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AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

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DIVISION OF HORTICULTURE

CULTIVATION AND CARE OF TREES ON TEXAS FARMS

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*In cooperation with School of Veterinary Medicine, A. and M. College of Texas.
**In cooperation with United States Department of Agriculture.

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BULLETIN NO. 293. FEBRUARY, 1922.

CULTIVATION AND CARE OF TREES ON THE FARM IN TEXAS

BY

H. NESS.

THE PRESENT NEED OF INFORMATION IN ARBORICULTURE

The culture of cotton and corn together with oats and, in favorable localities, wheat constitutes the specialty of most of our farmers in Texas. In the care and cultivation of these crops, they have attained great proficiency through the accumulated experience of several generations, and they are still making a rapid progress in this very proficiency. But in the cultivation of other crops, such as go with the staples named to make a diversified farming, there is a great scarcity of intelligent skill and little progress. Even the cultivation of garden crops is carried on in a crude and more or less irrational way, except in a few localities, where such crops have become the main dependency, having taken the place of the cotton farming. It is, however, in the cultivation of trees, whether for fruits or other purposes, that lack of rational methods is especially noticeable. In fact, the farmer, who is accustomed to handle plants only in mass, or the crop as an entirety, has rarely the proper conception of the needs of a plant that must be handled as an individual; although the principles underlying success are practically the same for both kinds of culture.

In the growing of trees, both for fruit and shade, it is very evident that the average cultivator of field crops demands that, planting having been carefully performed, his trees shall grow gratuitously, as those of the forest; the differences, both in the conditions and in the plants, do not readily occur to him. In the forest only a small percentage of the great multitude of trees started, namely, the fittest, survive the struggle for existence and reach maturity, while to the trees planted in the orchard no such test of culling for vitality has been applied. The plants in the forest, having a great variety of habits, are also thoroughly adapted to the mutual association in the occupation of the common ground. The conditions for growth in the soil of the forest are far more ideal than those we are usually able to obtain by our cultivation. The accumulated litter (1) conserves the moisture in the soil, (2) regulates its temperature and texture, (3) chokes out the hurtful competition of grasses and weeds, (4) is constantly increasing the humus contents and fertility, and (5) promotes the activity of the bacterial life so necessary to the soil in the formation of available nourishment for the higher plants.

Our cultivation is unable to aim at anything more than three of these results, namely: (1) the amelioration of the texture of the soil, (2) the conservation of its moisture, and (3) the destruction of competing

weeds; all of which are attained in a much lesser degree of perfection than by the litter-cover of the forest floor.

By cultivation, new soil particles are constantly being exposed to the heat of the sun, which in our latitude is sufficient to consume organic matter at a very swift rate, the final result being a serious loss of fertility and deterioration in the texture of the soil. Cultivation also facilitates erosion which, in a country of frost-free winters and frequent rains, is, after all, the most serious menace to the land. It will thus be seen that cultivation has its drawbacks; but in a rational agriculture, these are to be compensated for by other means, which will be discussed further on.

THE PRESENT STATUS OF FRUIT CULTURE ON THE TEXAS FARM

It would be superfluous to make any remarks concerning the advantages of fruit on the farm, except for the fact that the cultivation of any kind of fruits is so little practiced in our State that a great many farmers, and even whole communities know neither the advantages of the enjoyment of fruit, nor the disadvantages of the lack of it. The only taste of it that they ever obtain is when they occasionally buy a little from the grocery store at an immense price and at a sacrifice of even more urgent necessities; nor it is certain that the interest in fruit culture in Texas is on the increase. Judging from the declining interest through the last ten or fifteen years taken by the farmers in the State Horticultural Society, one is rather led to the belief that the interest in fruit-growing, the chief branch of horticulture, is on the decline in our State.

CAUSES OF THE DECLINE IN FRUIT CULTURE IN TEXAS

The causes of this condition may be inferred to be as follows: About thirty-five or forty years ago, peach growing took on an immense boom in East Texas. It was found that both the soil and the climate of that region gave promise of almost unbounded success. The small family orchards, often made up of volunteer seedlings, produced abundant fruits of great beauty and fine quality. This soon attracted the attention of peach growers from the North and the East. They came, bought the lands, and planted the Elberta peach in orchards covering hundreds of acres. Nor were they suddenly disappointed, for the success remained in abeyance for some years. Meanwhile the business grew into a boom; everybody with push and means went into it; companies were formed, lands were bought, the cheaper the better, and planted to orchards too extensive for expert care. In fact, expert care of the orchards entered but rarely into the plans; only expert commercial knowledge was thought necessary. The land selected for the orchards was frequently such as had been worn out through many years of continuous cotton culture, or cut-over lands, yet foul with briars and brush. The trees were in many cases bought in job lots and sometimes so cheaply that no ordinary nursery business could afford to make such bargains and exist. In short, the peach orchard boom in East Texas was conducted on the principle of getting the largest orchard

for the least expenditure of money and skill. The consequences were not long in arriving. After one or two apparently accidental crops, occurring among several seasons of repeated failures, the trees commenced to die at the age when they should have been in the midst of their greatest productiveness. The causes of the failures could not be easily placed, for the seasons were not abnormal; and in some cases trees of the old type that chanced to have survived the contempt brought on them by the advent of the new planting remained normally fruitful. In cases where the injury might have been attributed to late frost, it did not appear to affect the fruit buds only, but the wood buds also seemed abnormally sensitive and gave rise to an irregularity and weakness of growth, which lasted the entire season and, perhaps, showed its effect even for a longer time. In short, the trees behaved as though degenerated in vitality. Reasons for the support of this hypothesis may be readily found when we remember that the advent of the peach boom with its large and showy new varieties of the North Chinese race of peaches brought contempt upon the old seedling orchards, so that their destruction was speedily accomplished. At the same time the increase in the propagation of the peach was such that where bushels of seed formerly were sufficient for stock, it now took as many carloads. With the passing of the seedling orchards the only source left for stock was, therefore, the seed from the new commercial abnormalities. The trees from these are as variable in vitality and longevity as are the characters of their fruit.

ORCHARD SOILS IN TEXAS

Since the peach is by far the most generally planted and most successfully grown fruit tree in Texas, and since all other fruits adapted to our climate will reach their maximum vigor and productiveness on the soil where the peach thrives best, that very soil may be considered as the best general orchard soil in the State.

It is very likely that the same trees under a latitude different from ours, as for example, that of New York, or Michigan, may, to reach perfection, require a soil different from ours.

The red-colored, fine, sandy loams of the Norfolk and Orangeburg series of soils found so widely distributed throughout East Texas, or the similar "Miller Fine Sandy Loam," are the orchard soils in our State. The last named is especially well represented along the Brazos River near Waco, and at many other places. These soils vary from 10 to 24 inches in depth, and are underlaid by a yellow to dark brown clay, which contains enough gravel so as to permit of a fair circulation of both water and air to a depth adequate for the best root development.

All sandy loams of similar character, whatever name be applied to them, and wherever found in the State, are suited to orchard or garden culture.

The Orangeburg soils differ from the Norfolk series and the Miller fine sandy loam especially in that they contain a larger quantity of ferruginous gravels, both in the surface and in the subsoil. The subsoil is also, on an average, more compact. Because of the red color due to a larger amount of iron ingredients, the Orangeburg series is

locally known as the red lands. A portion of the city of Palestine is located on the Orangeburg clay. This series of soil is derived from the weathering of green sand and marl and is rich in lime, phosphoric acid, and potash. It is the soil upon which the peach reaches the greatest perfection in East Texas.

All these sandy loam soils, wherever found in the region of sufficient rainfall, were originally covered with forest consisting principally of hardwoods. Fresh from the clearing, these soils contained a considerable quantity of organic matter, due to the decayed offal of the forest. They might then yield 35 to 50 bushels of corn, 60 to 100 bushels of Irish potatoes, 150 to 200 bushels of sweet potatoes, and 100 to 150 bushels of tomatoes per acre.

These series of soils are also known for the earliness of their crops. Here strawberries and truck crops are matured perceptibly earlier than on soils of the black or gray loams, such as the Susquehanna and the Lufkin series of soils, which also are widely distributed throughout the eastern part of Texas.

By constant clean cultivation, such as cotton, corn, and truck crops require, the organic matter left in these soils from the litter of the forest is soon exhausted. The yields are then quickly reduced, because of the material changes in both their physical and their chemical characters. The capacity for retaining moisture becomes greatly lessened; hence crops of any kind, on such soil, are soon retarded and injured by drouths. Another very serious defect of soils denuded of organic matter is their liability to erosion from heavy rains. The damage done to southern soils by erosion is so evident on every hand, and so notorious, that any description of it, or comment upon it is superfluous. Although these sandy loams quickly lose their fertility with the loss of their humus, yet in no kind of soils can this loss be more cheaply and quickly restored; provided this restoration is made before the erosion has gone so far as to prevent the chances for an ample and even stand of a cover crop.

THE NECESSITY FOR RESTORING FERTILITY BEFORE PLANTING

Soils, impoverished through long and one-sided cropping, should not be planted into an orchard until fertility and the proper mechanical conditions are restored or, at least, ameliorated.

This restoration, as well as the maintenance of the fertility, is in the South accomplished most cheaply and quickly by cover crops. Stable manure, which in the Northern States is the chief reliance for such purposes, is rarely accumulated in sufficient quantity on Southern farms, where the cattle are kept almost continuously in pastures, and these frequently woodlands, or areas yet unclaimed by the plow. Nor are commercial fertilizers of much value on land lacking in humus; since their action can, at the best, be only temporary. But in regard to green manures, which can be returned to the soil, either by plowing them under, or by pasturing them, the South is most favorably situated.

Because of the frost-free and frequently rainy winters, two classes of cover crops for green manures are advisable in the South; namely, one for the winter and another for the summer.

COVER CROPS FOR SUMMER

For summer we have the various varieties of cowpeas, some maturing in about three months, as the Speckled pea and its relatives; others of heavier growth consume a much longer season, as the Wonderful or Unknown pea.

When cowpeas are used as green manure, they should be plowed under while in their greatest bulk and succulency; that is, before any of the pods have reached maturity. At that stage the vines are at their greatest bulk, and fertilizing ingredients are most equally distributed throughout their tissues which, at that time, are also in condition most readily to undergo fermentation or decay. As the maturity of the seed proceeds, much of the carbon will be used in that process; hence there is a decrease both in the mass and in the most valuable fertilizing ingredient, the nitrogen, which will be concentrated in the seeds, leaving the vines poorer for fertilizer in quantity, as well as in quality.

The fact that cowpeas can be planted at any time in the summer, regardless of the high temperature, provided enough moisture be present to start them into growth, makes them the most available fertilizer, at once rich both in humus and in nitrogen, which in this way is more quickly obtained than from any other source,—therefore, a soil-renovator par excellence for the South.

There are many varieties of the cowpeas. The difference lies mostly in the habit of growth, which ranges from nearly erect or ascending to rank runners, or even climbers. The more erect forms are of earlier maturity and more easily plowed under; therefore, best suited for green manure. For such purpose they should be planted in drills two feet apart and given thorough cultivation at the start, after which time they will soon be able to take care of themselves and hold competing weeds and grasses in subjugation.

The Iron cowpea is one of these dwarfer forms, and besides, it has also the additional merit of being immune to nematodes. It can, therefore, be used in renovation of soils infested with this troublesome pest without prolonging their existence in the soil by acting as their host.

The cowpeas of very rank, running growth, such as the Unknown or Wonderful pea are, as already stated, of later maturity and more difficult to turn under with the plow. They are especially useful in alternating with the corn, being drilled in between the corn rows after the last cultivation. They will even then, if the season be favorable, have time to make an immense mass of herbage after the corn has matured, without having been a hindrance to the growth of the corn. In fact, a late pea crop, so planted, does not only offer abundant grazing for cattle and hogs and acts as a renovator of the soil in various ways, but also keeps the soil free from weed pests.

COVER CROPS TO SMOTHER WEEDS

Many fields, which have been abandoned because of the exhaustion of fertility, yet foul with weeds of such frugality that they thrive where cultivated crops starve, have been planted into orchards, both in Texas and other Southern States. Bermuda grass has frequently got a hold in such fields, but makes only a scanty growth until the soil is broken,

preparatory to the planting of field crops or trees, when at once it is stimulated into luxuriant growth by cultivation. Such fields can most easily be freed from these pests and restored to fertility by one, or if necessary, two crops in succession of rank growing cowpeas or the Velvet bean.

The Velvet bean is the most rampant grower of our cultivated leguminous plants. By preference it is a coiling climber, some varieties reaching to the height of fifty or sixty feet in a single season; but, if it finds no support upon which to climb, it will assume the habit of a runner. In that way it will extend its growth more by producing branches and covering space in all directions than merely by extending in length. The ends of the rapidly growing shoots are always in a constant swinging motion; feeling, as it were, for a support and finding one, such as a tall weed or shrub, or any other projecting body, it is immediately seized upon and covered by the numerous coiling branches. If such a support fails to endure the weight, it is forced to the ground and deeply covered by a mass of leaves and branches. Where no support for climbing is found, the branches frequently twine one about the other, forming dense whorls of vegetation, covering the ground to such a depth that any other plant, making the attempt to compete for the ground, is smothered.

No plant is more suited for ridding the land of weed pests, whether annuals or perennials, than the Velvet bean. Nor is this all that this plant is good for. In Bulletin No. 102, published in April, 1910, by the Florida Experiment Station, it is stated that the weight of green material per acre of a crop of Velvet beans is 21,132 pounds and that the amount of nitrogen added to the soil by turning under this mass amounts to 141.2 pounds.

The Velvet bean is now extensively and very profitably grown as a forage plant in Florida on poor sandy land, formerly of no value. The cattle eat the herbage greedily, and the pods which are produced in great quantity are gathered at maturity and ground whole into a most valuable concentrated feedstuff.

The Velvet bean cannot readily be turned under while alive, because of the unmanageableness of its bulk. But as soon as killed by frost, for which a very slight degree is sufficient, its tissues become brittle, and can then be very easily broken up by a disk harrow, after which it may readily be turned under. It is also quickly broken up by the tramping of cattle, which will feed on it in a dead state with undiminished relish.

The Velvet bean, intended for cover crop or green manure, should be planted in drills about three and one-half to four feet apart, and about as thickly as we plant cowpeas. This density of seeding is necessary to secure a solid stand, since the germination is much less regular and certain than in the cowpeas. The temperature required for germination and growth is about the same as for the cowpeas. The season required for maturity is so long that matured seed can only be secured in the southern half of the cotton belt.

As in the case of the ranker growing cowpeas, the Velvet bean can only be used preparatory to the planting of the orchard, while the dwarfer or more erect varieties of the cowpeas are well suited for the orchard after it has been planted.

COVER CROPS AFTER PLANTING

Such crops should be planted in the middles and not closer to the trees than five feet, which space should be kept clean and covered with a dust mulch by frequent cultivations. Cowpeas employed for this purpose should be planted in drills as close together as cultivation with a small sweep will permit; and the planting should be made so early that the crop can be turned under in June, or before too great an amount of the soil moisture has been removed from the use of the trees. The cultivation of the soil can be much improved by thoroughly pulverizing it with a disk harrow immediately after the peas have been turned under.

