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Transplanting Fruit Trees

Pruning the roots of a 2-year-old apple tree just before transplanting

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This publication is a digest and popular revision of Research Bulletin 33, Missouri Agricultural Experiment Station, by the late J. C. Whitten, Professor of Horticulture. For the most part and whenever possible direct quotations have been made, in order to preserve the style and forcefulness of the author. Due, however, to rearrangements, additions and eliminations, which have modified or changed the meaning to a greater or less extent in some instances, quotation marks have been omitted.

Transplanting Fruit Trees

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ABSTRACT.—Experimental investigations of the season of transplanting and the subsequent effect upon fruit trees have received little attention by investigators. Spring planting is preferable toward the north, while fall planting is generally considered best toward the south, due to the difference in climatic conditions. Fall planted hardy fruit trees and most hardy deciduous shrubs have given better results under Missouri conditions than when spring planted. Sour cherries suffer no appreciable mortality when planted in the fall. Early fall-planted trees begin root growth no sooner than late fall-planted trees. Root formation starts about the first of January and proceeds slowly throughout the winter, below the frost line. There is no advantage in a winter mulch in Missouri orchards. Young apple trees should have their branches pruned back as soon as possible after transplanting. Autumn wounds stimulate greater growth than spring wounds. Spring transplanted trees should be set no deeper than they stood in the nursery, while trees transplanted in the fall may be set from one to one and one-half inches deeper.

The season of transplanting, as a factor affecting the subsequent development of fruit trees, appears to have been the subject of comparatively little experimental investigation. Some of the best horticulturists hold conflicting opinions as to the time of most successful transplanting.

Those who express a preference for fall planting, emphasize the desirability of planting in very early autumn, for the alleged reason that it gives time for the roots of the tree to become better established before cold weather approaches. Experience at the Missouri Agricultural Experiment Station shows that this does not hold true under Missouri's conditions.

THE DEVELOPMENT OF FRUIT TREES AS INFLUENCED BY SEASON OF PLANTING

It is the usual custom of most fruit growers to transplant their trees in the spring. Possibly this custom may be the outgrowth of the opinion among early agriculturists that "the spring is Nature's time to plant." While spring transplanting is most largely practiced, practical experience has shown that most deciduous trees may be successfully planted at almost any time during their dormant period when soil and climatic conditions are at all favorable.

There is some conflict of opinion as to the most favorable season for transplanting fruit trees. Reference to the leading manuals on this subject shows that in both Europe and America a minority prefer fall planting. Some express no preference between fall and spring. Those who prefer fall planting usually emphasize the desirability of planting in very early autumn for the alleged reason that it gives time for the roots of the tree to become better established before cold weather approaches.

A careful classification of these expressed opinions, based upon the climatic conditions at the source of each, reveals a very interesting fact which apparently has not been adequately considered. It is found that those who recommend spring planting base their opinions upon experience in severer climates, while those who recommend fall planting base their advice upon ex-

perience in the milder fruit-growing sections. Careful consideration of the foregoing fact suggests that spring planting may perhaps be preferable toward the north and fall planting toward the south.

The abundant experience of practical fruit growers may seem to be an adequate basis upon which to decide this question for a given district. However, emphatic opinions differ, even among fruit growers of the same neighborhood. In view of these differences of opinion among practical growers, and in view of the fact that definite experimental data seem to be inadequate, it is difficult to satisfy the question as to the best season for transplanting for Missouri orchardists. For this reason, observations of the behavior of fall and spring-set trees were begun at the Missouri Experiment Station about twenty-five years ago. Frequent visits were also made to large commercial orchards which contained both fall and spring-planted trees. These observations revealed evidences that fall planting was to be preferred. Consequently, definite experiments were begun in 1908 with a view to recording accurately the results of fall and spring planting, and, if possible, to determine the reason for any difference in the behavior of the trees.

These experiments have yielded results that should prove of vlaue to Missouri orchardists. Additional questions in connection with transplanting, such as the depth to plant, orientation of the tree, mulching, shaping the tree at transplanting, etc., have arisen and have been given attention.

FALL AND SPRING PLANTING

Sour Cherries.—In Missouri it has been customary to plant sour cherries (sweet cherries are not generally grown in the state) and other stone fruits, in the spring. They are regarded as being the most difficult of our orchard fruits to transplant successfully. Planted in the spring, often from one-third to two-thirds of the trees die. This large mortality of cherry trees necessitates repeated replanting before a full stand of trees is secured in the orchard.

Repeated spring plantings of sour cherries at the Experiment Station have usually resulted in similar mortality of the trees. Only in occasional seasons, when soil and weather conditions were favorable at the time of planting, and when well-distributed rainfall kept the soil neither too wet nor too dry throughout the summer, has spring planting resulted in a good stand of trees. If the summer is too wet, the trees seem to thrive no more successfully than during summer drouth. The roots of sour cherries apparently require a moderate but constant supply of moisture in a well aired soil but suffer when the soil is saturated with water, which shuts out air for any great length of time. This is especially true of young cherry trees recently transplanted.

