are very common on young trees, all of which may be easily overlooked by anyone who is not thoroughly familiar with them. The woolly aphid is such an insect and it is doing a great amount of damage in all sections of the state. This insect lives on the roots of trees and is introduced to our orchards almost wholly by infected nursery stock. When once established it spreads rapidly and is almost impossible to eradicate. Crown gall is a common disease in many nurseries and it attacks all kinds of fruit trees. It is the worst kind of folly to plant a tree which has a trace of this disease, for not only is the tree pretty sure to die before it comes into full bearing but the infection may be spread by the cultivator or in the irrigation water to all parts of the orchard. A statement made in a former bulletin on the subject of inspection will bear repetition here:

"All possible assistance should be given the County Inspectors in their inspection of nursery stock. In counties where many trees are being planted, sufficient assistance should be provided, so that there will be no possibility of any shipments being overlooked. And finally some means should be devised whereby the importance of inspection can be impressed on the growers since, in some instances, they antagonize the in-
spectors and hinder their work. It is no doubt true, that the inspection of nursery stock alone, if well done, pays many times over for all the expense incurred, even in those counties which expend the most money in orchard inspection.

But in those counties where several hundred thousand trees are planted each spring the inspectors are so rushed with their work that the most careful men are liable to overlook an occasional infected tree; therefore no grower can afford to be unfamiliar with these common pests. Each tree should be reinspected as it is planted and to make the work thorough, the roots should be dipped in water so as to remove any dirt which might conceal small galls or a few aphids.

In this discussion it is presumed that the planting is done in the spring as this is nearly the universal practice in this state.

It should also be stated here that the requirements of apple trees have been foremost in mind in the following pages. The same principles will apply, however, to all of our other kinds of fruit with the possible exception of the peach. A short discussion of the special requirements of this fruit is given at the end of the bulletin.

The proper formation of the top is by no means the least important reason for cutting back the branches of newly planted trees. In the first place the importance of low headed trees for his climate cannot be too strongly emphasized. Hundreds of trees are dying in all parts of Colorado because of the exposure of the long trunks to the afternoon sun, either directly or by reflection from hot dry soil in summer or snow in winter. Young trees are specially liable to injury which results in early death or a weak, sickly growth from which they never recover. There is less injury from sun scald in the humid states, but in these districts many authorities are advocating lower headed trees.

In addition to forming low heads there can be no question but that it pays to still further protect the trunks of newly planted trees from injury by sun scald. Various devices are used, such as wrapping the trunks with burlap, paper, straw, wood veneer, or by shading the trunk on the southwest side with a thin piece of board set pright in the ground. Whitewashing the young trunks to serve the same purpose has come to be extensively used in portions of California. Whatever method is adopted, it should be applied soon after the trees are planted and kept in good condition through the second winter or until the shade of the trees becomes ample.

The advantages of low headed trees may be mentioned as follows: Greater ease in picking, thinning, pruning and spraying and less damage to trees and fruit from winds. Some growers object to low headed trees on account of the greater difficulty of cultivating around them, but with proper pruning low headed trees develop ascending branches as shown in plate I. There is not the slightest
difficulty in working around the trees in this orchard, whereas the branches on high headed trees commonly droop after they have borne a full crop of fruit and so interfere with all orchard management.

The following extract is taken from Prof. Bailey's Pruning Book:

"The relative merits of high or low heads for fruit trees are always in dispute. This controversy is partly the result of confusion of ideas and partly of differing mental ideals and of varying climates. Two factors are chiefly concerned in these disputes—the question of ease of cultivation, and the question of injury to the trunk by sun-scall. It is the commonest notion that short trunks necessarily make low heads, and yet any one who can see a tree should know better. The number of trunks which a tree has does not determine the direction of the leaf-bearing limbs. This tree (referring to illustration) can be worked around as easily as if it could be if it only had one long trunk. In fact, branches which start high from a trunk are very apt to become horizontal and to droop. There must be a certain number of scaffold limbs to form the head. If these limbs are taken out comparatively low, they may be trained in an upright direction and hold their weight and position. If they are started out very high they will not take such an upright direction, because the tree will not grow beyond its normal stature. High trained trees are often practically lowest headed."