Such crops of green manure may be given every year until the trees become so large as to seriously interfere with the growth and the cultivation of the peas.

COVER CROPS FOR WINTER

As winter cover crops for orchards, the various small grains such as oats, wheat, barley, or rye may be used. But they are neither as cheap nor as well suited for green manure as winter legumes, because they are not nitrogen-producers, and will have to be sown every fall.

Of winter legumes, suitable for cover crops in orchards for our region, there are but two species that can be recommended, namely, the bur clover, *Medicogo denticulata,* and the crimson clover, *Trifolium incarnatum.* The scarcity in the number of species suitable for this purpose is made up by the fitness of these two. This is especially true for the bur clover, which is excellently adapted to all parts of Texas, where the rainfall is sufficient to insure regular moisture throughout the cooler seasons of the year.

The bur clover is strictly adapted to a cool, moist climate. Its seed will not germinate, no matter how favorable the moisture conditions may be, until the autumn brings a sufficiently low temperature. Germination and growth commence in this part of the State (150 miles from the Gulf coast) during October and continue throughout the winter at all times whenever the temperature is above freezing. During unusually hard freezes in January and February, some of the leaves may become damaged; but the plant is rarely killed and soon recuperates upon the approach of milder weather. In April, it commences to flower; and, by the end of May, all the seed will be mature, and the plant withers and dies.

In habit of growth the bur clover is low, sending out numerous prostrate or ascending branches from the crown of the root, so as to form a dense matting on the ground. When crowded for room, many of the branches become erect and reach the height of 14 to 18 inches. Flowering takes place as the growth proceeds, so that nearly the entire length of each branch is fruit-bearing. Grazing or mowing does not prevent the formation of seed, but may delay it for a short season.

The best time for sowing the bur clover is during September or October; and the best method is to broadcast it with a revolving hand-seeder on clean, well pulverized ground, and harrow it in with a spike-tooth smoothing harrow.

DANGER OF LATE COVER CROPS TO TREES

On moderately deep land, with a subsoil of the proper porosity, such as will admit of a fair circulation of air and water and the proper penetration of the roots of trees, there is no danger during the months of March and April of a cover crop like bur clover; provided the soil-moisture has been conserved by a dust mulch of clean cultivation during the previous summer and fall. On shallow soil with quite impervious subsoil, such as we have on the College farm and on soils similar to this, a dense crop of bur clover may, if the months of March and April happen to be rainless, so thoroughly exhaust the soil of moisture as to endanger the life of the trees. This is especially the case where they have suffered from lack of cultivation in the fall previous to germination of the bur clover. Hence, it is necessary to leave the ground in a clean and well pulverized condition at the end of the summer months. The months of March and April, when all the activities of the dormant trees are suddenly revived, is the season which decides the thrift and usefulness of the trees for the entire year. Adverse conditions at the start will hardly be overcome during the remainder of the season. This holds good, not only for fruit trees but also for ornamental and forest trees.

Since the cover crop of bur clover must be left growing during those months to secure reseeding, and since its demands upon soil moisture at that most critical period of a tree's growth are very great, injury to the trees may readily occur on shallow soil in poor tilth.

On proper orchard soil, and with proper summer cultivation, bur clover is, however, to be recommended as a winter cover. It will be highly beneficent in three ways: (1) as renovator of the soil, (2) as protection against erosion, (3) as a preventer of noxious weeds.

Too rank growth on the part of the bur clover may be kept in check by mowing, which should be done whenever it threatens to become too tall. Mowing from time to time will, in fact, cause it to form a dense, low matting, which requires less moisture from the soil, and yet gives a more efficient protection both against evaporation and erosion. At the same time, the mowing is no hindrance to the production of seeds.

Clean culture of trees, with a safe space on either side of the row, as in the case of the summer cover crop, can easily be obtained by the use of the cultivator and the hoe at the time when the bur clover is not germinating, and as often afterwards as the necessity for it demands.

As the trees increase in size, it becomes necessary to widen the strip of cleanly cultivated ground along each row of trees. Beginning with a width of five feet on either side of the row, the distance should be so extended as to keep pace with the growing spread of the branches, and always extend as far out as their extremities.

CRIMSON CLOVER

Crimson clover, the second legume named for winter cover, is a true annual clover. Its season of growth and requirements upon the climate are almost the same as those described for the bur clover; hence it may be sown at the same season and in the same manner as the bur clover. In regard to soil, it is more fastidious, being adapted only to the light soils, or sandy loams. But as it is able to resist a greater

cold than the bur clover, it can be grown further north. It has been used extensively both as winter cover crop in orchards and for winter pasturage, from Delaware to Florida. It is recognized in the South Atlantic States as one of the best soil renovators.

The crimson clover is a rigidly erect plant, reaching a height of 12 to 18 inches. Under favorable conditions it stools abundantly, so that a single seed may produce a tuft of thirty to fifty stems, each one ending in a long showy flowering spike. The sowing must be done every year, since it is not liable to return as a volunteer in sufficient quantity, as is the case with the bur clover.

On heavy clay soils, where the bur clover seems to thrive to perfection, the crimson clover will make but a poor showing. Its preference is, as before stated, the lighter loamy soils, similar to those preferred by the peach.

THE EFFECT OF GRASSES AND WEEDS ON TREE GROWTH

In connection with the subject of cover crops, it is necessary to state that all trees, whether forest or fruit trees, are easily stunted, especially in their youth, if their roots be forced to share the soil with those of other plants.

Not all herbs have an equally evil effect on the trees in this respect, some being much more injurious than others. Grasses are recognized as being the most hurtful to young trees; and among them the sod-formers, similar in habit to the Bermuda, are the worst.

It is now generally conceded by investigators of plant physiology, that certain species of plants have a great antipathy to certain other species occupying the same soil, and to such an extent that in the competition one or both contestants are permanently injured. This fact is easily observed everywhere, and in different degrees for different species of plants, wherever they are associated on the same ground.

Anyone may have noticed the starved condition of corn, or any other cultivated crop, occupying the ground near a large oak. It may also be noticed that the same crop on the same kind of soil will be less injured in a similar nearness to a hickory, of size and thriftiness similar to those of the oak. In the same way a large and thrifty oak, growing on a lawn of Bermuda grass, will hold the growth of the grass in check and keep the sod from acquiring its normal density. This unthriftiness, on the part of the grass or crop so placed, is not only visible in the immediate vicinity of the tree, but extends far beyond the extremities of the lower branches, and frequently covers an area several times larger than the spread of the tree.

Let the case be reversed, so that instead of an oak which has acquired its vigor and size before the arrival of the grass, a young, yet ever so thrifty tree be planted in the sod; it will never recover its full vigor as long as it remains surrounded by the sod, no matter how well fertilized, or well watered, or how well the grass is kept cropped by mowing.

This effect of grasses and weeds upon trees and cultivated crops, and a difference in the severity of this effect from different species, have always been evident to the cultivator. He has also been aware that there are crops easy or hard on the land; that is, that some crops leave

the land more impoverished in fertility than others. Experiences of this kind have given rise to the theory and practice of rotation of crops.

The causes of these phenomena were formerly attributed to the difference in the qualities and quantities of the nutritive ingredients taken up by the different plants; and it was claimed that a proper rotation, therefore, required plants which used these ingredients in a supplementary way.

The idea of this cultural relation which one class of plants bears towards another has, from the investigations of recent years, undergone considerable changes, some of which we will now discuss.

DO PLANTS EXCRETE FROM THEIR ROOTS?

Even as far back as 1830, De Candolle expressed the idea, in his vegetable physiology, that plants excrete from their roots; and that these excreta are poisonous to the plant itself and to other plants of similar physiological nature.

Students of plant physiology have from time to time been suspecting that the causes of this unthriftiness, arising on the part of a crop continued on the same ground for a series of years without change, was due to other factors besides the lack of nutrition. The great antipathy which certain classes of plants show to association with certain others, seems to be due to similar causes.

Bulletin 36, published by the Bureau of Soils, United States Department of Agriculture, mentions and quotes reports of experiments carried on at the Woburn experimental fruit farm near Bedford, England. These experiments, though apparently very simple, revealed some very significant results of the interrelation of the plants used in observations, and the effect upon the soil in which they grew.*

The experiments were carried on by the Duke of Bedford and Spencer U. Pickering on the Duke's estate, with apple trees; their growth being compared on land covered with grass sod, on uncultivated land in competition with weeds, and on the land kept in clean culture.

"The reports of the Woburn farm for the years 1897 to 1905 include accounts of most significant and interesting observations upon the effects of one plant relative to another through the apparent intervention of toxic materials."

These authors stated in their report for 1897 that the trees surrounded by grass or weeds showed a much poorer growth than those under clean culture. The effect was most pronounced in the case of the grass. In the interpretation of the causes, the authors pointed to the absorption of the nutriment materials, the promotion of excessive evaporation, and the prevention of aeration by the grasses and the weeds.

"Three years later, in the report of 1900, the statement was made that about the worst treatment to which young apple trees could be subjected was that of sowing the surrounding soil to grass. Trees which were purposely improperly planted and afterwards entirely neglected, exhibited better growth than did trees surrounded by grass. Normally cultivated trees increased in weight in four years ten to thirtyfold, while those surrounded by grass barely doubled their weight.

*Not having access to the reports of these experiments, I take the liberty to quote freely from the above mentioned bulletin, or to make abstracts of them.

Neither the weeds alone, nor weeds coupled with careless planting and total neglect produced such bad effect as the grass.

"In yield of fruit, the trees surrounded with grass showed a deficiency of 89 per cent., the neglected trees 82 per cent., and trees of weed plots of 55 per cent. below the normal."

In 1903, another report brought out additional points. "The roots of the trees injured by the grass were examined and found to be obviously unhealthy, long and straggling, dark in color and more slender than normal roots. They showed no tendency to grow downward away from the grass.

"Young trees planted in a pasture with all the sod replaced around them died during the first season, whereas, when even a small area of sod was permanently removed, they lived. In another case, where holes three feet in diameter were opened in the sod, the trees planted and the sod replaced, at the end of two seasons, the trees which were still alive exhibited a growth of 32 per cent. below normal, and the mortality of the whole series was 72 per cent."

As these experiments proceeded, the following are some of the additional facts brought out: Trees eight years old, growing and fruiting normally in cultivated ground, became unthrifty the first season after sodding.

Young trees planted with a small circular area of sod about them were retarded in their growth until their roots penetrated beyond the sodded area, when they recovered in growth and healthy appearance. Conversely, when the trees were planted in a sod-free area, they grew well until their roots penetrated into the sodded area beyond, when the evil effect became visible both in foliage and fruits.

Artificial watering, feeding, exclusion of air, as well as aeration, showed that the effects of the grass were independent of those factors. Strong root pruning every year stunted the growth of the trees more than did the presence of grass, but showed a different effect.

In view of the mass of evidence brought out, the authors of these experiments concluded: That the action of the grass is not merely a question of starvation in any form, nor of any simple modifications of the ordinary conditions under which a tree can thrive, but that the grass has some actively malignant effect on the tree, some action akin to that of direct poisoning.

The report for 1905 maintains that the diminution in the size of the leaves of trees grown in grass is less than the change in their color, which, in itself, is due to a diminution in the chlorophyll of both the leaves and the fruit. The fruit is, therefore, more highly colored than on trees under clean cultivation. They also observed that some of the grassed trees bore quite uniformly a greater number of fruits than the normal ones, and offered the explanation, "That this is an example of the well known fact, that any check of the growth of a tree, if not too severe, causes an increase in the crop." "In fact, the whole results observed are but an illustration of how a form of treatment, which when carried to excess is highly injurious, may, if adapted in moderation, lead to beneficial results. It is a case of poison proving to be valuable in minute doses."

Grass may, therefore, be employed with benefits under certain conditions; as, for example, to advance maturity, or earlier fruitfulness

in trees tardy in bearing, because of continuous and excessive growth. Certain varieties of pears and apples, when grown on very rich land, fail to mature their wood for fruit production, or the formation of fruit spurs, if such land be in a high state of culture; but, if grass be allowed to take the place of cultivation, early maturity of the wood and the consequent production of fruit is most likely to ensue.

This very exceptional advantage of grass and non-cultivation in the orchard was advocated as being general for all fruit trees and on all kinds of soils by the late Mr. Stringfellow.*

That soils may be or become infertile, in spite of the presence of sufficient plant food, is strongly set forth by Schreiner and Shorey.

The following is the opening paragraph of their bulletin† dealing with the causes of soil fertility: "Investigations into the causes of infertility of soils have established three facts, which may be considered fundamental in any discussion on this subject; these are: First, soils may be infertile because of the presence in them of some substance or substances inimical to plant growth. Second, many plants produce and possibly excrete, as a result of growth, organic compounds which are poisonous to the plants producing them. Third, many of the organic constituents of plants which, on the death and decay of vegetation, find their way into the soil, or compounds which arise during the subsequent changes in the soil, inhibit growth when presented in the solution to the growing plants."

The truth of these statements was fully borne out in the experiments, when plants grown in soil which contained an abundance of plant food became unthrifty after having been watered with water extracted from infertile soil, or from soil upon which a previous crop had failed to thrive. The same kind of soil, when watered with distilled water, gave a much better plant growth.

The authors of this bulletin not only proved in an indirect way the presence of farmful substances peculiar to unfertile soils, but eliminated such substances and directly tested their effect on growing plants.

Circumstantial evidences testifying to these facts are not wanting in practical agriculture. The grass, on meadows which remain unbroken for a series of years, soon becomes thin, vigorless, and of a mixed stand. Even as strong a growth as Johnson grass loses its stand if the soil is not broken by plowing every few years. Undisturbed, the ground of such a meadow becomes filled with dying and decaying root-stalks, while the vigor of the living ones appears as greatly reduced as if a chronic disease had infected the soil. It is also a common observation that a peach tree, roses, and many other trees and shrubs, when planted in a place where one has previously died, rarely prove to have any more than an unhealthy and lingering existence.

STREET PLANTING IN BERMUDA SOD

The Bermuda grass is, of all grasses grown in our region, perhaps the most inimical to the growth of trees; yet a very common way of street and park planting in our cities and towns is to set the trees

*Chapter IX, The New Horticulture.

†The Isolation of Harmful Organic Substances from the Soil. Bulletin No. 53, Bureau of Soils.

directly in the Bermuda sod, without any attempt to guard them from the baleful encroachment of the grass. It is, therefore, not an uncommon phenomenon in our State, even in cities and towns of pretensions, to see plantations of trees, intended for shade and ornaments, turned into eye-sores.

THE SITUATION OF AN ORCHARD

The contour of the land upon which an orchard is situated, as well as its location with reference to forests, large bodies of water etc., are of great importance to the thriftiness and fruitfulness of the trees.

High or sloping land is generally preferred to low and level land. Fruit culturists speak of such a thing as "air drainage." It has frequently been noticed that in a late frost, peach trees occupying the higher grounds, as for example, the top of a hill, or the upper part of a slope, frequently escape with their fruit buds uninjured, while the buds on those of the lower, adjacent lands are killed. This is supposed to be due to the fact that the colder air, being heavier, drains off from the higher ground and settles on the lowland. Also, the temperature being equal, frost is much more liable to do injury in the calm air of the lowland than in the swifter current on the exposed hill, or on the slope.