The occasional fall plantings of sour cherry trees, made at the Experiment Station, have uniformly resulted in a good stand of trees. Sour cherries set in the fall have uniformly transplanted as successfully as apples or other fruits.

The trees set in the fall of 1913, transplanted successfully, all of them making fine growth the following summer. They produced a good crop of fruit when six years of age. Two-thirds of the trees set in the spring of 1914, which started growth died before mid-summer. The spring planted trees which lived through the first summer made a fairly good growth but had not quite caught up in growth and vigor with the fall-planted trees seven years later.

The average annual twig growth of the fall-set trees exceeded that of the spring-set trees which lived, in the proportion of 74.8 inches to 32.7 inches. Since two-thirds of the spring-set trees died before they made appreciable growth it is evident that the one-third which lived were the strongest growing specimens of the spring-set lot. If these are compared with the one-third of the fall-set which made the strongest growth the relation is 99 inches average length of twig growth, and 10/64 inches average diameter increase, for fall-set trees; and 32.7 inches length growth and 4/64 diameter increase, for spring-set trees.

Peaches.—In Central Missouri peach trees prove to be planted more safely in spring than in the fall. If a severe winter follows autumn planting of the peach, often the trees are killed. Even in milder winters the wood is usually injured sufficiently to turn brown within. With such injury the trees frequently die and at best make poor growth.

Peach trees which have a well-established root system usually recover from such winter injury if their roots remain undisturbed and if they are properly cut back. The root system of young peach trees, even in the nursery, is rarely injured by the coldest winters in Central Missouri, providing it is allowed to remain undisturbed. Fall-transplanted peach trees do not establish sufficient root system to winter safely. Even their root system is usually injured and if the winter is severe both tops and roots are usually injured beyond recovery. In the southern counties of the state, however, peach trees are frequently transplanted in the fall with good results.

Plums.—Japanese plums and other slightly tender species subject to winter injury in this section are more safely planted in the spring.

Pears.—Pears and hardy plums apparently profit by fall planting to about the same degree as do apples.

Persimmons and Native Nut trees.—Persimmons, native walnuts, chestnuts, hickories, and pecans have been transplanted at various seasons of the year. The best results have been secured by planting these species just as their new leaves are pushing out in spring. They do not transplant successfully when fully dormant, either in fall or early spring.

Ornamental Trees and Shrubs.—In the development of the University grounds, during the last twenty years, large numbers of ornamental trees and shrubs—both deciduous and evergreen—have been set at various seasons of the year. They have been set when and where they were needed for ornamental purposes rather than to determine the most favorable season for transplanting.

The results of this general experience, however, may have some value, especially to those who have not had opportunity for extensive observation of the results of planting at different seasons.

Thoroughly hardy deciduous trees and shrubs (with the exception of persimmons and nut trees previously discussed) have usually made better growth when transplanted in late autumn. If the soil is very dry in autumn, as occasionally happens in Missouri, transplanting may be more safely postponed until early spring.

Slightly tender deciduous species, including magnolia, tulip (or yellow poplar), vitex, sweet gum, and some of the soft wood species whose twigs tend to shrivel and dry out in severe winters, are safer planted in the spring. The best time in spring is not yet fully determined. It may vary with the individual

species. Magnolias have done best if transplanted during their early blossoming period; the tulip trees and sweet gum just as their buds were bursting; and most other species before their buds start growth.

Evergreens. The best season for transplanting coniferous evergreens is a vexed question, especially in the central west where fluctuations in weather conditions are very extreme. The evergreens are difficult to transplant. This is no doubt due to the fact that they carry their leaves throughout the year and consequently evaporate water through these leaves, as opposed to deciduous trees in which evaporation is greatly reduced during the dormant period. The roots of evergreens cannot endure brief exposure to the air without severe injury. For that reason their roots should be protected with moist soil, wet burlap, or other moist packing, at all times while being handled.