Form of Tree.—The business of orcharding is not old enough to have developed systems of pruning which may be said to be characteristic of the state. The conditions existing in the fruit districts have been so favorable for the production of fine fruit that the growers have not felt the need of the finest development of the art. We have grown fine fruit whether we would or no. But now that competition is more severe and insects and diseases are multiplying more attention must be given to methods and systems of culture.

In pruning trees one of two ideals must be adopted, which are known as the pyramidal and vase forms. The former preserves the leader, which is made to form a central shaft to the tree. This style has the advantage of more bearing surface, as the leader grows and in time forms a "two-storied" tree. The objections to tall trees are apparent and need not be discussed here. The leader is don away with in the vase form and a few limbs, usually not more than five, are selected to form the top. A more or less open center tree is thus formed, but by skillful pruning this space is occupied by branches of bearing wood. Very tall trees are thus avoided, but what is more important, such trees are not so apt to be destroyed by blight, as recently pointed out by Mr. Waite. Death to trees result when the blight germs gain entrance to the trunks and large limbs. Such attacks are usually brought about by the presence of small limbs, water spouts or fruit spurs, which become diseased as which the germs follow till the main trunk or branch is reached. Should the leader of a pyramidal tree be attacked seriously enough to necessitate its removal the tree would be ruined, but by havin
several main branches or trunks one of them might be spared without seriously crippling the tree. But the protection may be carried still further by keeping the main branches of the vase shaped tree free of all small limbs and fruit spurs which are so susceptible to attacks of blight.

**SHAPING THE NEWLY PLANTED TREE.** — The term low headed, is a relative one, but a top may be considered low when the first branch is thirty inches from the surface of the ground. Some of our successful growers prefer higher heads than this, while others start them lower. Our own preference is for a trunk about twenty inches in height. But whatever height is determined upon, the tree must be cut back preferably, just after it has been planted. Should the tree be supplied with suitable limbs at the point where the head is desired three to five of them, properly spaced, should be selected to form the frame work of the tree. The rest are removed. The selected branches should then be shortened in to a sound bud within a few inches of the main stem. But ordinarily the lower branches are pruned off in the nursery so that we seldom get a tree from which suitable branches may be selected. **In this case the entire top should be removed without regard to branches, making the cut a foot to eighteen inches above the point where the lowest limb is wanted.** In doing this it is expected that branches will push out below in sufficient numbers so that suitable selections may be made. For this reason strong yearling trees are always preferable to older ones and in fact apple trees of this age are now commonly used in California. Should suitable branches fail to grow, one of the lower branches which nearly always form, must be developed to form a new head.

The trees should be gone over several times during the first summer to remove surplus shoots and especially those which push out far below the point where the lowest branch is wanted. Occasionally some of the upper branches develop a vigorous growth at the expense of the others. These should be headed back so as to give all a chance to develop, otherwise some of the important scaffold limbs may be found to be very weak at the close of the season.

When a branch is headed back great pains should be taken to make a slanting cut just above a sound bud. If made too far above the stub will die back at least as far as the bud, and often farther. If made too close, the bud may be so injured that a stub is formed which will die back at least to the next sound bud.

As soon as the trees are planted, then the top should be cut back as described above. Ordinarily a profusion of branches will be pushed out which may be allowed to grow as they will during the first season or they may be cut back to one or two buds. By the time these branches begin to grow the roots are established in the soil and new ones formed so that an adequate supply of plant food is
provided. It will be remembered, however, that the plant cannot use this food until it has been made over in the leaves. It is for this reason that a large leaf surface is necessary and it is also desirable in that the shade forms a protection from the sun.

The kind of top which the tree is to assume is developed with the first season's pruning, which should be begun in most sections not earlier than the first of March. This is true for the reason if done earlier a longer time must elapse before the wounds can heal and necessarily the cut surfaces are exposed that much longer to the drying action of the sun, wind and frost. It is commonly understood among orchardmen that trees must not be pruned when the wood is frozen. Pruning when the trees are in this condition often results in bad wounds and the dying back of branches, but this result is probably due to the agencies just mentioned rather than to the fact that the wood was frozen. In any case the rule is a good one to follow. Then, too, there is always more or less danger from winter killing after early pruning is done so that the trees would need to be gone over a second time.