Reasons of this kind are, however, only general and must vary with other factors, such as the nature of the humidity and the swiftness of the wind during the freeze.

The direction of the slope is worthy of great consideration. A slope towards the south, or southwest, is, in the first place, exposed to the prevailing summer winds, which at a distance from the Gulf coast becomes parchingly dry; especially since their persistency and velocity seem to increase with the drouth. In the second place, trees planted on a southern slope are also liable to be aroused from their dormancy too early to escape destructive freezes in the spring.

A slope to the north or northwest is, therefore, to be preferred where a choice can be made. A slope in that direction is not only less exposed to the evaporation due to the parching sun and winds of the summer, but sudden changes of the winter are less felt, since the thawing and heating of the soil is slower after each freezing.

Large bodies of water have a most powerful effect in ameliorating the climate by preventing sudden changes, which are so frequent in the early spring, and the most common cause of failure in fruit crops.

Because of the influence of the Great Lakes, failures in the peach crops are no more frequent in Michigan and along the southern shores of Lake Erie and Lake Ontario than in the eastern half of Texas. In fact, the recent Atlas of American Agriculture, compiled by the Office of Farm Management, United States Department of Agriculture,* shows that killing frost, ten or more days later than normal, has occurred less frequently during the last twenty years in the peach-growing region of the Great Lakes than anywhere in Texas.

Forest belts are more efficient protectors of fruit trees against the extremes of both summer and winter. The severity of the blizzard,

*Part II, Section 1, Frost and the Growing Season.

both as to temperature and velocity, is checked in passing through a forest. Similarly, the prevailing hot and dry southerly winds, so frequent in the summer, lose much of their devastating effect in passing through a forest.

WOODLOTS FOR SHELTER

In the exposed prairie regions planted, shelter belts are not only a necessity for the protection of orchards, gardens, dwellings, and outhouses, but can be so planted as to become the most valuable and permanent investment of the farm. The present use of lumber for all kinds of purposes is so vastly exceeding the natural forest growth that only general planting on every farm, in every section of the land, where timber is absent or becoming scarce, can obviate the imminent famine.

The economic, as well as the most effective way is, therefore, to plant for shelter and windbreaks, not merely a narrow strip of a few rows of trees on the windward side, but a grove of forest trees that will act as a windbreak and shelter, as well as yield materials for posts, fuel, and numerous other things, for which timber is needed on a farm. Besides these purposes, the aesthetic value, or the value for beauty and pleasure to a farm home from such a planting is alone worth its keeping.

The sketch* on the following page, Fig. 1, will give an excellent idea of the arrangement of such a planting.

It will be noticed that this plan provides for three woodlots, namely: one to the north, 40 rods long by 20 rods wide; another to the south, 33 rods long by 10 rods wide; and the third to the west, 32 rods long and only 5 rods wide. The residence with the lawn and the barn and the other outhouses and yards, as well as the orchard and garden, are enclosed on the three sides most exposed to prevailing winds of all seasons.

This plan is proposed for farms in western Kansas; but, since the prevailing winds in Texas are from the same direction and equally hurtful, the same arrangement is ideal also for our State.

It will be noticed that this plan is intended for a farm with its dwellings located at the corner formed by the crossing of two public roads; but modifications can easily be made for other locations as well as for other dimensions of the yard and lots, without abandoning the principle of protection involved.

PLANTING AND SELECTION OF SPECIES

The planting should be so done as to obtain the actual forest conditions as early as possible; that is, shading of the ground, and the ground covered with an ever-increasing layer of litter from fallen foliage and twigs. To secure this condition, the ground must be flat-broke, harrowed, and in every way prepared for the planting as for cotton or corn. The trees should be set in rows, at a distance of not more than 10 feet apart each way.

The species to be selected will naturally vary with both the climatic

*From Bulletin No. 52, Bureau of Forestry, U. S. Department of Agriculture.

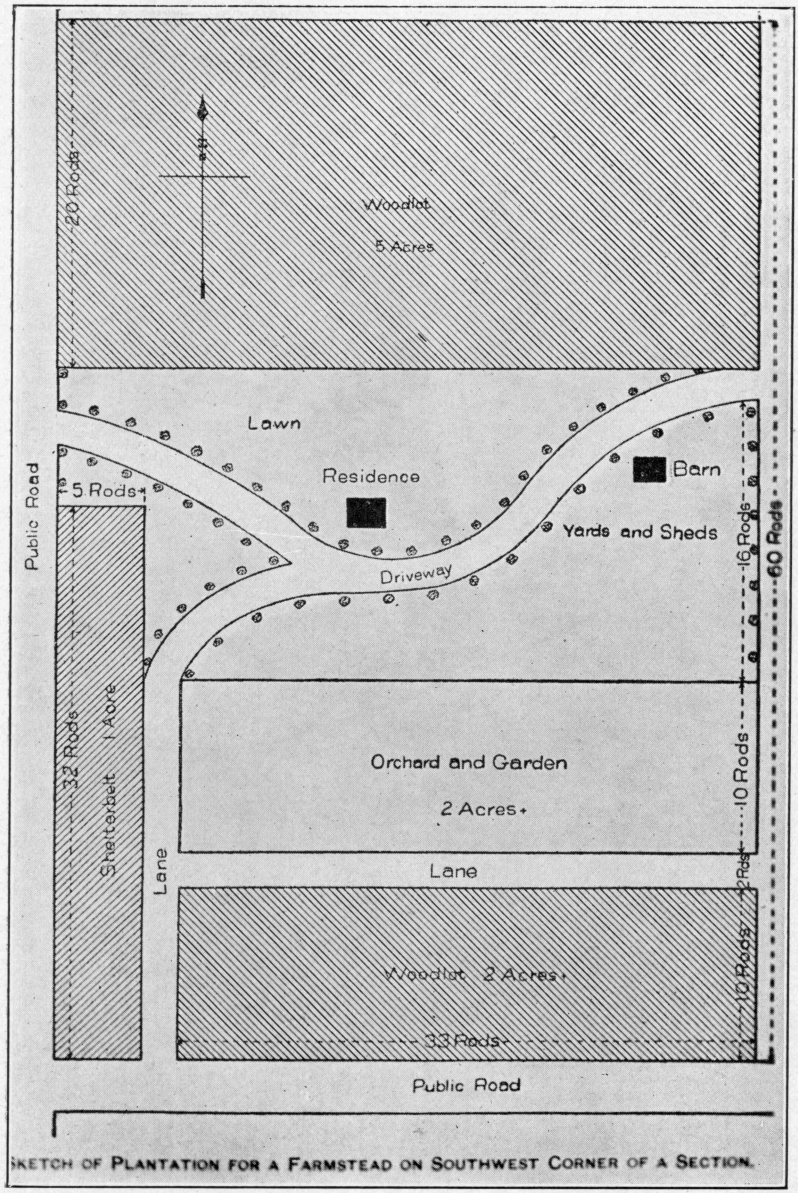

Figure 1.
(From Bulletin No. 52, Bureau of Forestry, U. S, Department of Agriculture.)

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region of the State and the soil of the locality; yet in all places the following qualities should be kept in view; *the fitness for windbreak, the value for timber, the longevity and the beauty of the trees.*

Fitness for windbreak will include hardiness of growth, size and form of the tree, density and persistency of foliage.

The value for timber will depend upon the use to which the timber is to be put. Some species, such as catalpa, the native mulberry, black locust, and bois d'arc are especially valuable for posts, since they are also to withstand rotting in contact with soil and water. Other species, such as the oaks, black walnut, ashes and pines, are valuable for more general purposes.

In regions where windbreaks are especially needed conditions for tree growths are generally so severe that the life of short-lived trees is made still shorter. Many trees that habitually are of a fast growth in their youth and, therefore, often preferred for planting, are easily stunted or killed when exposed to the accidents of drouths and winds. A planting of that kind soon becomes irregular through losses to its stand and fails to develop that forest condition under which the trees mutually protect each other. Some species, like the hackberry, the cedar elm, or upland elm, and even the Russian mulberry, readily drop their leaves during a midsummer drouth and stand naked during the season, when protection is most needed. A strong foliage, persistent in drouths, and a habit of growth resistant to the winds, are necessary qualities to shelter belts in our open prairie regions.

The beauty of the trees is a feature of great importance, not only from a sentimental point of view, but also from the actual enhancement in value, which it gives to the whole farm. Beauty is, in this case, concurrent with good service; while unsightly trees are sure to fail in their purposes of shelter and shade.

The appreciation of the home-like comfort and hospitable appearance, which a little judicious planting will give to a farmstead, is frequently ignored by the rural population of our State. This general bareness of the farmsteads is often obvious to the traveler; and it sometimes happens that, where a farm house is placed on a hill of the proper height and distance from the railroad, the passengers may, in passing, have a peep at the sky on the other side, by looking underneath the house, as it stands perched on its stilt-like pillars, the view unobstructed by anything in rear or in front. This may occur in a locality where the land is valued at one hundred and fifty dollars per acre.

The observer will meet with quite a different sight in the better residence parts of our larger cities. There, beautiful trees and flowers are gracing the yards and making the homes look social and attractive and, in many cases, offering a real feast to the eyes of the passerby. Perhaps it is this very contrast between country and city homes that is the cause of the exodus of the best of our country youths from the farm to the city, now so generally complained of.

REGIONS OF RAINFALL IN TEXAS

According to the amount of yearly rainfall, Texas may be divided into five longitudinal zones, the western limits of which can approximately be outlined by more or less curving lines passing from Red

River, or the northern boundary of the State, to the Gulf and the Rio Grande in the south.

The following map shows these lines with the amount of average yearly rainfall in inches for each zone.

The eastern zone, which has a rainfall of 50 inches, includes in its southern half what once constituted the region of the long-leaved pine in Texas, and in the northern half the region of the short-leaved or yellow pine.

This eastern zone together with the next, which has a rainfall of

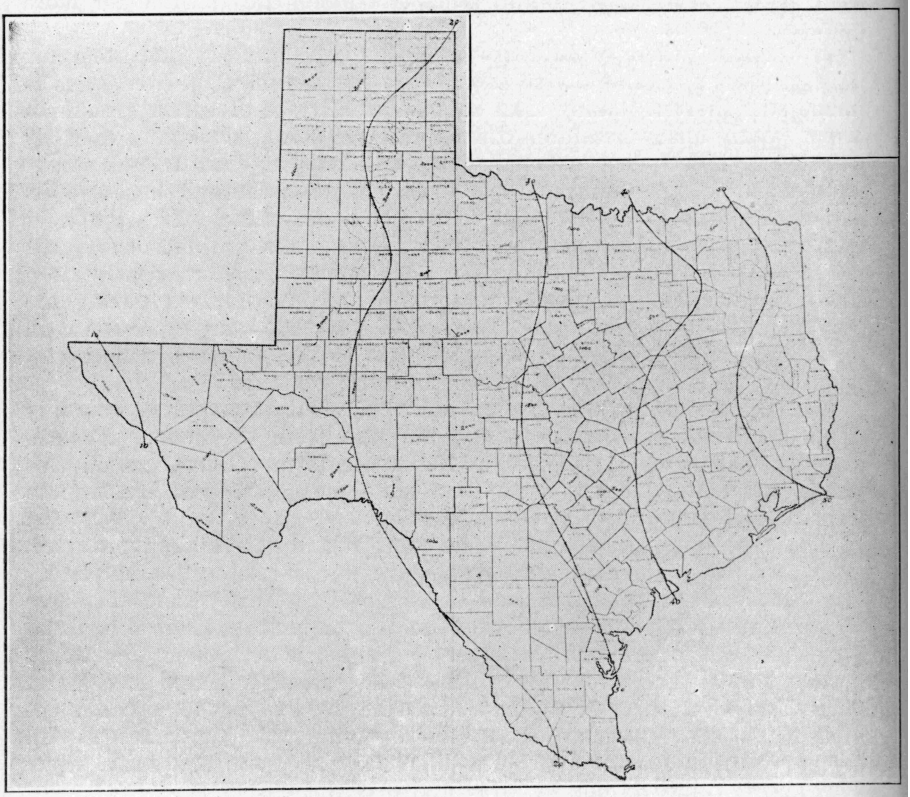

Figure 2. Map of Texas, Showing Regions of Rainfall.

40 inches per year, covers what originally was an area of more or less solid forest in Texas. West of this second zone, the treeless prairies become more and more dominant with only scattered bodies of forests along water courses and in spots where the surface is made uneven by valleys and hills.

In these two first zones the rainfall is sufficient to accommodate any species of trees thriving in the States to the east. The next, or third zone, with the rainfall reduced to 30 inches, has its western limits passing through Wichita County in the north, through San Saba in the center of the State, and Nueces County on the Gulf. In this zone

most of the species of trees adapted to the eastern zones will thrive in the rich bottoms or the alluvial lands along water courses, and on uplands having a soil of the proper texture for the retention of moisture and root development.

The line describing the western limits of the fourth zone, which has an average rainfall of 20 inches for the entire area, takes its start at the northeastern corner of the Panhandle, curves to the southwest until it reaches the southwestern corner of Randall County, in the very center of the Panhandle, thence making two more curves, one eastward, the other westward, before reaching the Rio Grande in Val Verde County.

As we pass westward across this immense zone, the woody vegetation becomes more and more scattered and dwarfed until it is finally reduced to what is called shinneries and chaparrals.

The larger part of the surface is held by the grasses. Yet the eastern half of the zone, which, when considered by itself, has a rainfall of 25 inches, will on suitable soil with proper cultivation and without, or with very little irrigation, grow a large number of forest and fruit trees to normal development. Further west, as the rainfall decreases, the number of species which may be expected to succeed without irrigation becomes smaller and smaller, and the difficulty of starting the growth becomes greater. But in the direct proportion as the difficulty of a successful plantation increases, the necessity for its existence increases.

For this region and the remainder of the State to the west of it, which includes the Trans-Pecos country, there is so little tree planting done in Texas that it is necessary to go out of the State for object lessons.

The nearest State with plantations old enough to draw examples from, both in regard to species best adapted to the arid conditions and care needed in their cultivation, is Kansas.

SPECIES OF FOREST TREES FOR WEST TEXAS

As a premise to the short catalogue of trees which may be grown in the region having a rainfall of 20 inches or less, it may be stated as a law in regard to the growth of trees *that a favorable soil goes much further in overcoming an unfavorable climate than a favorable climate does towards overcoming an unfavorable soil.* The direct factor that determines the choice of species for each locality is, therefore, the moisture condition of the soil, the moisture condition of the atmosphere being only an indirect factor. By abundant irrigation, swamp vegetation may be made to thrive in the midst of a desert.

As a plantation of this kind is to serve a variety of purposes, it should, if possible, be made up of a variety of species.

One or more of the outer, or border rows, on the windward side of the plantation ought, wherever it is possible, to consist of coniferous evergreens; such as red cedar, or some species of pines or cypresses adapted to the region.

RED CEDAR

This tree needs no introduction, as it is known in all parts of the State. Being adapted to a very wide range of conditions, it is found

in native state from the moist, rich bottom lands to the dry, sterile chalk hills. In Kansas at the forestry station of Dodge City, which is located under the 100th meridian, and has a rainfall of 20 inches, this tree is doing well.