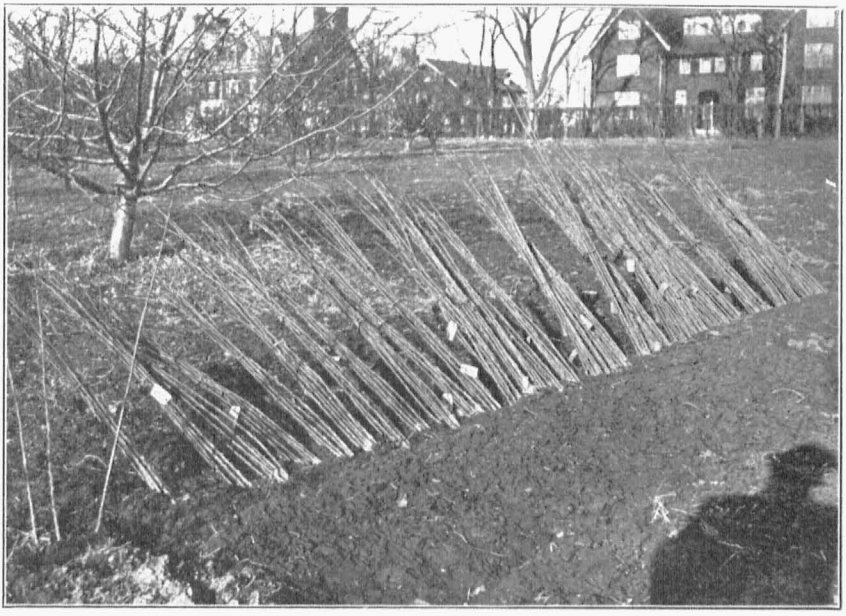

Fig. 1. Apple trees heeled-in temporarily, awaiting weather and soil conditions favorable for ransplanting in the orchard.

There is perhaps not a month in the year that has not been recommended as the best time to transplant evergreens for certain localities. At the Missouri Experiment Station evergreens have been transplanted in late spring just as new growth was beginning. The next most favorable time has proved to be in early fall, after growth has ceased, but before the trees have matured their growth for winter.

If the soil is moist and the atmosphere is humid, early autumn planting gives good results under Missouri conditions. If the soil and air are dry in autumn, as is often the case, planting should be delayed until growth starts in spring.

ROOT FORMATION OF EARLY AND LATE FALL PLANTED APPLE TREES

The chief advantages ascribed to fall transplanting of deciduous trees are that the soil becomes thoroughly settled about their roots, that the wounds at the ends of the cut-back roots become calloused over, and that the new roots may be formed before the trees leaf out in spring. Practically all of those who favor fall transplanting have advised that the work be done as early in autumn as the trees are in condition to move from the nursery, in order that their roots may become established before the ground freezes. It seems to have remained an unsettled question, however, as to what extent the success of fall planting may depend upon callousing of the wounds or the formation of new roots before winter sets in. To just what extent the new root system does become "newly established" in the fall has been a matter of doubt. In view of the fact that late fall planting has given better results than early fall planting at the Missouri Experiment Station it is of interest to compare the root development of early and late fall-set trees.

The first new root growth, on fall-transplanted apple trees, was observed from late December to early January in different years. In each case the new growth has occurred on the roots below the frost line, after the surface soil was frozen to a depth of a few inches. Spring transplanted apple trees have repeatedly been observed to put out leaves ahead of new root formation. Once this new leaf growth was formed, further progress was usually observed to be delayed until new root growth became established later in the spring. Mortality of spring-planted trees has apparently been due to loss of water through their leaves which started ahead of their roots.

ROOT FORMATION OF SPRING-TRANSPLANTED APPLE TREES

Winter Growth of Fruit Tree Roots.—A study of the resumption of root growth of spring-transplanted trees should be associated with what is known of the normal root growth of trees whose roots have not been disturbed by transplanting. Observations at the Missouri Experiment Station indicate that the root systems of established fruit trees have no such definite rest period as do their tops. Repeated observations of fruit trees taken up at intervals from the time they shed their leaves in the fall until they leaf out in spring indicate that root growth continues after the trees shed their leaves; that it may progress slowly, below the frost line, at any time during the winter and that rapid root growth begins in spring, especially on roots near the surface, before the buds begin growth. On undisturbed trees this growth progresses mainly from the tips of the finer roots.

Effect of Operation of Transplanting on Root Growth.—Observation of transplanted trees shows that the operation of transplanting is followed by a cessation of root growth which lasts over a considerable period, no matter how careful the work is done. On fall-planted trees root growth is resumed before mid-winter, below the frost line, from the deeper main roots, and may continue all winter below the frost line. On spring-planted trees root growth is delayed until after the buds start and is resumed mainly from the larger roots which first receive warmth, nearest the surface of the soil. Regardless of the season of transplanting, the small fibrous roots rarely resume growth but for the most part wither away and, they are an incumbrance to the transplanted tree.

Difference Between Early and Late Spring Planting.—It is an interesting fact that trees which have been dug in the fall and "heeled in", over winter, or trees which have been received from distant nurseries, usually have started leaf growth and root growth at about the same time when spring-planted. Trees that are handled enough to loose some of the water content, between the time of lifting from the nursery and setting in the orchard, are usually delayed somewhat in putting out their leaves. In some cases leaf growth has not begun until new root growth is under way.

Very little difference has been observed at this Station between the results of early and late spring planting, providing the trees are equally dormant when planted. Dormant fruit trees from cold storage have been planted out with good results as late as June 3. Trees should be dug from the nursery before their buds start and kept dormant until they can be set in the orchard. No advantage has been observed in very early spring setting except that of getting the work out of the way. If the soil is too wet to work well in early spring, setting may be delayed, if the trees can be kept dormant.