From three to five limbs are now selected to form the framework of the tree which should be cut back about twelve inches from the trunk. The rest are removed. If the lowest branch has been taken out at twenty inches from the ground, the highest branch should be at least a foot above; two feet would be better. A common mistake is to cut trees back too far thus crowding the branches as shown in plate I. Neither were these branches thinned out nor headed in during the first season but were all allowed to develop into leaders. This latter mistake often results in long willowy branches which droop with a load of fruit and is the main reason for condemning low headed trees. Many growers carry their pruning up to this point successfully, but fail to head in the first season's growth and so miss one of the critical points in the proper formation of the top.

It is a common notion that the branches gradually get higher from the ground as the tree continues to grow. The apparent gain in height is due solely to the increase in diameter of the limbs which soon begin to crowd if sufficient space has not been left between them. The centers of the limbs will always remain the same distance apart, so in forming the head one should have in mind what the appearance of the limbs will be when they have attained a diameter of six or more inches.

SECOND YEAR:—It may be regarded as a rule, that when a limb is cut back, unless the cut is made just above a strong lateral, two or more branches will develop near the cut end and some of the buds lower down will develop into shoots. The usual practice is to allow two of these to grow on each of the previous years limbs to form additional framework for the tree. The two selected should
PLATE II. YOUNG APPLE TREES WELL HEADED IN.
be some distance apart, one at the end and one farther back, and so placed that the development of crotches will be impossible. They are now cut back from a half to two-thirds of their growth and the laterals are shortened to one or two buds so that they may later develop fruit spurs and also shade the branches with their cluster of leaves. If too many have formed, some of them should of course be removed. On the other hand if we are to develop Mr. Waites' idea of making the tree more resistant to blight these laterals should all be removed and so carry the fruit bearing wood farther away from the trunk and main branches.

Some growers object to heading in trees at all, for the reason that all of the buds are likely to develop into branches and so the formation of fruit spurs is retarded and the surplus branches must be cut out. But it is highly desirable that all of the buds should develop and then by heading them back to spurs, as just mentioned, the formation of fruit spurs is largely under control of the pruner.

Any tendency toward one-sidedness may to some extent be corrected and open spaces filled in by selecting branches that are already growing in the general direction of the vacancy. Then by cutting to a bud, which is on the side toward the opening, such faults may gradually be overcome.

Third Year:—The frame work of the tree should now be well formed so that it will require less attention from this time on. Surplus branches and those that rub or are inclined to form crotches should be removed. Very vigorous growths should also be headed in.

Thus far our discussion has been confined to the shaping of open or vase formed trees. If a leader is desired, the treatment is practically the same, except that the upper shoot is allowed to grow with little heading in. Branches are allowed to develop on this leader at proper intervals, using the same care as to location, pruning and development as in the former case.

A discussion of some photographs of actual experience in pruning young trees will help to review and fix the points of the different stages of pruning in mind. These were second grade trees and were evidently three years old when planted. The lower laterals had all been pruned away in the nursery so that the tops were much too high for Colorado. There was also difficulty in getting branches to form at suitable places from which to make the selections for the head. However, the results are much better than as though the tops had been left as received from the nursery as is so often done.

The trees in figures 1, 2 and 3 were all headed back to about 24 inches in April, 1904. This left them mere stubs. Had there been any laterals below this point they would have been pruned back to single buds so that clusters of leaves might have formed and thus provided some shade for the trunks. These pictures show
how the trees looked in April, 1905, at the time of the first pruning. No. 1 had formed five vigorous branches, No. 2 produced four and No. 3 but two.

The five branches on No. 1 were saved to form a framework for the tree and were cut back to about one foot in length. These are well distributed about the trunk, but have the fault that they are too close together. The lowest limb might well be double the distance from the top that it now is. No. 1a shows No. 1 after it was pruned, with the idea of making an open-centered tree.

No. 2 is also open to the objection that the limbs are too close. All of these were saved to form the framework of a tree with a leader as is shown in No. 2a. The only difference between this and No. 1a being that the topmost branch was left longer than the others. The pruner of this tree is open to severe criticism in that he has allowed three vigorous limbs to grow from near the surface of the ground. These limbs could serve no useful purpose and so only rob the other limbs of plant food. Such growths are best prevented by pinching off the buds early in the season.