PINES

Two species of pines are reported upon from Dodge City in Bulletin No. 165 of Kansas Experiment Station, namely, the Austrian pine and the Scotch pine. Concerning the Austrian pine the following statement is made: "The Austrian pines have done bravely and have been particularly successful, making finely formed trees in spite of their constant exposure to the wind. They have made a regular growth and demonstrated their value for planting in locations, where trees are most needed." The report on the Scotch pine is also favorable. It compares well with the Austrian pine in hardiness and rate of growth, but the young trees are stated to be slender and more liable to become deformed by the wind.

In visiting a nursery near Clyde, in Callahan County, some years ago, the writer saw four-year-old specimens of both Austrian pine and the native bull pine, also called western yellow pine, which for vigor and beauty left nothing to be desired. They were growing on sandy land underlaid by red gravelly clay. This land was originally occupied by a growth of shin oak.

Both of these species of pines have been tried and proved failures on our experiment grounds at College Station. This failure may be due to the shallowness and compactness of our soil, or to the low altitude, or both in combination. Pines, firs, and spruces are very sensitive to both altitude and latitude. The elevation of Callahan County is between 1500 and 2000 feet, while that of Brazos County ranges from 200 to 400 feet.

Other species of pines tried at College Station have failed, on account of a shoot-boring larva; except the long-leaved pine, which is immune to this pest and is promising perfect success on our grounds.

CYPRESSES

Of this genus of coniferous trees there are two species which can be recommended, not only for the arid plains region of the State, but as equally suited to nearly all parts of the State, since their adaptability to soils and moisture condition is ample enough for nearly all parts.

The first, or the Italian cypress, is known to the horticulturists under a number of names, such as the horizontal cypress, the pyramidal cypress and the fastigiate cypress, all according to the forms or varieties in which it occurs.

This tree, which is a much more rapid grower than the red cedar, or any of the pines, reaches a height of 70-80 feet. It has been planted in this country only for ornamental purposes, but is a timber tree of first rank as well. There is no conifer with wood more resistant to decay, nor one that resists greater hardships and still maintains its growth.

There is one specimen of this tree on the grounds of the A. and M. College. It stands in front of the Civil Engineering Building in extremely poor and impervious sod. Some thirty years ago the grass

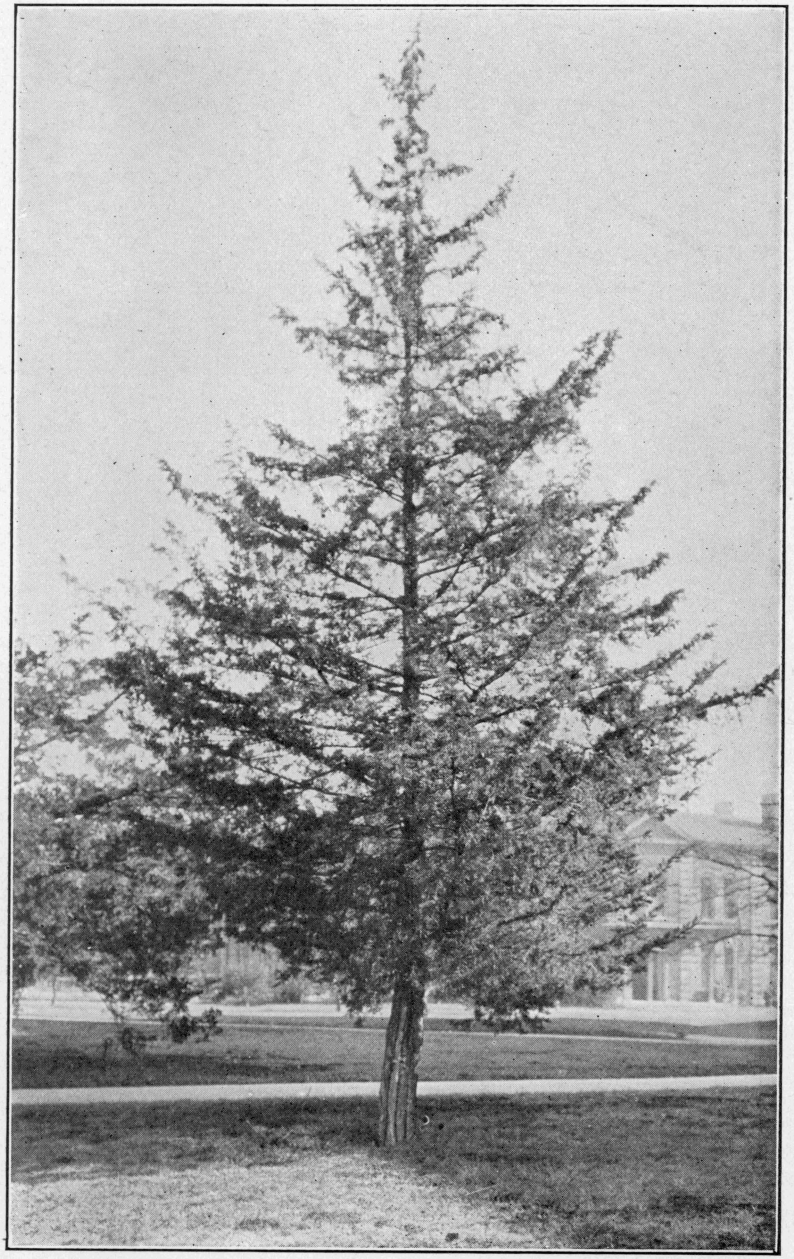

Figure 3. Italian Cypress with Injured Trunk.

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Figure 4. Italian Cypress on the College Campus, Four Years After Planting.

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Figure 5. Italian Cypress Planted for Windbreak; Three Years After Planting.

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Figure 6. Arizona Cypress on Lawn of Research Administration Building; Four Years After Planting.

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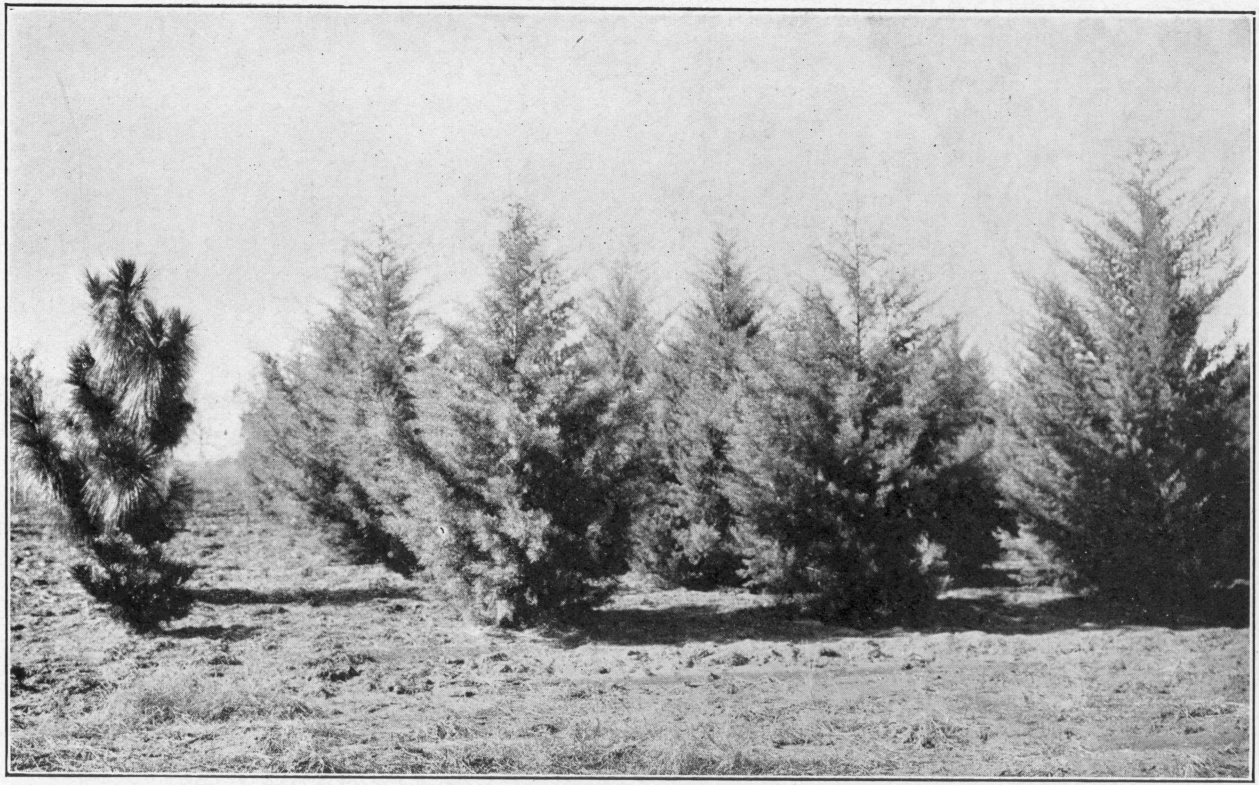

Figure 7. Group of Arizona Cypresses in the Station Arboretum; Three Years After Planting. Long-leaved Pine to the Left.

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took fire, the flames of which killed all the lower branches and the bark of the trunk from the ground to five feet above, leaving the wood exposed on one-half of the circumference. About six years ago careless workmen cut off a large slice of the bark on the opposite side. In spite of all this injury, the tree is growing and slowly healing both wounds. The dead wood, which on the burned side has been exposed for so many years, shows no signs of decay, nor has any decay fungus found a lodging place upon it. When cut into, it proves as sound and hard as old seasoned timber under continual protection from weathering. The lowest temperature recorded at College Station during the last thirty-three years is about 4 degrees F. below zero, which left this tree uninjured.

ARIZONA CYPRESS

This cypress is, as the name indicates, native of Arizona, where it grows in the mountains at an altitude of 5000 to 6000 feet. Though native, it is less known in cultivation than the Italian cypress. It reaches a height of 30 to 40 feet and in very favorable situations even 70 feet. A goodly number of specimens of this cypress have been raised and planted in recent years on the grounds of the A. and M. College and the Experiment Station. They have proved perfectly hardy, both in extreme drouths and in extremely wet seasons, on a soil very unfavorable to trees. The rapidity of their growth is even greater than that of the Italian cypress, and their beauty is much superior. The form is uniformly pyramidal, but the color varies in the different individuals from bright green to brilliant silvery. The prevailing summer wind does not distort their form. This tree has also been planted at the substation of Lubbock, in the south-central part of the Panhandle, and has there proved itself as thrifty as at College Station. Concerning its timber value, I have no knowledge or records.

The Italian cypress is the tree most generally used in southern France as windbreak for orange groves, vineyards, and orchards. Furthermore, these two cypresses are not only suitable for windbreaks in all parts of Texas and throughout the entire South wherever trees can be made to grow, but they are also, together with several other species belonging to the true cypress genus, the most beautiful ornaments for lawns and parks. For cemetery plantings, several species are classic, having been so employed both by the Greeks and the Romans and the most ancient, civilized races of Asia.

DECIDUOUS TREES

The following species of deciduous trees have done well at Dodge City Forestry Station* in western Kansas, and may be expected to behave in a similar manner when planted in that part of Western Texas having a rainfall of 20 inches per year, or less:

Green Ash
Black Locust
Honey Locust
Osage Orange (Bois d'arc)
Kentucky Coffee Tree
Black Walnut

*Bulletin 165, Kansas Experiment Station, Division of Forestry.

Other species mentioned in the same publication as having been tried with less success are:

Hackberry
White Elm
Russian Mulberry
Tree of Heaven
Russian Olive
Cottonwood
Catalpa

From the behavior of the species in the second list on the grounds of the A. and M. College it may well be inferred that they are poorly suited to the conditions of arid and windy West Texas. The elms and the hackberries drop their leaves too readily. In the catalpa the leaves are too large, and so tender as to be easily lacerated by the winds. Ailanthus, or the Tree of Heaven, has produced, on our grounds, only specimens of distressed and naked appearance. The Russian Mulberry is more of a large bush than a tree. It is readily aroused into growth too early in the spring, and, therefore, liable to injuries and destruction from late frosts.

OTHER DECIDUOUS TREES WORTHY OF TRIAL

In places of the plains region where the water table in the soil is not too deep, and where good wells may be obtained at a depth of 15 to 30 feet, many other species of deciduous trees are sure to succeed. Deep-rooted hardwoods, such as the pecan and certain species of oak, are all worthy of trial.

PECAN

Since the pecan is at once both fruit and ornamental tree of the highest rank, it should be planted so as to serve both purposes. This is best done by planting it as an avenue tree along the driveways as indicated in plan shown by plate No. 1. In this position the trees can be given all the room to develop the unrestricted form required both for fruit production and for ornament and shade.

The pecan is native from southern Illinois and Indiana to the Gulf and westward, as far as the valley of the Concho River and Laredo on the Rio Grande River. Its natural habitat seems everywhere to be the alluvial soil along the water courses, but when planted on good upland soil, its vigor and productiveness are no less. The first year after being transplanted, the pecan is apt to suffer severely from the loss of its tap root. For that reason very young trees with tops trimmed well back are most liable to survive the transplanting, because they can more easily repair the injury to the root system. When the pecan has overcome the injury from transplanting, it becomes at once an extremely hardy tree, and can then withstand such hardships as few other trees can.

In the wild state, the pecan seems to reach its highest development in the production of nuts, both as to quality and quantity, in the counties drained by the Colorado River and its tributaries to the northwest of Austin.

It is generally conceded that the cultivated varieties originated in that part of the State are best suited to dryer regions, while the vari-

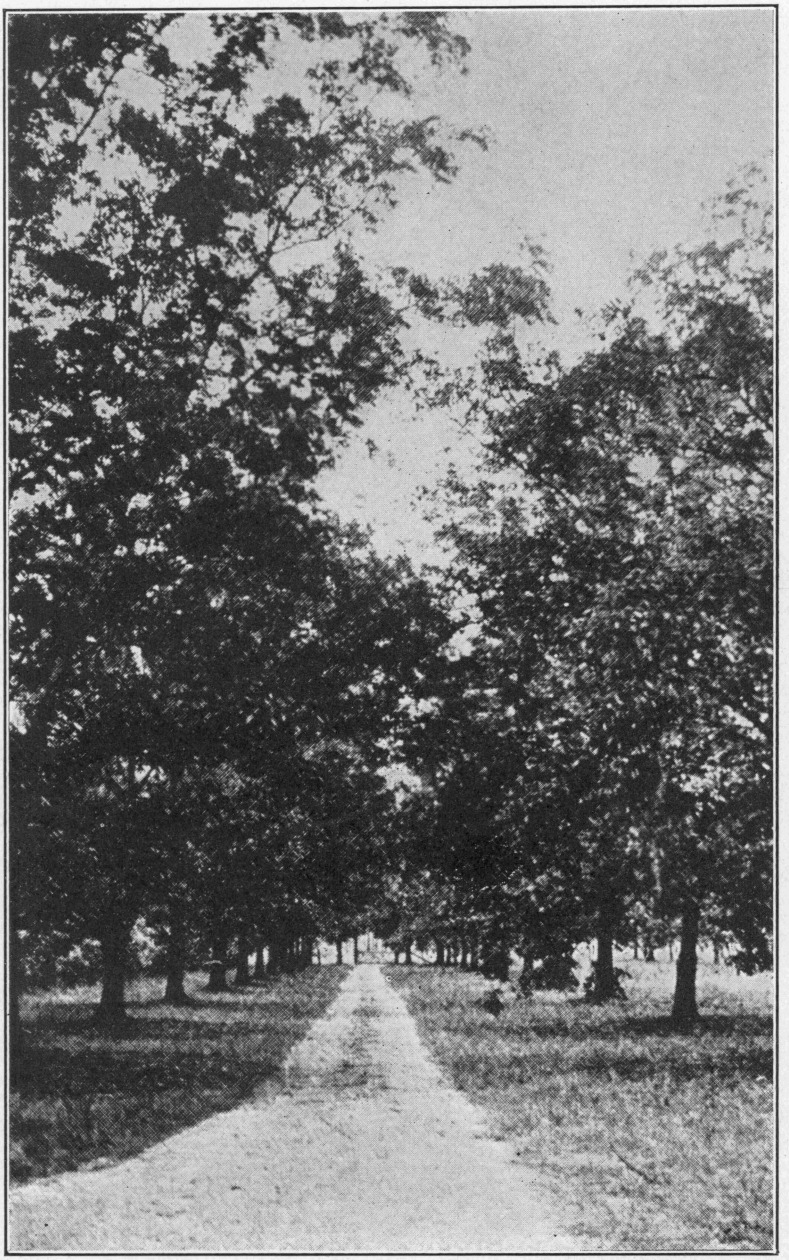

Figure 8. Avenue Shaded by Pecan Trees. (After Hume.)