HOLDING TREES DORMANT FOR LATE SPRING PLANTING

Storage.—Most nurserymen have storage facilities in which they are able to hold trees dormant until they are shipped for planting. Once they are received by the orchardist they are usually "heeled-in" unless conditions admit of setting them as soon as they are received. If wet soil or other circumstance delays planting, the trees may put out their leaves while heeled-in. If the trees start growth while heeled-in in the trench they are likely to suffer when transplanted, due to loss of water through the leaves, before the roots become established.

Rehandling.—If it becomes necessary to hold trees in the trench for late spring planting, they may be kept dormant by rehandling as often as the buds show signs of starting into growth. As the buds begin to swell the trees may be, lifted from the trench, turned over to expose their opposite sides to the sun and heeled-in again. Usually this delays the growth of the buds from ten days to two weeks. If trees are handled in this way as often as is necessary, they may be held dormant for planting until very late spring, when the soil becomes dry and warm enough to induce the roots to start simultaneously with the leaves after they are set. Rehandling should be avoided if possible as trees transplanted without rehandling usually succeed best.

Pruning.—Since the terminal buds normally start growth more promptly than do the lower lateral buds it is advisable to prune the trees back properly for setting, at the time they are first heeled-in. The more dormant, lateral buds remaining on the shortened branches start new growth slowly. Furthermore, removal of the surplus growth reduces the evaporating surface and saves the trees from undue drying out.

RELATION OF MULCHING TO THE DEVELOPMENT OF FALL-PLANTED APPLE TREES

In order to throw light on this subject, for Missouri conditions observations were made upon trees mulched and not mulched. The apple trees under observation were Transparent, Grimes, Jonathan, Winesap and Early Harvest. The trees of the former two varieties were two years old and the latter three were one year old when transplanted.

Immediately after planting in the fall, alternate trees in each row were mulched with straw. The mulch was allowed to remain about the trees until time to begin spring cultivation, when it was removed in early April. The trees mulched and not mulched were given similar treatment and clean cultivation during the summer.

The mulch was somewhat detrimental rather than beneficial in this instance, apparently due to its warming of the soil about the roots of the mulched trees, even through it was removed in early April. In cultivating ing the soil about the trees, after the mulch was removed, it was evident that more moisture was retained in the soil where the mulch had lain over winter than in the soil about the trees that had no mulch.

There was no visible difference in the time at which growth above ground began on the mulched and unmulched trees. This fact was to be expected as it has been shown repeatedly at this Station and elsewhere that a mulch about the roots of a tree does not retard the spring growth of its buds above the mulch. Spring growth of the bud is governed by the temperature of the twigs and buds themselves and is practically uninfluenced by the temperature of the roots.

The general observations made in other seasons on results due to the presence or absence of a mulch about fall-planted trees, at this Station, indicate that there is no advantage in a winter and spring mulch under Missouri conditions. Whenever there is an abundance of soil moisture in the spring the mulch appears to be slightly disadvantageous and in no instance has it proved to be beneficial.

RELATION OF SOIL AND ATMOSPHERIC TEMPERATURES TO FALL AND SPRING PLANTING

If trees are planted in very early spring the soil about their roots is warmed slowly, while the air above warms rapidly. As a result the buds of early spring-planted trees tend to start growth in advance of the roots. If planted in late spring after the soil has become warm, root growth and top growth are more nearly simultaneous,providing the buds are fully dormant when the trees are planted.

RELATION OF WOUNDS TO THE ACTIVITY OF ADJACENT BUDS

It is a matter of common observation that the terminal bud of a branch normally starts growth in spring in advance of the lateral buds lower down. If the terminal bud is removed in pruning back the branch, the buds which remain near the cut end tend to start in advance of those lower on the twig. Insect punctures on the side of the twig often stimulate the growth of the adjacent buds in advance of those more remote from the wound. In forcing twigs into growth in vases of water in the greenhouse during winter, the lower bud adjacent to the cut end of a twig may start growth in advance of the others. Uninjured buds near a wound of any kind tend to make an earlier start.

THE TIME TO PRUNE TRANSPLANTED TREES

Early spring has been most generally recommended for pruning. It is the usual custom to prune back the branches of young trees when they are transplanted. Some writers have recommended delaying pruning back fall transplanted trees until spring. The precaution often urged against cutting back the branches in the fall is that the tree loses too much moisture through the cut surfaces of the twigs. Fear has been expressed that the cut-back branches will dry out sufficiently to kill back badly during winter.

In order to answer this question for Missouri conditions, generally observations have been made on young trees pruned at different seasons at the Missouri Experiment Station in the last twenty years. The results uniformly indicate that better growth results if the branches are cut back in the fall. This holds true for young trees generally, whether they are transplanted in the fall or spring or whether they are not transplanted.