No. 3 failed to throw out enough branches to form a suitable top. The two which were produced are nearly opposite, so that a bad crotch would soon result. Both branches were cut back to the second bud, as shown in 3a, in the hopes of inducing dormant buds to push out lower down.
No. 4 shows one of this lot of trees that was left unpruned. Notice the weak spindling growth and short laterals as compared with the others. There is small chance of making a decent tree out of such a specimen even though it should live. Such illustrations as this, which may be seen on every hand, should prove to any one that all trees should be headed back when planted, if for no other purpose than to induce a vigorous growth.

At the close of the season of 1905 the pruned trees had made a growth respectively as shown in 1b, 2b and 3b.

Pruning should, of course, be done in late winter or early spring, but these trees were pruned for the purpose of illustration and the results are shown in 1c, 2c and 3c. Tree No. 1 has now taken the form shown in 1c. One of the scaffold limbs seemed superfluous so it was removed and the new growth, shown in Fig. 1b, was cut back about one-half. The few side shoots were cut back to a single bud with the idea of developing fruit spurs. During the season of 1906 numerous branches should develop on all of these scaffold limbs. As a rule two of the best placed of these secondary limbs will be selected on each of main scaffold limbs to form additional framework. The rest may be removed or cut back to develop fruit spurs as may se
The form of the tree then, should be developed at the beginning of the season of 1907 and subsequent pruning should be directed toward retaining this shape, cutting back excessive growths and thinning and renewing the bearing wood.

The pruning of tree No. 2 is much the same, except that a leader is being developed. Fig. 2c shows that although the top was cut back the same as Tree No. 1, the topmost branch is developing into a vigorous central shaft. The first set of scaffold limbs have been formed and a second set is to be developed at a suitable distance above. The new growth is to be cut back the same as has been described.

The tree shown in the series 3–3c is, so far, pretty much of a failure. The severe heading given it in the spring of 1905 failed to make branches develop lower down. It would have been a better plan to have inserted two or three buds at suitable points around the main stem in June, 1905. This can probably be done next June, but the chance for success is not so great. Limbs can be developed by this means just where they are wanted, but the average person will succeed better with trees which do not require such manipulation.

Pruning Bearing Trees.—The form of the young tree should be well established after the third season. From this time on the question of pruning is simply to retain so far as possible the
form we have started, to prevent the formation of crotches and cross branches, to thin out an excess of branches so that sunlight may be admitted and the amount of bearing wood reduced and renewed.

One of the peculiar effects of high altitude, with the accompanying sunshine on plants, is that it induces fruitfulness and early bearing. Many varieties of apples produce paying crops when the trees are six years old and the tendency of young trees to overbear annually is pronounced. We therefore are rarely obliged to prune to induce fruitfulness. Should such an occasion arise, the following should be borne in mind: Prune in summer to induce fruitfulness and in winter to promote wood growth. This is true for the reason that summer pruning checks the growth of the tree by removing a portion of the leaf surface. An injury of any kind will have the same effect, likewise a weak growing or sickly tree should be severely headed in while still dormant in order to induce a vigorous top growth.

Thin out the top then every year. No general rule can be given as each tree presents a different problem. A thick growth of branches results in weak bearing shoots and spurs. And finally when cutting back limbs on bearing trees the cut should be made just above a strong lateral wherever possible. The tendency of the sap will be to flow into the lateral and thus prevent the formation of numerous branches which nearly always results when a so-called stub-cut is made.

A number of our best varieties of apples are apt to develop long slender branches which may bend and rest on the ground and indeed it is not uncommon for such branches to break under a load of fruit. Some of these kinds like the Wine Sap are very apt to overbear periodically as they get older, often to such an extent that the branches are broken down with a load of undersized fruit. It may take such trees two seasons to recover from the effect of overbearing, but the third year the process may be repeated. A severe heading in and thinning out of the branches would largely correct these faults, and make it possible for the trees to bear annual crops of fine fruit.