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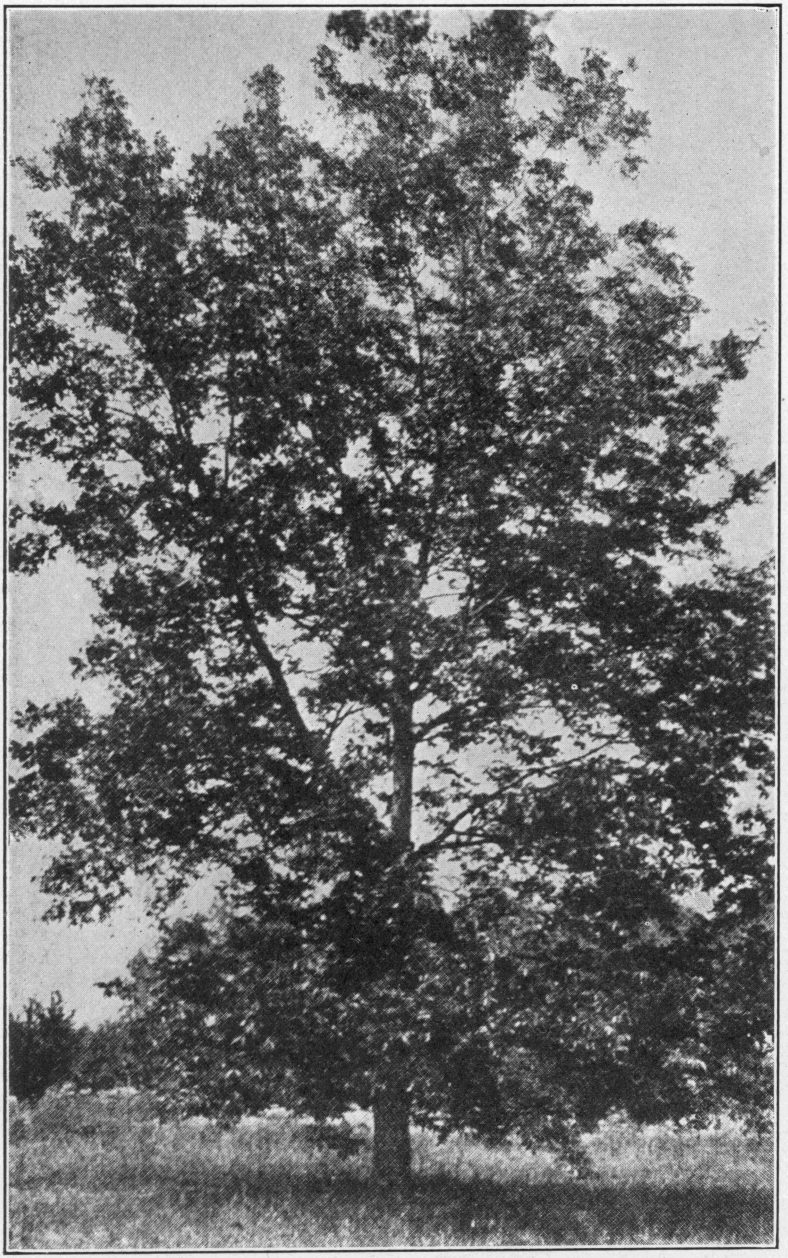

Figure 9. Pecan Tree at Twenty Years of Age. (After Hume.)

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eties originated under the moister climates of the east are better suited to the eastern or more rainy belts of Texas. In any region, the planting of grafted varieties of which the fruiting quality is known, is to be preferred to the planting of unknown seedlings that may be poor bearers, or even sterile.

OAKS

The most valuable as well as the largest and handsomest of the oaks belong to the white oak section of the oak genus. Their preference as to soil is similar to that of the pecan, namely, the rich bottom lands. The natural distribution of some of them is very wide, as it ranges from Canada to the Gulf, and from the Atlantic States to West Texas and the region of the great plains, wherever there are river valleys and alluvial deposits.

As the most important timber trees among our native oaks having the farthest western distribution may be mentioned:

Bur Oak (*Quercus macrocarpa*).
Chinquapin Oak (*Quercus accuminata*).
Live Oak (*Quercus Virginiana*).

The bur oak, or mossycup oak, as it is sometimes called, because of its bur-like cup, fringed at the top with a rim of moss-like fibres, is one of the most valuable of the oaks because of its great size, reaching sometimes a height of 150 feet, its durable wood, and its majestic beauty. It attains its largest size in river bottoms of Illinois and Indiana. It is frequently met with in Texas as far to the west as the Nueces River Valley. Its northern limit is given as the valley of the Red River of the north.

The chinquapin oak is also a large tree, being 100 or more feet high in favored localities. It covers nearly the same territory as the bur oak, and is reported by William Bray* as occurring in the Guadalupe Mountains of West Texas.

The live oak is strictly southern, having its distribution from Virginia to the Rio Grande Valley in Texas. Its greatest size is reached in the bottom lands of the Brazos and San Bernard rivers in southern Texas. It is also found covering poor sand hills and dry slopes of lime rock, where it becomes dwarfed in size.

TAMARISK OR SALT CEDAR

There is, perhaps, no tree more capable of withstanding the severe condition of the plains region than the tamarisk. It is a small tree, but because of its dense growth and great hardiness is especially suited as a border tree of windbreaks and woodlots, where it may give shelter to other trees less hardy. It grows well, even in soil strongly impregnated with alkali; and when planted on the seacoast will even endure the sea water both as a spray and in the soil. In the town of Pecos this tree has been extensively planted in the yards and along the streets, where it has made an excellent showing, and in a few years reached a larger size and more of tree-like proportion than is usual for it in regions of abundant rains. On the grounds of the State Experiment

*Bulletin No. 82, University of Texas.

Station at Lubbock, the tamarisk is being used with excellent effect as an ornamental hedge, for which purpose it is well adapted, because of the ease with which it can be controlled by pruning and training.

TREES FOR THE REGIONS OF MODERATE TO AMPLE RAINFALL

As the rainfall increases in passing eastward across the State, so the number of species of trees that will succeed increases. In the case of those deciduous trees which have a very broad latitude of distribution, the choice is only dependent on the soil; but in the case of the conifers and other evergreens, it is necessary to take into consideration the latitude and altitude of their native habitat. Spruces, firs, and pines are exceedingly sensitive in this regard and must not be expected to thrive in a low situation if their nativity be northern. Even in the third zone with only 30 inches of rainfall as given on our map, the greater number of our eastern forest trees are at home, wherever the water courses traverse the prairies, or where the even contour of the prairies has been broken.

The central part of this region is, as already stated, the native home of the pecan. Here are found nuts in which large size, excellent flavor, and thin shells are most frequently associated.

Besides the pecan, the most common large forest trees of this region are:

Post Oak
Bur Oak
Chinquapin oak
Live Oak
Red Oak, var. Texana
Water Oak
Box Elder
Cedar Elm
White Elm
Cottonwood
Sycamore
Green Ash
Hackberry

In the next two zones to the east, having 40 and 50 inches of rainfall, respectively, the following species are, in addition to those of the list above, the most important native trees conspicuous for their size, beauty, and quality of timber:

White Oaks.—White oak (proper), overcup oak, basket oak.

Red Oaks.—Red oak (proper), Spanish oak, willow oak, water oak.

Of the hickories, the following three are recommended for the quality of their timber:

Shagbark Hickory
Muckernut, or Big Bud Hickory
Pignut Hickory

Other large trees:

White Ash
Sweet Gum

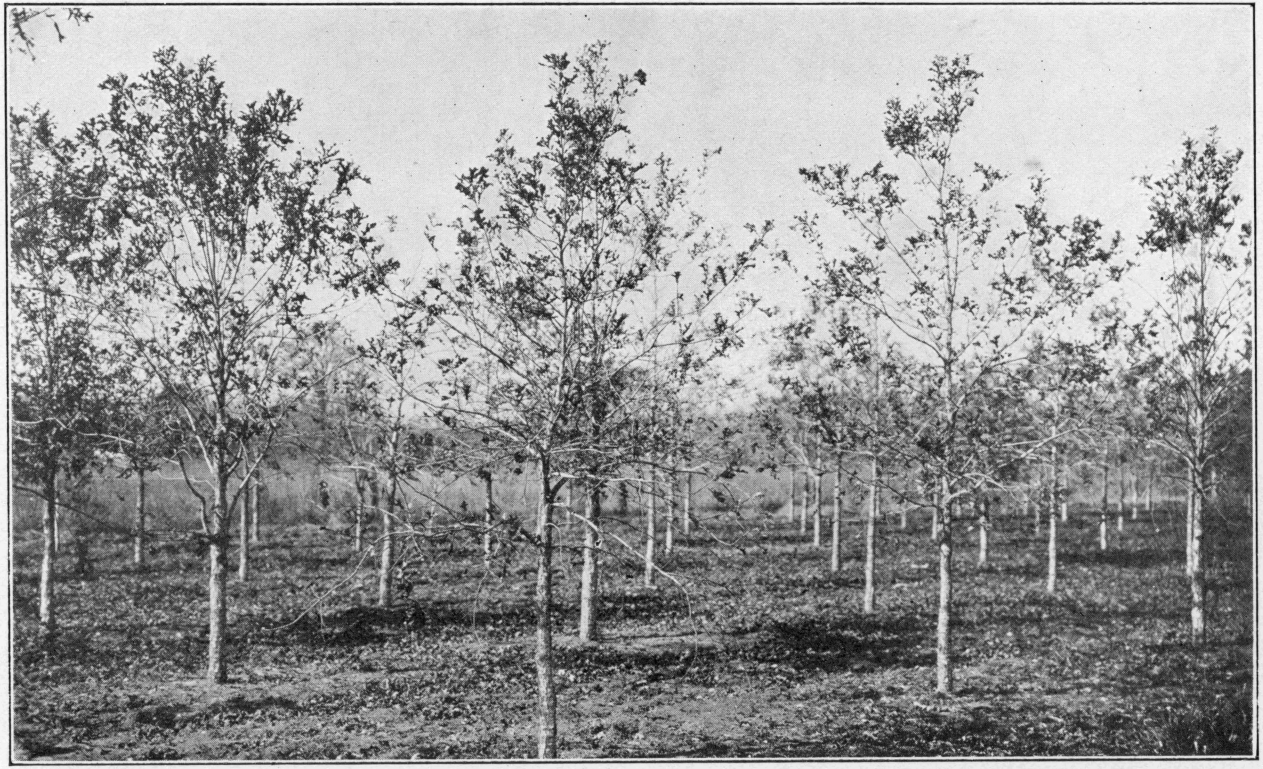

Figure 10. Overcup Oaks and White Oaks Planted in the Station Arboretum in February of 1916. Photographed December 1, 1920.

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Black Gum
Water Gum
Yellow, or Short-leaved Pine
Loblolly, or Old Field Pine
Long-leaved Pine

Of the pines, the yellow, or short-leaved pine, has the greatest distribution, forming forests from New York State to Florida and west to Trinity River in Texas. In East Texas it furnishes the greater part of the lumber. It is the tree that most readily replenishes the forest after clearing, or rebuilds the soil after destructive erosion, because of its ability to reseed itself and grow in situations where other forest trees fail.

LONG-LEAVED PINE

Of this, perhaps the most valuable timber trees among the pines, there is only the merest remnant left in Texas, the bulk of it having been cut for lumber. It reseeds itself with difficulty, because the tender seedlings seem to be easily injured if heavily shaded by larger trees. In spite of its botanical name, Pinus palustris, which means swamp pine, it prefers a well drained soil to a swampy condition. It is difficult to obtain a good stand from the seed, because of the liability of the seedlings to damp off during germination. On the grounds of the Texas Experiment Station it is, however, the only pine that has given promise of success, since it escapes the attacks of a shoot-boring insect that has put every attempt with other species to naught. A single specimen of this pine is shown on the left of the Arizona cypresses in Figure 7. It stands untouched, in close proximity to where a planting of four other species, among them the short-leaved and the loblolly pines, have failed because of this insect. The long-leaved pine seems to be well adapted to our soil, which, in general, is unfavorable to forest trees.

The experience obtained on the grounds of the main Experiment Station leads to the conclusion that the oaks are more successful on this stiff and shallow soil than any other class of deciduous trees; and that among them those of the white oak group are the best. Figure 10 shows overcup oaks and white oaks planted during February, 1916, and photographed December 1, 1920; hence after an interval of four seasons.

Several species of poplars and willows, some of them obtained from the dry regions of Central Asia and imported because of their drouth resistance, were planted on the same ground at the same time, and have received the same care as the oaks. About half of these poplars and willows succumbed to the severe drouth of 1918; those remaining have never fully recovered, being too ready hosts for borers and insect pests. The oaks seem to be entirely exempt from the pests, and made good growth, even during the drouth of 1918.

There is very little planting done of oaks and other hardwoods for shade or timber in Texas, because people are so generally afflicted with the erroneous notion that their growth is much more uncertain and slow than, for example, the hackberry tree, the box elder, the cottonwood, the elm, and the chinaberry tree. It must be remembered that the fast growth made by these trees lasts only for a few years of their

very early youth, while the growth of the hardwoods, especially the oaks, increases in rapidity for an entire generation of men, at the end of which time the yearly addition to the bulk of such a tree is incomparably greater than that of any soft wood tree at any time of its life.

The five large oaks of the white oak group mentioned above, the three hickories, the black walnut, and the white ash will thrive throughout the three eastern zones, when planted on good, tillable soil underlaid by a fairly pervious subsoil, and given, at proper time, a reasonable amount of cultivation and training.