REASONS FOR PRUNING NEWLY SET TREES

Pruning the newly set tree is primarily for the purpose of reducing the evaporating surface of the tree until new root growth becomes established to supply adequate water. Incidentally, also, it may serve in starting a proper framework, or branching system. The degree of pruning which is desirable differs with the species. Trees like the peach, which start new branches readily from the central trunk but the twigs of which tend to dry out badly, should be cut back most severely, Trees like the sour cherry, which does not start gowth readily from the dormant buds on the older parts but which makes its new growth from the active buds near the terminals of its branches, should be pruned least.

AMOUNT OF PRUNING FOR DIFFERENT SPECIES

After careful study the different species are arranged in the following order, from those which should be pruned most to those which should be pruned least, at the time of transplanting: peach, nectarine, Japanese plum, apricot, pear, apple, European plum, American plum, and sour cherry.

Peach, Nectarine and Japanese Plum.—The peach should be pruned to a single whip by removing the side branches and shortening the main stem to 2 or 3 feet in height. The nectarine and Japanese plum should be pruned in a similar way, except that the latter may retain stubs, a few inches long, of three to five main limbs if the branches are large and well established. These species start new growth most readily from the main trunk or the base of the limbs.

Pear and Apple.—The pear and apple should be cut back to a medium degree. The side branches should be cut back so as to reduce them one-half to three-fourths. The central stem should be shortened but left from 10 to 16 inches higher than any of the surrounding branches. At the end of the first season's growth the permanent framework may be established by removing all but from three to five well distributed, outward spreading limbs to secure a modified leader tree. If the tree is large so permanent limbs may be chosen at the time of transplanting, this permanent frame work may be established then. If the tree is a one-year-old whip having no branches it should be shortened to a height of about 2½ or 3 feet, with the view to securing a good branching system below the point of cutting back.

American Plum.—The American plum should be cut back somewhat less severely than the apple. If the tree is well branched three or four main limbs may be left intact to form a permanent head and the remaining stem and branches removed. The side branches remaining may be shortened one-third to one-half.

Sour Cherry.—The sour cherry should not have its permanent branches cut back, as it starts new growth most readily from the larger, active buds at the terminals. Three to five main limbs should be chosen for the permanent framework and the remaining limbs and central stem should be removed. The limbs which remain should have their terminals left intact.

THE DEPTH TO PLANT

The character of the soil and climate of a region should no doubt govern the depth to which the roots of a fruit tree should be set. For most sections it is generally recommended that the roots be set a little deeper than they stood in the nursery. Very deep planting has been emphasized in the prairie states of the northwest, where there is danger of root injury by severe winters. Deep planting is also preferred in the plains where winter desiccation is marked and where rainfall is very limited. No doubt the roots should be set deeper in

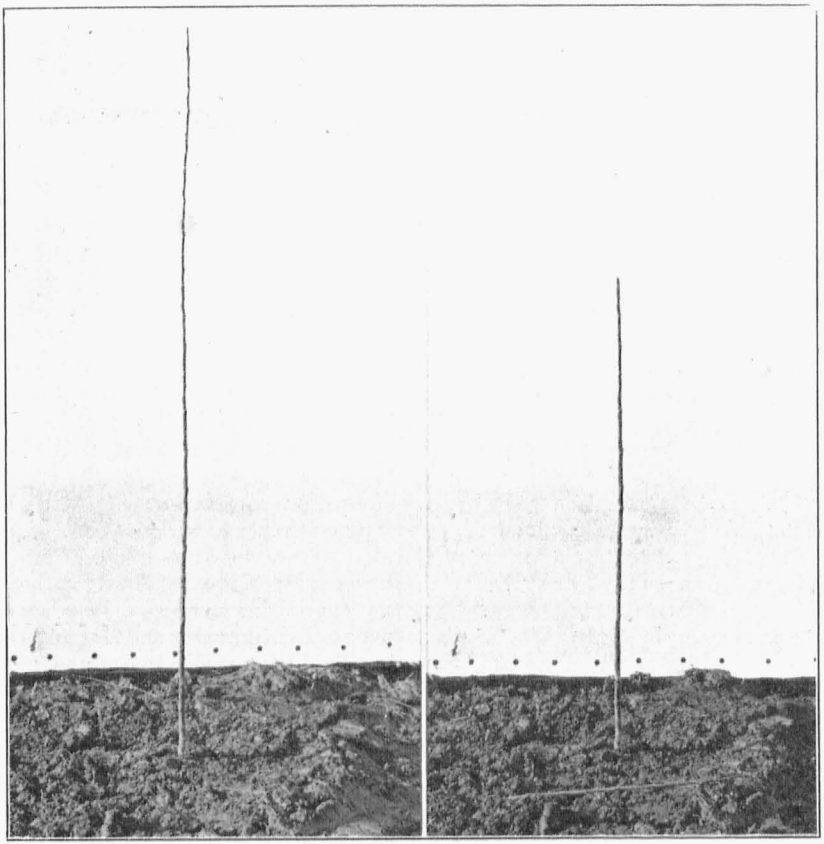

Fig 2. A one-year-old apple tree after transplanting, before and after pruning

loose, sandy soils than in heavier soils. Most Missouri growers of long experience advocate setting a little deeper than the tree stood in the nursery. Many who have had limited experience set their trees much deeper than this, with the idea that the trees will stand straighter and firmer and that the roots are thus secured against drying out.