But one should become well acquainted with the habit of growth of different varieties as a few kinds grow slowly and will not bear heavy pruning. Others are erect growers and some are spreading. One cannot expect to entirely overcome such tendencies but they may be corrected to a marked degree. The upright varieties may be spread somewhat by pruning to the outside laterals and the spreading kinds may be contracted by cutting to those which have an inward direction. And by cutting back the vigorous growths each season, those two feet and over in length, the limbs are made stocky thus in great measure doing away with drooping branches. However, we believe, that under our conditions, it is advantageous
in many ways to keep trees from becoming very tall. This can only be done by intelligent annual pruning. In Plate II. is shown a photograph of a successful young Colorado orchard that has been severely headed in.

Thus far our discussion has had to do entirely with apple trees. The same principles apply to most of the other fruits with the exception of those like the peach which bear fruit on last season's wood. The pear is pruned much the same as the apple, as are also the blue or domestica plums. The latter should be headed lower and they require much less attention after the character of the top has been formed. The sour cherry and red or cultivated varieties of American plums require almost no pruning. The tops should be very low.

**Pruning the Peach.**—Peaches are borne on wood of the preceding year's growth, consequently the training from the beginning should be somewhat different from that given our other common fruit trees. The importance of peach growing in the state will warrant a brief description of methods of training and pruning.

We must have the tops low, twelve to eighteen inches of clear trunk being ample. In fact the trees in some of our best orchards are headed just above the surface of the ground. For this reason medium sized, well grown yearling trees are always preferable to two year old trees, or to overgrown trees of the same age. The limbs on large trees are nearly always cut off from the lower portion in the nursery so that it is rarely possible to make branches grow where they are wanted by heading back.

Take for example a nursery tree that is provided with suitable laterals for forming a top. As soon as the tree is planted, cut the top back to from twenty four to thirty inches from the ground. Then reduce all of the laterals to spurs of from one to three buds. Many of the remaining buds will soon start into active growth so that a large number of small shoots result. The foliage will not only protect the trunk from the sun but a large leaf surface is necessary for the preparation of plant food. The second spring after planting the trees receive their first pruning and the formation of the top begins. Select from three to five of the strongest and best placed branches to form the frame work. If the lowest one is fifteen inches above ground the upper one may well be twelve to fifteen inches higher. The intervening ones should be well spaced between and symmetrically arranged around the stem so that there will be no open spaces, one-sidedness or crotches. These limbs, no matter how vigorous their growth may have been, should be cut back a half or two-thirds of their length, while all of the rest are removed entirely. By making these main limbs short they become stout and stocky and the load of the matured top is borne close to the central trunk so that the strain is materially lessened.
Should the nursery tree be lacking in laterals at the proper height the top must be cut back anyway if we are to have a low head. If the lower laterals have been pruned away in the nursery there will be difficulty in securing branches from which a well balanced head may be formed. One must take this risk. Should suitable branches appear they are headed in as above. If no branches at all are pushed out where wanted, or those that are formed are so situated as to make the tree very much one-sided, a branch from near the surface of the ground will nearly always develop, which can be used to form a new trunk and top. This should be treated the same as a newly planted tree and in three or four years it cannot be told from the rest.

During the second and third years the pruning and trimming does not differ materially from that already described. The laterals should not be too thick, but enough should be left to produce a good bearing surface low down. The trees should be pruned each year from now on, heading in the main branches and vigorous laterals from a half to two-thirds of their growth and thinning out laterals where too thick. Always head back to a good lateral wherever possible and so prevent the growth of surplus shoots. In any case, short branches should be encouraged to grow low down on the trunk and branches to provide protection from the sun.

It is a mistake not to keep the branches on peach trees well cut back, for if this is not done and the laterals which produce the bearing wood grow farther from the body of the tree each year, which finally results in long, bare branches with a tuft of bearing wood at the end. Neither should the attempt be made to cut the branches back evenly all around the tree, but each branch should be considered as a separate problem.

Should trees become too tall to be handled to advantage, new tops can be secured by cutting back all of the limbs at the time the pruning is usually done. A luxuriant growth will push out from these stubs so that but two seasons of fruit bearing will be lost.

Precaution needs to be taken, however, not to cut off too large limbs, especially on old trees. Neither should a small limb be cut back too close to its junction with a large limb. Perhaps the best results will follow if none of the limbs are larger than two inches in diameter at the point where the cut is made. The stubs should be left from about two to four feet in length, depending upon the age of the tree, the size of the limb and its location. Too severe heading in may easily result in the death of the tree.