Another tree to be recommended for the same kind of soils and conditions, is the tulip poplar. Not native in Texas, it reaches its western limits in northeastern Arkansas, and its southern in northern Florida. The tulip poplar, or tulip tree, belongs to the magnolia family and is one of the largest and, perhaps, the handsomest deciduous tree in the American forests. It furnishes the lumber called yellow poplar, and it will thrive both in bottom lands and on uplands, or wherever the shagbark hickory thrives.

PLANTING OF LEVEES AND RIVER BANKS

Besides planting trees for woodlots, windbreaks, and aesthetic purposes, another very urgent need has arisen in Texas, namely, the planting for the protection of alluvial bottom lands and levees against floods.

In clearing such lands for fields, a great thoughtlessness has frequently been perpetrated in removing every tree of the ancient forest cover to the very brink of the river bed and thereby every obstacle to the caving of the bank and the total removal of the soil.

The protecting effect of the forest to the river bank is easily seen, wherever a few, or even a single tree, by chance, has been left. The site of such a tree, or group of trees, will soon become a promontory through the wearing away of the bank on either side. The increasing recession of the bank may be noticed after every rise in the river, until the ground holding the tree, or clump of trees, has been surrounded. The promontory has then become an island which, by a little further erosion, soon topples into the river with everything on it.

It is easy to conceive from the resistance offered by a few or only one tree to the erosion of the stream what a solid, untouched forest along the entire bank might accomplish.

The erosion along the bank of the Brazos River and its encroachment upon the alluvial bottom lands on the side of Burleson County is especially severe, because on that side the original forest has been cleared away as though not needed for protection of the river bank. The consequence is that the river is continually cutting on that side, and thereby also endangering the safety of the three costly iron bridges which connect Brazos County to Burleson.

A levee has been constructed at what is considered a safe distance back from the river, and raised to a height sufficient to exceed that of the highest recorded overflows. But this levee is a wall of loose, naked dirt, which is readily worn down by heavy rains. Furthermore, in many places it is used as a path for both men and beasts, which also may endanger its effectiveness.

Much of the strip of land between the levee and the river is yet cul-

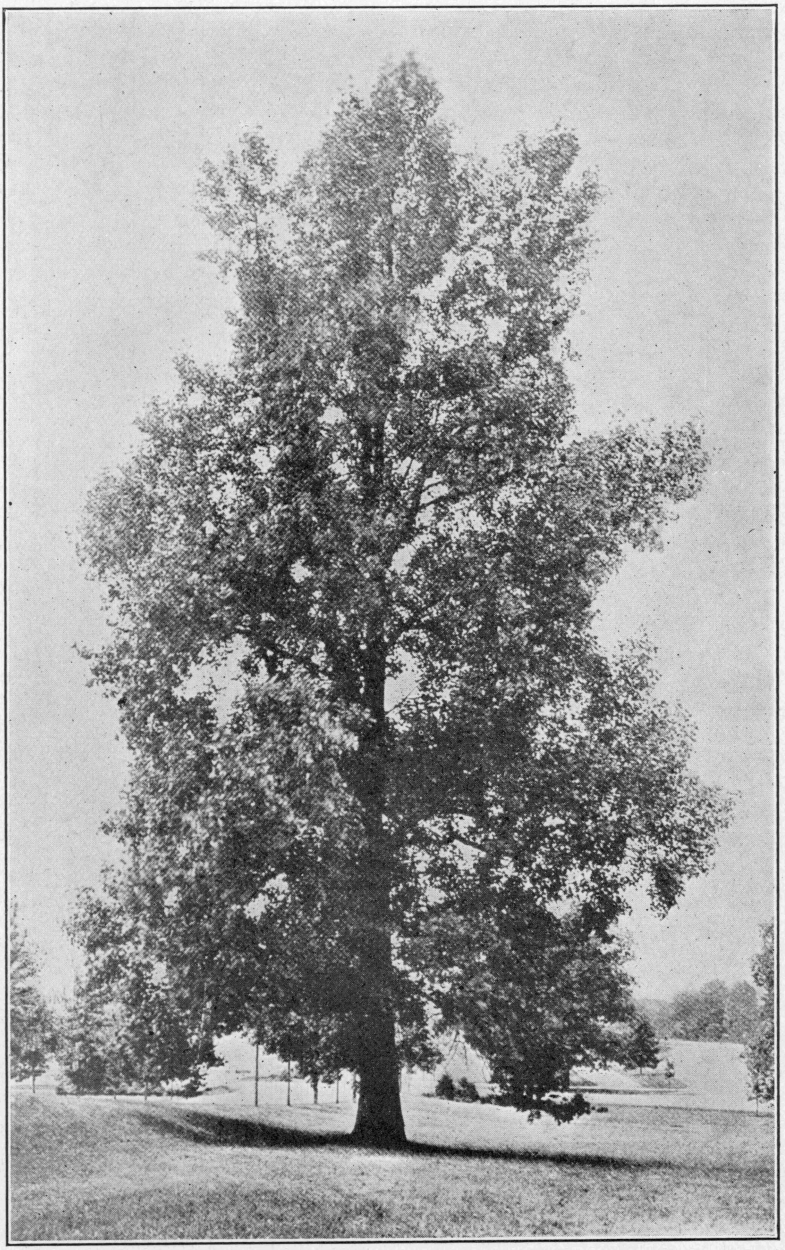

Figure 11. Tulip Tree in New York Botanical Garden. (From "North American Trees", by Britton.)

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tivated in cotton or corn and thus more than ever subjected to erosion from the strong current of the overflow, due to its confinement within the levee.

From its general contour, it is easy to conceive of the manner in which this alluvial plain, called the Brazos bottom, was formed, and to understand why the river, which deposited the sediment, now occupies the extreme border of it. As the deposits of silt and soil rich in plant food were made by the overflows—more or less periodic,—a vigorous growth of trees must have made its start. This increased in density and in variety of species with each succeeding overflow. The obstruction thus offered to the current favored the deposition of new sediments. By the increasing elevation of the land through these deposits of silt and the offal of the forest, the obstruction to the free current gradually forced the channel of the river to one side, while the deposits of sediment were laid down on the other. Now that the bottom land has been cleared, the very conditions that caused its formation have been removed, and the current of an overflow runs unimpeded and free to carry off the soil that it once deposited.

A part of the city of Sacramento, California, adjacent to the river of the same name, is situated several feet lower than the bottom of that river, the channel having become filled with silt due to the hydraulic mining of early days. The river is now held within its ancient channel by means of a levee which is planted on the side of the river from the water level to its top with weeping willows. The roots of these willows not only fill the soil of the embankment, but form also a dense matting, which serves as a living lining at the bottom of the river next to the embankment.

It is evident that similar planting should be made for the protection of the river banks and the levees in Brazos bottoms and elsewhere in the State where similar conditions demand it.

Bermuda grass, which is being used, makes in the loose soil a sod utterly unfitted for the purpose. Nor is there another grass that can quickly and completely cover the ground and form a sod that would stand the test. The problem resolves itself, therefore, into the proper selection and planting of trees.

For the conditions existing in Brazos bottoms, between Brazos and Burleson Counties, two classes of trees would be advisable, namely, one for the bank of the river bed and the embankment of the levee, and another for the strip of cultivated land between the river bank and the levee. For the first two, namely, for the embankment of the levee and the river bank, quick-growing plants, easy of propagation and capable of withstanding submersion by water and silt—in short, water-loving species, would be needed. The weeping willow, *Salix Babylonica,* will fill these conditions better than any of our native willows, or any other native tree that I know of. In addition to this, there is another willow worthy of trial, namely, one imported from Crimea, Russia, by the Bureau of Plant Industry under the introduction number of 27762. This is of a low, diffuse habit of growth; and, as its branches set roots readily, when in contact with the soil, it ought especially to be useful in holding the soil against erosion. This willow is also recommended for hedges and windbreaks in regions with small rainfall. The drouth-resistant quality of this willow would make it more suitable for the

embankment of the levee, while the water-loving habit of the weeping willow makes it an ideal covering for the bank of the river bed.

As a tree for planting in the strip of land between the brink of the river bed and the levee, Bois d'arc, also known as Osage Orange, has many qualities worthy of recommendation. In the rich alluvial soil, it would, in time, reach its greatest possible size, namely, 50-60 feet high and 2-3 feet in diameter. In the open air it is of a low-branching growth, but when crowded into a dense stand, it will grow taller and make a trunk clear of branches to a good height. As a timber tree, furnishing materials where both durability and strength are needed, it has a well known reputation and is much sought, especially since the natural supply is exhausted. Though of a slow growth, it will in the rich, moist soil make a good sized post in six or seven years. By planting Bois d'arc in rows 5x5 feet apart, it will need thinning by the time it has reached the proper size for posts; and then half of the stand may be cut out, leaving the other half for further thinning when of a more valuable size. The stumps will not decay nor die after cutting but set vigorous sprouts, which by early and proper thinning will continuously give rise to new crops of timber. The growth from the stumps, if properly managed, will grow straight and tall, because of the lateral shade from the uncut, surrounding trees.

Willows will grow from cuttings so easily that it is scarcely necessary for the purpose, here indicated, to start them in a nursery; but cuttings may be planted directly in the desired positions along the bank of the river bed and the levee.

Cuttings of willows may be made from sound shoots having the thickness of a lead pencil up to an inch or more in diameter, and managed as described under the heading "Propagation." The planting should be made as nearly as possible in rows, beginning at the edge of the low-water mark on the river bank, and at the base of either slope of the levee. The planting should be sufficiently close to secure, at an early time, a solid covering for the surface and a complete filling of the soil with roots. The cuttings should, therefore, be set at a distance that would correspond to 5x5 or 6x6 feet in rows.

Where other vegetation, such as weeds and grasses, occupy the immediate place intended for a plant, this should be removed with a hoe, and the conditions necessary for the growth of the cuttings made as suitable as possible.

The Bois d'arc, or Osage Orange, is propagated from the seeds, which are easily obtained in clean state by allowing the fruits to undergo a slight fermentation. This may be done by placing them in a barrel or any other vessel, where the proper amount of moisture can be retained. After being washed and dried, the seed may be kept until planting time, which is about the same as for early corn. The seed may be planted in good garden soil in the manner described under Propagation.

After a year's growth in the seedling bed, transplanting into the permanent location may take place. Clean cultivation and pruning to prevent too low branching will be necessary for the first two or three years. After that, the plants will be strong enough to do without special care.

The Bois d'arc produces an exceedingly ample root system which, in addition to its other merits, makes it well suited to the purpose for

which it is here recommended. Spiny and low-branching habit of growth are the only drawbacks; yet these become less obnoxious with age, if close planting and proper pruning during its first three years of growth be resorted to. The pruning can best be done in the summer, before the spines of the wood to be removed have reached the objectionable hardness.

PROPAGATION

The propagation of trees is made in two ways, namely, from the seed, and from certain parts by cuttings taken from the tree itself. In the last case, the new individual that arises has no power of varying from the mother tree, possessing for all practical purposes characters identical with it. This sort of propagation is known as vegetative. It is used whenever it is desired that the progeny be the same as the mother and in certain cases where vegetative reproduction is quicker and more certain than from seed. As examples of the latter instance, we have only to remember the many plants propagated by cuttings made from one part or another, when propagation from seed would be impractical for ordinary purposes, as is the case of the potatoes, grapes, sugar cane, and so forth.

In the propagation by seed, the individuals arising have the power to vary from the mother plant and from each other. In some cases this variation is so great as to give rise to entirely new types, which are in reality monstrosities, and which in wild nature would probably be too short-lived for further reproduction. These extreme forms are, therefore, scarce in nature, but very common in cultivation, where they are sought out, nursed, guarded, and propagated by man, whenever their characters are favorable to his purposes. Most of our varieties of cultivated fruits, vegetables, and flowers are such monstrosities which, under cultivation, have repeatedly given rise to new and more deviating forms and even groups of such forms, until the tracing of their original ancestors becomes, in some cases, a mere conjecture upon probabilities.

This great variability is not peculiar only to our fruit trees, which have been under long cultivation, but equally conspicuous among many forest trees raised from seed gathered in the wild state. Certain genera of plants are especially famous among botanists and gardeners for their aptness to produce sports or variants. One hundred different individuals, obtained from a package of seed of any species in the cypress genus, would produce a hundred different forms, and some of them strikingly unlike. The same is true to a great degree in other forest trees. In ornamental planting, therefore, where uniformity may be wanted in one case, and diversity in another, as for groups in a park or on a lawn, a well stocked nursery, in which to make the selection in each case, is a necessity for best effects.

Seed is also the source of our grafting stock for apples, pears, peaches, and other stone-fruits, as well as nut trees, such as pecan and English walnut. One-year-old apple or pear seedlings are obtained from seedling nurseries in this country, or from supply firms that import them from Europe; if and when they may be more cheaply obtained in that way than raised at home.

CARE AND PLANTING OF SEEDS

Peach and plum seeds intended for sowing should be exposed to freezing and be kept constantly stratified in moist earth or sand until time of planting, which should be done in January or early part of February in this State.

Hickory nuts and walnuts, which ripen later in the season than the peaches, may be planted at once or be stratified in sand and kept wet until planting, as in the case of the peach seed. Pecans may also be kept stratified in sand, not moister, however, than is sufficient to keep the kernel from losing moisture by evaporation.

Acorns start their germination immediately upon falling from the tree, if moisture and temperature permit. The live oak acorns, in fact, germinate so readily that, during warm and moist spells occurring at the time of maturity, they do not wait to fall, but commence germination by bursting the shell and protruding the root of the embryo, while still clinging to the mother tree. For this reason acorns should be planted immediately upon ripening, or be kept in slightly moistened sand at nearly freezing temperature until planting time.

A good method of handling acorns, where only a moderate quantity is to be planted, is to place them in a single layer in shallow boxes on the top of a layer of moist sand four to five inches deep, and cover them with another layer of sand about one inch deep. In this position they will soon germinate, if kept constantly moist and at a temperature of about 60 degrees F.

Before starting the shoot, the acorn will make a root several inches long. When this root has reached the length of two and one-half to three inches these sprouted acorns may be transplanted from the boxes into nursery rows. This planting is best done in a furrow about two inches deep made with a garden hand-plow. The root should be shortened back at this planting by pinching off about one inch of its extremity. This amputation will have the effect of causing the young tap root to branch the very first year; hence it will produce a tree much more easily transplanted than one with a single, unbranched tap root. In this transplating, great care should be taken not to tear the acorn loose from the young plantlet or injure its connection with it; otherwise the young plant will be deprived of the remaining food supply stored in the acorn, upon which it is dependent, until its leaves are developed for work. The young plants should be planted very carefully with roots sunk into the soil, this well firmed around them, and the acorn covered with one and one-half to two inches of earth. The film of moisture adhering to the young plants should not be allowed to dry during the planting.

This same process of forcing an early branching of the tap root may also be employed in the walnut, pecan, and other hickories.

These hardwoods, with long tap root, may also with great advantage, after having germinated in the above described manner, be planted in the place of permanent growth instead of in nursery rows. When this is done, it is best to set three to four plants in each place, allowing all of them to grow until the stand is secured, then select the best one in each group for development, and pull up the others.