At this Station shallow planting has given better results than deep planting. This point has been repeatedly tested in different years and the results

of deep and shallow planting have also been observed in many of the orchards of the State. The results indicate that a majority of the trees set in the state are planted too deep. Deep set roots, especially if spring planted, start growth slowly. The trees usually sway in the wind until a funnel-shaped cavity is formed in the moist soil around the base of the trunk. Borers enter the trunk below ground more readily where such a cavity is formed than in shallow-planted trees around which cultivation has been practiced in close contact with the base of the trunk. Field mice find shelter in the soil cavity about a deep-set tree and often girdle it. They rarely girdle trees where the soil is bare and settled in winter so as to afford no shelter about the base of the trunk. "Root rot" occurs much more frequently in trees set deep.

If trees are set in autumn they may be set an inch or so deeper than they stood in the nursery. The soil at this season is aired and warmed to a greater depth. New root growth starts, in early winter, on the lower roots which become established for early spring growth. If trees are transplanted in spring they should be set no deeper than they stood in the nursery. If the soil is heavy spring-set trees should stand a little shallower than they stood in the nursery. In the case of spring-set trees, new root growth starts first on the roots nearest the surface of the soil, which is better aired and which warms up first. In order to stand straight and firm a newly set tree depends largely upon speedy, new root growth to anchor it in the soil.

PROPER ORIENTATION OF THE TREES

In the Central West fruit trees tend to lean more or less to the northeast. This is particularly marked in prairie districts. It is also more marked in some varieties of trees than in others. This tendency is largely established while the tree is young, or during the first few years after it was planted in the orchard.

The tendency of fruit trees to lean toward the northeast is due apparently to two causes: The fact that the prevailing winds are from the southwest during the growing season, and the fact that the tissues of the southwest side of the tree tend to "scald" more or less, due to extreme fluctuations of temperature of the sunny side of the tree especially in late winter and early spring.

Sunscald on the southwest sides of the trees in this section has been supposed to occur in summer due to the influence of the hot sun and dry southwest winds during the heat of the summer. That it occurs in late winter has been shown by observations covering a series of years at the Missouri Experment Station.

The fluctuations of day temperatures of the south side of the tree are most marked on cold, clear sunny days, when the roots of the tree are frozen, so water cannot be taken up by the roots to cool the trunk. Examinations have shown that the cells of the south side of the tree trunk are injured by the fluctuations of temperature between night and day.

That the temperature of the tree is lowered by evaporation on hot summer days, is further shown by the following observation: On a hot day in July the atmosphere registered a temperature of 102 degrees. The temperature of the young tree trunk was 90 degrees, just beneath the growing layer. The leaves were then removed from the tree to reduce evaporation. The temperature of the tree soon rose to 103 degrees, or one degree above atmosphere.

Shading the sunny side of a tree trunk or covering it with lime white-wash reflects the rays of the sun, thus enabling the trunk to remain at atmospheric temperature, or a little below, and avoid sunscald.

This injury to the tissues of the sunny side on the tree trunk in winter combined with the prevailing southwest winds, accounts for the fact that young trees make stronger growth on the northeast side and tend to lean toward the northeast during the growing season.

The tendency of young trees to lean toward the northeast may be largely avoided by proper orientation of the tree when it is set in the orchard. No matter how symmetrical the young tree may appear, it will be found to possess a "heavy" side. One side has a heavier growth.

In planting the tree the heavier side should be set toward the southwest in this interior section. To orient the tree, it should be caught so it will balance, and come to rest across the palm of the hand. Its heavy side will turn toward the palm. That side should face the southwest in setting.

PRUNING THE ROOTS AT TIME OF TRANSPLANTING

The Stringfellow system, in which the tree is reduced to a short trunk or stub above ground and a single tap root below, to no pruning of either top or root has been tested as well as many other systems of root pruning. An intermediate degree of pruning, the severity differing with the species, has given best results under Central Missouri conditions. The following suggestions are based upon these results.