SEEDS THAT REMAIN DORMANT A YEAR

The seeds of the holly, yaupon, and red cedar will have to be stratified in constantly moist sand or earth for an entire year before germinating. The berries may be gathered any time from December to March and immediately stratified, as the process is called by gardeners. When planted a year later they will germinate quickly and quite regularly.

SEEDS THAT NEED SOAKING

The seeds of black locust and the coffee tree germinate irregularly and very slowly unless soaked in water for 36 to 48 hours before planting, or softened by pouring scalding water over them and leaving them in the water for several hours before planting.

PLANTING THE SEED IN THE NURSERY

The method of planting large forest tree seeds such as mentioned above, is the same as used for the larger garden and farm-crop seed planted in drills. The conditions for germination and growth are also the same; hence preparation of the seed bed should be as in careful cultivation of garden vegetables. The distance between the rows may be from 3 to 4 feet and the distance between plants in the row 16 to 20 inches. The seeds are, however, dropped much thicker to secure a good stand, as a large percentage are apt to fail, or produce weak and useless plants. Peach seed, for example, need to be planted 3 to 4 inches apart to secure a fair stand. In all cases it is good practice to be liberal with the seed, and afterwards weed out to proper stand by systematically pulling up the poorer plants.

If oaks and other hardwoods with long tap root are to be given nursery care for more than a year, they ought to be taken up and replanted into new rows at the end of the first year. At this transplanting, which is necessary to secure ample branching of the root, the tap root should be shortened back according to its thickness, and the stem in a corresponding manner, also in proportion to its thickness; that is, the thinner the root or stem, the greater should be the retrenchment of its length. Even pecan seedlings, intended for budding, may, with advantage, be treated in this way, and the budding deferred until the young trees have fully recovered from the transplanting.

DELICATE SEEDLINGS

Seedlings of conifers, such as pines, cedars, cypresses, and their kindred, are in their early youth delicate, and readily destroyed by such excesses as beating rains, too close and too damp atmosphere, too high temperatures, and even very intense light is unfavorable just as they have emerged from the soil. They must, therefore, be given special protection against the unfavorable conditions arising from these causes.

The safest place to start them is either in greenhouses, where the intensity of light can be softened by a coating of whitewash on the glass, or in beds under a lattice roof, cutting off one-half or more of the direct sunlight. For protection against beating rains or freezing temperature, these beds may be made in ordinary cold frames, which

can be covered with glass sashes or canvas whenever occasions so demand.

Seedlings of pines are also very liable to destruction through damping off during germination. The conditions most liable to produce attacks of this disease are soggy soil rich in organic matter, too warm and too moist atmosphere, and too dense stand of plants. The conditions favorable to immunity from the damping-off fungus are well drained and well aerated sandy soil, dry and free atmosphere, and direct sunlight. The safest way for pine seed is to plant directly in sand of a coarseness suitable for making mortar and containing clay to make it moderately retentive of moisture. A layer four inches thick of such sand on top of mellow loam makes an ideal seed bed for raising pines. The damping-off fungus does its mischief near the surface and is not apt to attack the plants after their roots have reached soil underneath the sand. For small quantities of seed, shallow boxes may be used, in which the seed are sown broadcast. While waiting for the germination, the box may be kept covered with a pane of glass to retain the moisture, and thus avoid frequent watering, which may be unfavorable. As soon as the plants commence coming up, ample air and light become necessary to prevent damping off.

As soon as such seedlings have developed the leaves, produced on the first joint from the embryonic bud, they may be transplanted from the seedling bed without much risk. The best plants are obtained by transplanting into two and a half or three-inch flower pots. This is the safest way. When their roots have fairly well filled the earth in these pots, they may be transplanted either into the open ground in nursery rows, or into six-inch pots, whence they may go, either into the nursery for another year's growth, or be planted in the place of permanent development. In all cases the ball of earth in which the roots are embedded should be kept intact; and, in case of transportation, should be wrapped carefully and tightly in burlap.

CUTTINGS

A large number of plants, both woody and herbaceous, have the ability to produce roots upon pieces from their stems, when these are placed in proper contact with moist soil. Some other plants, though not readily producing roots on cuttings from the stem, produce, with great ease, buds upon cuttings from the roots. As examples of fruit trees, vines, and shrubs belonging to the first category may be mentioned: figs, quince, Merianna plum, grapes, gooseberries, and currants. Among the forest trees the following are always propagated from cuttings: all species of poplars, which include the cottonwoods, willows, sycamores, and mulberries.

The cuttings from these plants are made during the dormant season from "hard" wood, that is, from well matured one-year-old wood. Short-jointed, densely grained wood is to be preferred to long-jointed, softer and more loosely grained wood.

The roots are produced in most cases from the callus, or the healing growth which arises from the cambium cells and covers the surface of the basal cut. In other cases roots are also protruded through the corky freckles, called lenticels, on any part of the epidermis in contact with moist soil, as, for example, in cuttings from the quince. In grape

cuttings, the roots grow with special ease from the nodes or joints. But in whatever place they may arise, they are started in the cambium, which is a layer of cells situated between the wood and the bark, and from which the elements of both the wood and the bark are developed. This layer of cells is, therefore, the seat of growth in thickness.

A cutting from hardwood is generally made eight or ten inches long, and the basal cut is made closely beneath a bud, because the callus growth and the roots are produced most easily at the node. The cut at the top is, however, made some distance above a bud, so as to insure this against the danger of being killed by the drying of the wood, due to the exposed wound.

Cuttings of this kind may be planted in the open field in nursery rows. Where the soil is loose and mellow, so as to cause no bruising, they may be pushed into the ground; but where there is danger of even a slight bruising of the bark around the basal cut, they should be planted with a dibble, care being taken that the soil be packed firmly against them, so as to leave no open space underneath the ends of the cuttings, since this is apt to induce decay instead of healing and growth.

Root cuttings are resorted to in propagation of many plants, the blackberry being a good example. Cuttings are made from young, sound roots having the thickness of a lead pencil up to that of a man's finger. The length may vary from three to five inches according to the abundance of material. They should be planted in the manner as just described for cuttings of the stem, only with this difference, that the upper end is not to protrude above the surface of the soil, but to remain slightly covered.

SOFT WOOD CUTTINGS

Many plants, especially of our ornamental shrubs and herbs, are multiplied from cuttings of soft or immatured wood. We have only to keep in mind fuchsias, geraniums, cape jessamine, and begonias. Even many of the evergreen conifers, such as the Rosedale arbor vitae, the oriental arbor vitae, and others too numerous to mention, are propagated from cuttings of immature wood.

Many of these root quickly under ordinary conditions; to others bottom heat must be applied, and a glass cover to reduce the transpiration from their foliage.

SOIL FOR CUTTINGS

To succeed in forming callus and roots, cuttings of most kinds of plants need a well aerated soil in which the moisture is abundant and constant. For that reason a sandy loam, or even pure builders' sand, is the best in which to root cuttings.

LAYERING

Some plants which make roots with difficulty from cuttings produce roots easily upon any part of the stem or branches coming in contact with moist soil. This is taken advantage of in vegetative propagation, and shoots are bent to the ground and the parts upon which the roots are desired are covered deeply enough with earth to insure contact with constant moisture. When ample roots have been made,

the layered shoot or branch may, upon the return of the dormant season, be separated from the mother stock and transplanted into its proper place. This is the common way of propagating the Scuppernong and other grapes of the Muscadine class, as well as many other plants that set roots more easily from layers than from cuttings.

The production of roots from layers may be promoted, when necessary, by cutting the under side of the covered part of the layer half way to the center or the pith, then splitting forward in the direction of the tip, making this split an inch or more long and gaping so as to prevent its healing back to the upper half. Callus and roots will readily be formed on the wounded parts, because the transfer of materials for growth is stopped by the wound. Many plants that root with difficulty from cuttings, may be propagated by layers made in this manner.

Blackberries and dewberries are generally propagated from root-cuttings, but may also, as the raspberries, be propagated by layering of the tips of the shoots or branches during the season of growth. This is done by bending the growing branches to the soil and burying the tips deeply enough to keep them in constant moisture. The growth in length will stop, but thickening of the tissues of the extremity, similar to a callus growth, will ensue; and upon this, roots will arise, also buds developing erect shoots, which at once show a tendency to independent existence. The more perpendicularly the tips meet the soil, the more easily the rooting takes place.

THE PRINCIPLES OF GRAFTING AND BUDDING

The most frequently employed method of multiplying the individuals of any variety in fruit culture is that of grafting and budding. The scion used in grafting differs from the ordinary cutting in this, that it does not develop a root of its own, but is connected with another plant in such manner that the two unite by the growth into one individual; the scion becomes the top, while the stock, or the plant to which the scion unites, furnishes the root for this composite individual.

In the process of budding, only one bud is inserted into the stock in such manner as to unite with it, after which the top of the stock above this bud is removed. This leaves the shoot from the bud to become the top of the new tree.

AFFINITY OF PLANTS THAT CAN BE GRAFTED ON EACH OTHER

Plants to be united by grafting must be of a certain relationship, and as a general statement it will hold true that the closer this relationship is the sounder the union and the more healthy and long-lived the tree will be. Therefore, varieties of the same species as, for example, pear upon pear, apple upon apple, and peach upon peach give rise to the soundest trees. But this statement expresses only a general truth, since experience has shown that the consideration of stock is also bound up with the consideration of the soils. Cases are abundant in which a more distantly related stock will produce a better tree because of its being better adapted to a particular soil. Though the peach is generally grown on peach root, it has been found in California that on certain dry soils it thrives better and becomes more long-lived on hard-

shelled sweet almond than on the root of its own kind.* Peach root is used extensively for apricot. On a soil well suited to the peach, the apricot makes a tree of no less value than when on the root of its own kind. When it is desired to grow apricot on a soil too stiff or too wet for apricot or the peach root, it has been found profitable to put it on the Myrabolan plum. The same stock may also be used for peach on the same kind of soil.

Many varieties of the European pear make hardy and very fruitful trees on the quince, although the two plants are very dissimilar both in appearance and in size, the quince being merely a large shrub. The union of the graft is nevertheless good, when the proper variety of pear is employed, since it accommodates itself to the reduced size of the nurse by becoming a dwarf.

Too great dissimilarity between the stock and the scion results, as a general thing, in the incompatibility of the two, evinced by early unthriftiness and death of the tree. The difference of their natures increases with age. A knot or swelling is formed at the union and one of the parts outgrows the other in thickness; finally, a crevice may arise on the circumference at the union, as if a constriction of a bandage were impeding the growth. These phenomena are due to the increasing dissimilarity of the tissues of the two parts, which finally refuse to hold together. A longitudinal section of such a union will show that the conductive tissues at the junction are much distorted instead of passing directly through from the stock to the scion, and that this distortion becomes more and more pronounced towards the periphery or that it has increased with the growth and age of the plant, until the outermost layers have failed to connect; hence the crevice. The difference in color of the tissues on either side of the junction is also evidence of difference in the chemical composition of their make-up.

It may easily be conceived that the materials transported from the scion to the stock and vice versa are reassimilated by the cells proper to each part, and that each cell "filters and cooks according to its own recipe." This is the true reason why the scion and the stock do not induce any greater changes in the nature of one another, and why there must be a certain close physiological similarity between them in order to permit them to utilize the materials and products obtained from each other.

IMPORTANCE OF CAREFULLY SELECTED STOCK

There is, perhaps, no feature in our horticultural practice, in which there is less care and judgment employed, than in the selection of stock for our fruit trees. This fact is, without doubt, one of the most fertile sources of the many disappointments which we suffer in this business. When we remember that peach is very commonly used for stock for all varieties of plums, no matter of what species, or how related to the peach, it is no wonder that our plum trees are of very uncertain behavior and short duration. A plum tree on peach stock is a cheaply raised tree; since a year after the peach seed is planted, the tree may

*Wickson, California Fruits, p. 289.

be ready for the orchard or the market. A plum tree on plum stock will need twice or three times as long to reach the same size and development; but its usefulness would certainly be improved as it would last probably twice or three times as long.

Where the stock is obtained as seedlings of varieties selected for their fruit alone, it is easy to perceive how uncertain and variable in hardiness and longevity such stock may be, for the variations in their vitality would be as great as the variations in their fruits, if fruited.

The effect of indiscriminate use of peach seed for stock is already referred to under the heading "Causes of the Decline in Fruit Culture in East Texas."

Selections of varieties for stock are certainly as important to success in fruit culture as selections of varieties for fruit. In selecting seedling races for stock, the following considerations are to be kept in view: (1) Uniformity in size and habit of growth, (2) longevity, (3) resistance to root diseases, (4) freedom from suckering or sprouting from the roots, and (5) adaptation to special soils.

For peach stock there is no race answering the above conditions better than the seedlings of the old-fashioned Indian Cling, so common on the southern plantations of earlier days.

LONGEVITY AND HARDINESS OF THE INDIAN CLING PEACH

In 1909, when there was not a single tree of our standard commercial varieties of peaches bearing fruit in the community about Troup, and perhaps none in that county or in the neighboring counties, the writer visited Troup in the interests of the Texas Experiment Station during the month of July. When inquiry was made concerning bearing peach trees in the community, it was found that the only trees known to be bearing fruit that year were on the place of Mr. Childs, about three miles southwest from Troup. The writer visited the place, in company with Mr. Hotchkiss, Superintendent of the substation at Troup, and found the trees, about a dozen in number. They were very old and in a state of decay, for the top branches were dead on nearly all of them. But all of them had some living branches, and these were loaded with nearly full grown fruit of the well known red-streaked Indian Cling. The ground upon which these trees stood had not been cultivated for several years past. It was furrowed by erosion and covered with tall weeds and briars. Some of the trees were fenced off into an adjacent pasture and were partly covered by shrubby, climbing vines, but, in spite of that encumbrance, the living limbs bore a promising crop. Whether these trees were budded with a certain variety or seedlings, could not easily be made out from the character of the fruit, the small variation of which might be due to the difference in the conditions of the trees. We were unable to get the history of these trees, as Mr. Childs was absent from his home, but Mrs. Childs told us that she had lived on the place for twenty-five years and that she had never known them except as matured and full grown trees, and could not remember any failures to produce fruit. The seeds from this crop were obtained from Mr. Childs for the orchard of the Experi-

ment Station, at College Station, and were planted directly in permanent rows March 3, 1910. Owing to the failure of some of the seed to germinate, some replanting with seedlings from the same crop of seed was done in 1913. The trees of the first planting, to the number of thirty-nine, flowered very uniformly during February of 1916; hence, a month sooner than safety from frost would permit; yet a few fruits were produced. In 1917 and 1918 the same trees and those of the later planting, totaling 63 trees, flowered in the month of March, which is a safe and proper season for our latitude. The drouth of both these years prevented normal ripening, however, so that the fruit in size and quality was undoubtedly below what it would have been with a favorable season. But the development of the fruit was sufficient in both years to obtain an approximate estimate of its character. The most remarkable thing about both the trees and their fruit is the similarity in characters, which is such that no one from a casual observation would take them for anything but trees budded with one and the same variety. The fruit is medium sized to large, rather rounded than oval, streaked or splashed with red, or varying from cream colored to dark red. The meat is of similar color, adheres to the stone, is very firm, though juicy, and of a delicious slightly acid to sweet flavor, which is peculiar to the Indian Cling race. The time of ripening is also uniformly the same for all of them, namely, from the middle of August extending into the early part of September; so that the time between the first and the last fruit ripe on a given tree seems to be longer than is the case in our commercial varieties.