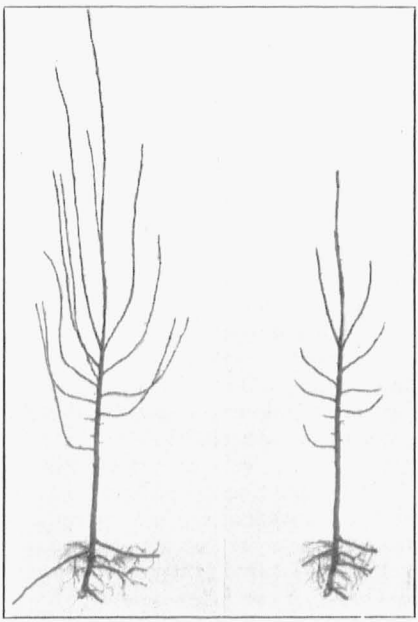

Fig 3.—A two-year-old apple tree at time of transplanting, before and after pruning.

The root system of the tree should be pruned just before setting. The tap root should be preserved. The main lateral roots should be shortened to about 6 inches in length, and the small, fibrous roots should be pruned off. This is very important, since if they remain intact they are an incumbrance to the tree. These fibrous roots not only die, for the most part, but they prevent getting the soil in close contact with the essential, larger roots. As trees are ordinarily handled the small fibrous roots dry out and die before the tree is set. They coil more or less around the larger roots like a mass of curled hair. Even if the tree can be dug and planted immediately, the fibrous roots cannot be depended upon to start new growth unless a mass of moist soil can be moved with the roots so as not to disturb the fibrous roots in the soil. Even the naked fibrous roots, if not dried out, are bent so much in setting that they cannot function.

If a main root is more than 6 or 8 inches long it should be shortened. Long roots cannot well be set without bending. A bent or twisted root does not

function so well as a shorter root which lies in its normal position. If the end of an essential root has a ragged wound it should be cut back to fresh, healthy tissue, with a clean, smooth, cut. If, however, the end of an essential root has calloused and is healthy it should not be cut, unless the root is too long to plant without bending. Many observations made at this Station since 1895, show that new root growth starts, for the most part, from the sides of the larger main roots where they come in close contact with thoroughly settled soil. The small, fibrous roots die unless a large ball of earth is moved with the tree.

SETTING THE ROOTS IN THE SOIL

Preparing the Soil.—The holes which are to receive the roots of fruit trees should be dug just deep and broad enough to accommodate the natural spread of the roots. This general statement is based upon observation of the growth of trees in various soil formations in the state and in which various soil treatments have been tested. The question of digging larger holes, and of shattering the subsoil with dynamite below the bottom of the tree, has been given attention.

On all well-drained, typical fruit soils, deep plowing, thorough harrowing and digging the holes of sufficient size to accommodate the roots has proved to be the only treatment necessary to secure the maximum growth of trees. Digging large holes or dynamiting the subsoil has not resulted in any advantage to the trees in such soils. Where trees have been set in sod, as in a lawn, or where replanting has been done between established trees in an orchard, the newly set trees have made much better growth if the holes were dug deep enough and broad enough to kill back the competing roots and the surrounding grass to a distance of several feet. It has been found difficult to get replants in an established orchard to live unless the holes were dug about 18 inches deep and at least 4 or 5 feet wide. This gives opportunity for the replant to become established before the roots of the surrounding trees grow in and compete with the replanted tree.

Spread of Roots.—In transplanting trees it has been found that the roots of established fruit trees spread laterally to a much greater distance than do their branches. Often the roots of the older trees permeate the soil prepared for the replant before the end of the first season. This emphasizes the need of frequently cutting back the roots of the surrounding trees while tilling about the replant until it becomes well established.

Setting the Roots.—The roots should be set so as to stand in their normal position. Avoid twisting or bending them. Bending a main root greatly lessens its capacity to take up water and prevents its making normal growth. The roots may be kept in their normal position and the soil compacted about them by observing the following suggestions. Shake the tree vigorously with one hand while the earth is being shaken from the shovel with the other hand. In this way the soil sifts among the roots instead of bending them down, as will be the case if the soil is scraped in the hole in masses.

Compacting the Soil.—In setting, the soil should be tramped firmly about the roots from the bottom of the hole upward, and an inch of loose soil spread over the tramped surface to prevent the soil from baking and drying out. Much of the mortality of fruit trees is due to bending the roots and failure to compact the soil about the roots in planting. Each layer of soil shaken in should be tramped firmly, from the bottom of the hole upwards. It is impossible to properly compact the soil if the hole is filled before it is tramped.

PROTECT YOUNG TREE ROOTS FROM FREEZING AND DRYING

The roots of young, dormant fruit trees are easily killed by freezing. The roots will not endure the low temperatures to which the tops may be exposed without injury. It is a fact, also, generally recognized that trees are easily injured if the roots are allowed to dry out in handling.

The fact that the roots may be handled without cover for a time in a moist packing shed, or in the field during a moist still day, should not encourage the belief that exposure to winds and a dry air may not speedily result in injury. In planting large orchard areas the trees are frequently distributed ahead of the planters where the roots are exposed to the drying influence of sun and wind until they are injured.

Exposure of freshly dug trees for fifteen minutes, if the day is dry and windy, and for more than thirty minutes on an average spring day, results in injury to the roots. All possible care should be used to avoid exposure in planting.

SUMMARY

At the Missouri Experiment Station fall-planting hardy fruit trees and most hardy deciduous trees and shrubs has given better results than spring planting. It is also true that late fall planting has given better results than early fall planting. Late spring planting has given as good results as early spring planting, providing the trees are kept dormant until they are planted.

Trees "heeled in" for planting may be held dormant until late spring, sometimes until early June, by lifting them out of the trench, turning them over, and again heeling-in in the same trench, as often as their buds show indication of starting.

Sour cherries usually suffer a mortality of one-third to one-half of the number of trees when planted in spring, but suffer no appreciable mortality when planted in late fall.

Peaches and most species which are subject to winter injury under Missouri conditions succeed best when planted in the spring.

Apple trees planted in the fall usually begin new root formation about the first of January, from the sides of the lower main roots, after the surface soil has frozen. Early fall-planted trees have begun root growth no earlier than late fall-planted trees. New root growth apparently proceeds slowly throughout the winter, below the frost line.

Apple trees planted in early fall dry out more during fall and winter than do those planted in late fall. The reason, apparently, is that their parts are less thoroughly ripened or not fully at rest at the time of early planting. This date is followed by a period of high atmospheric temperatures and often by dry weather.

Fall-planted trees, mulched during the winter, have made slightly poorer growth than those not mulched. The soil about the mulched trees dries and warms more slowly, even where the mulch is removed in early spring.

Young apple trees having their branches pruned back in autumn make better growth the following season than do trees pruned back in spring. This holds true whether or not the trees are transplanted. Branches pruned back evaporate more water through wounds than do similar branches which are not pruned, for the first few days only. After the first few days the pruned branches lose less water throughout the winter than do those which are not pruned.

The wound made in pruning back a twig, or a slight wound anywhere on a twig, stimulates greater growth of adjacent buds. A wound made just above

a bud stimulates greater growth than a similar wound made below or at the side of a bud. Wounds made in autumn stimulate greater growth the following season than do similar wounds made in the spring.

In transplanting fruit trees under Missouri conditions the roots generally, should be set no deeper than they stood in the nursery. This is especially true if the trees are set in the spring, at which time the soil is slow in warming to the depth of the lower roots.

The tendency of trees in the orchards of this region to lean toward the northeast may be overcome in part by proper orientation of the trees at the time of transplanting, as explained in the text of this publication.

In setting fruit trees the soil should be pressed firmly about the roots to avoid drying out; the main roots should be set in their normal position without being bent or twisted. Digging large holes for the trees or shattering the subsoil with dynamite is not necessary.

When the trees are received from the nursery remove the ties from the bundles and heel-in in a trench which has been prepared deep and wide enough to accommodate the root systems. Work the soil around and among the roots, leaving no air spaces. When the trench is about half filled it is advisable to water the roots moderately. Then finish filling the trench, allowing the soil to cover half or more of the trunks or main stems of the tree.

When the soil is too wet for heeling-in operations the trees may be held in the original packages for a week or more without danger of injury by storing them in a damp cool place such as a cellar or building where the temperature may be kept above freezing. At the time of storage the roots should be examined and if dry the packing material around them should be sprinkled and kept moist until the trees are heeled-in or transplanted.

The roots of the trees should never be exposed to the wind or sun in heeling-in or in transplanting. They may be kept in water, placed in a tub or half barrel or damp gunny sacks or packing material may be placed around the roots.

At time of transplanting all labels should be removed from the trunks of the young trees to prevent killing by girdling.

An orchard plot giving the names of the species and varieties and designating their location should be prepared as a permanent record of the orchard plantings. Heeled-in trees must be properly guarded against injury by field mice, rabbits and livestock. It may be necessary to place around the trees an inclosure that will prevent the entrance of rabbits as well as livestock.

The small, fibrous roots of transplanted fruit trees usually die, due to drying out or bending in setting, unless they can be dug and reset immediately with a mass of soil. The dead, fibrous roots should be pruned away at the time of transplanting, since they are an encumbrance and prevent pressing the soil into close contact with the larger, essential roots.

The tops of young fruit trees should be pruned back at the time of transplanting, the degree of pruning differing with the character and habit of growth of the species.

The roots of fruit trees should not be allowed to freeze in handling. Tests show that while the tops of the trees may endure severe freezing without injury, the roots may be injured even by a few degrees of frost.

All transplanted fruit trees should be protected from injury by rabbits and field mice. One-inch mesh poultry wire, old newspapers, or gunny sacks torn in strips 6 to 8 inches wide make satisfactory protectors.