Among this number of clingstone peaches occur two trees bearing freestone fruits. There can be no valid doubt but that these are of the same parentage as the clingstones and that they are subjects of mutation rather than of impure parentage, since all other characters in both fruit and vegetative organs bear evidence to that fact. The note made on one of these trees August 21, 1918, is as follows: "Fruit red streaked and typical Indian in all respects except freestone. Fruit large, of excellent quality; tree vigorous, foliage full, uninjured by the drouth; growth strong."*

Another character in which the Indian peach differs from the modern commercial varieties is a less rapid and sappy growth from the shoots. This is especially noticeable in the first year's growth from seed. The seedlings of the Indian peach, to reach the size convenient for budding, need a longer time, by several weeks, than seedlings from the commercial varieties. For this reason young trees on the stock of the Indian Cling may have to be kept in the nursery a second season to reach the proper size for transplanting into the orchard, while the ordinary run of stock can be budded earlier and the scion will in Texas frequently make the desired size the same season. This difference in rankness of the growth of the trees is very noticeable when one compares the Elberta trees obtained from a nursery and planted in 1915 with the Indian peach trees obtained from seed planted directly in the same orchard the year before. (See Figure XII.) This slower growth

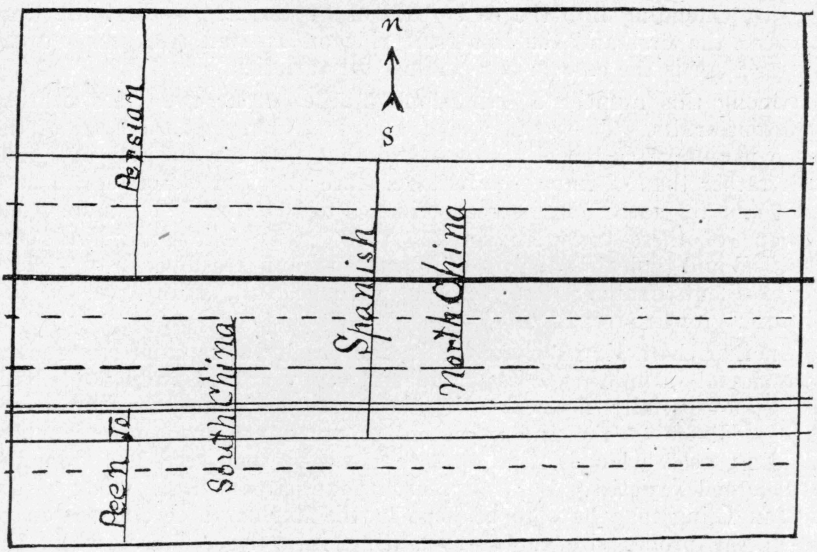
*Precipitation for the year 1917 was 15.5 inches; for 1918, 34.53 inches.

is undoubtedly compensated for by a greater hardiness and longevity. Another virtue quite noticeable in these trees is the smooth, clean trunk, which is exceptionally free from gumosis.

Besides the merits of the Indian race of peaches recounted above, there are indications pointing to the fact that these trees are more resistant to the crown gall than those of other races.*

Mr. Gilbert Onderdonk, well remembered veteran nurseryman of Victoria County, Texas, while special agent in peach investigations under the Hon. J. Colman, United States Commissioner of Agriculture, divided our cultivated varieties of peaches into five distinct races, all according to their origin of importation and their adaptability to the zones of this country. The Indian Cling he names the Spanish race, because it was brought to this continent from Spain by Spanish missionaries. Concerning this race, he makes the following statements in his catalogue of 1891: "The Spanish race occupies the entire range of the Northern Chinese race and extends considerably southward of it, the greater portion of the range of the Southern Chinese race being included in its proper habitations."

Mr. Onderdonk gives the following diagram showing the relative latitudes of five races of peaches:



In further commendation of the Spanish or Indian race of peaches he says: "We already have a hardy race of trees that suits our climate well, and is very productive. It has been cultivated in the southern latitudes till it has become thoroughly adapted to our southern climate on the lower border of the zone in which the peach has been considered possible. The vigor of this race from Spain has not been diminished

*See Bulletin No. 211, Texas Experiment Station. Also Field Experiments with Crown Gall.

Figure 12. Indian Cling Peach Tree on Left; Elberta on the Right. Note the Difference in the Nature of the Growth.

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Figure 13. Indian Cling Seedling Peach Trees, Showing Habit of Growth.

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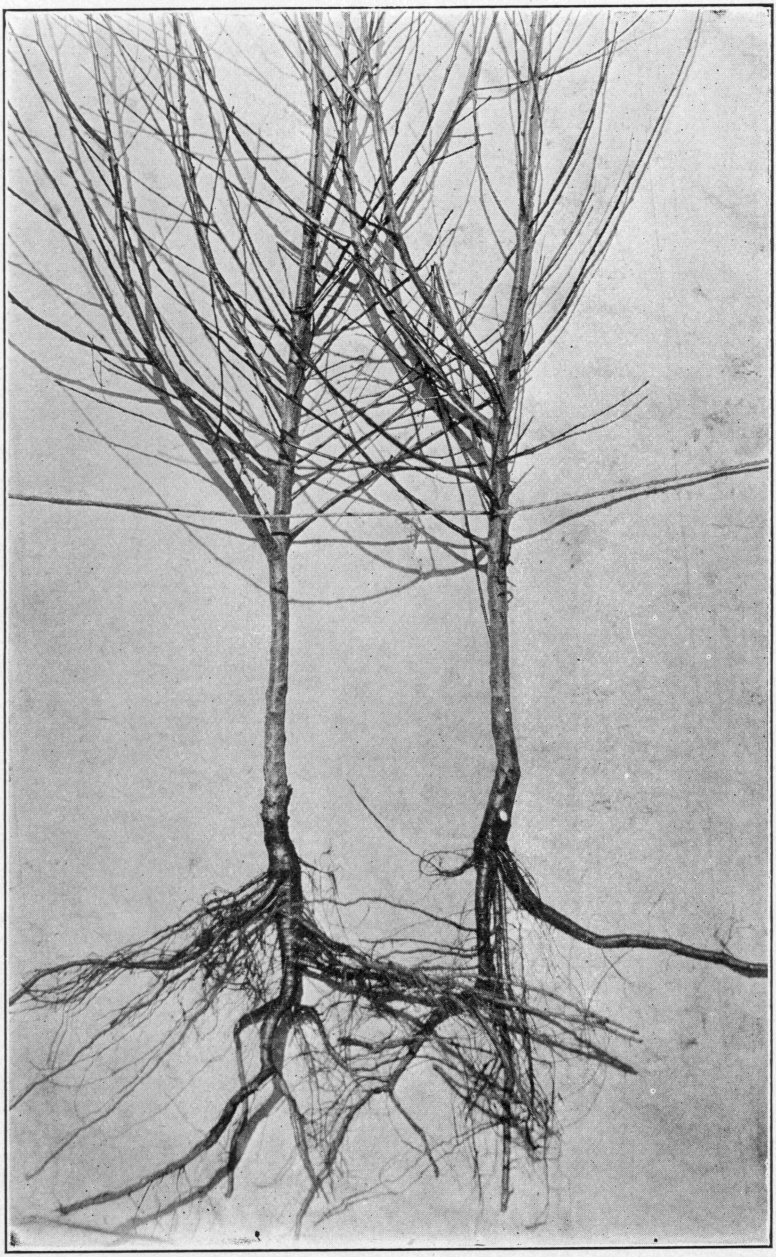

Figure 14. Indian Cling Seedling Trees, Showing the Root System as Developed in Very Stiff, Nearly Impervious Clay Soil.

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by its treatment in Mexico and Texas during its long existence here. If, before its introduction by the Catholic missionaries, it needed to be established into a distinct race, its propagation here for more than two centuries of time has given to the trees all the characteristics of a separate and distinct race from that now in general cultivation by the nurseries of the United States and Europe. It has extended in the extreme south, from Florida to Mexico. It has made its way up the Mississippi and other streams. It has overrun Texas and every part of Mexico where it will flourish.

"Everywhere the trees have been recognized as hardy seedlings, which, although not of the highest quality, were nevertheless successful growers and fine bearers, often developing choice varieties. They are known all over southern Texas as the most reliable race of peach trees that has been generally tested by the settlers. Surely we shall find a better foundation upon which to base improvements."

THE ART OF GRAFTING AND BUDDING

The modes of grafting and budding are as varied as the ingenuities of the operators. But all these modes depend on the same principle, namely, that the cells in the cambium layer, already referred to, are embryonic, that is, capable of growing and multiplying by division. In dividing, they throw off daughter cells that towards the inside become wood, towards the outside, bast and bark tissues. As growth ceases in the fall, these cells also cease their activity and become dormant, their walls firm, and their contents solid. The bark, therefore, adheres to the wood during that season. On the return of spring, the cambium cells are among the first to begin activity; they absorb large quantities of water, charged with digested plant food, from the adjacent tissues; their contents become liquefied, their walls turgid, and cell division sets in. New cells are thrown off in such rapid succession that their walls remain a mere slime for several layers on either side of the mother cells. The bark, therefore, separates readily from the wood during the growing season. When wounded, the cambium cells become excited into special activity; so that through a wound, they may be aroused into division or growth even during the dormant season, provided the temperature keeps above freezing.

Grafting may be said to consist in exposing a surface of the cambium layer of the stock by a wound, and in matching this by another wound upon the scion in such a way that when the exposed surfaces of the two cambiums are brought into contact they will fit snugly together.

In healing, the cambium of each part produces at first callus cells, which, as the process advances, become united into a coherent tissue, through which circulation is established between the scion and the stock. When this has been completed, the cambium layer from each part will meet by bridging across the gap. This is followed by the production of wood and bast tissues, which pass more or less uninterruptedly from one into the other, according to the compatibility of the two plants joined together in the process of grafting.

The time for grafting is during the dormant season, while budding is best done during the season of growth; since that operation requires that the bark slip, or separate from the wood without tearing.

The scions for grafting should be selected from vigorous and, if possible, bearing trees free from diseases or constitutional blemishes of any kind.

Degeneration of varieties through age has frequently been spoken of and examples cited. Degeneration may take place, but perhaps on account of recklessness in the selection of scions and buds for propagation rather than age.

Vigorous, well matured and short-jointed shoots of one season's growth, the same as recommended for cuttings, are to be used. Any portion of such shoots having buds, either too prominent so as to be easily injured in handling, as is frequently the case with buds on the upper portion of pecan shoots, or too backward, should be discarded, and only that part of the shoot having buds of the desired development should be used.

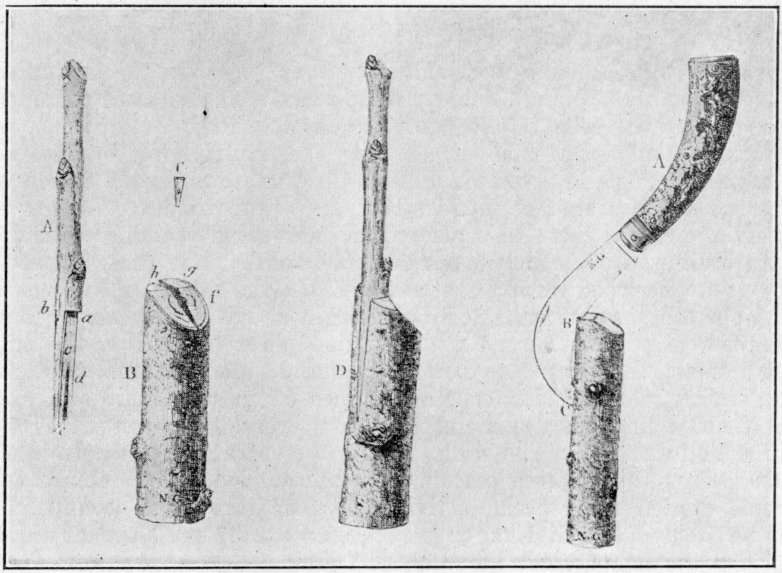


Figure 15. Cleft Graft. (After Gaugher.)
(A) Scion; "a", "b", hip; "c", "d", wedge. (C) Manner of making the split.
(B) Stock before insertion. (D) Scion inserted in the stock.

METHODS OF GRAFTING

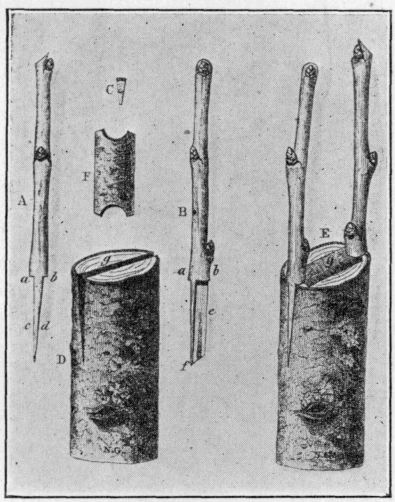
For the grafting of fruit trees only two methods are in general use, namely, cleft-grafting, when the stock is considerably larger than the scion, and whip-grafting, when the stock and the scion are of the same, or nearly the same diameter.

In cleft-grafting when the disparity in size between the stock and the scion is not too great, only one scion is put in. This is cut into a narrow wedge so as to fit into the split made in the amputated stock. In order that the fit may be as snug as possible, leaving no empty gap in the split below the wedge, a hip is cut at the upper part of the wedge,

and this hip rests on the truncated top of the stock after the insertion. The excess thickness of the stock behind the scion may be cut into a sloping surface, since this heals with greater ease than a square cut. The form of this graft, as well as the mode of operation, is illustrated in Figure 15.

After the graft has been made, as shown in D, the wounded parts should be tied so as to bring their surfaces in close contact and hold them until union through growth is secured. In cases where the grafting is made at the bench, before planting into the nursery rows, and where the union in planting is placed below the surface in moist soil, as is always done in grafting grapes, no waxing of the tie is necessary, although it will do no harm. But in all grafts exposed to the drying atmosphere, the wounded parts should be carefully covered with a tie of strips of thin cotton cloth saturated with grafting wax. Grafting wax can be made in proportions and of materials as follows:

Resin (powdered), 3 pounds.
Beeswax (finely cut), ½ pound.
Linseed oil, ½ pint.



Figuure 16. Cleft Graft with Two Scions. (After Gaugher.)
(A) and (B) Scions.
(C) Cross-Section of the wedge.
(D) Stock
(E) Scions inserted.
(F) Piece of bark to cover the cleft.

The resin and beeswax are placed in a pot and heated until melted, when the linseed oil is added and well mixed with the other ingredients by stirring. While the substance is in an easily flowing state, the cloth should be dipped into it until thoroughly saturated, then withdrawn and spread out so as to allow the excess of wax to drain off before becoming stiff by cooling.

On the stock, greatly exceeding the scion in diameter, two scions may be inserted, as shown in Figure 16.

The wounds should, in all grafting above the ground, be carefully

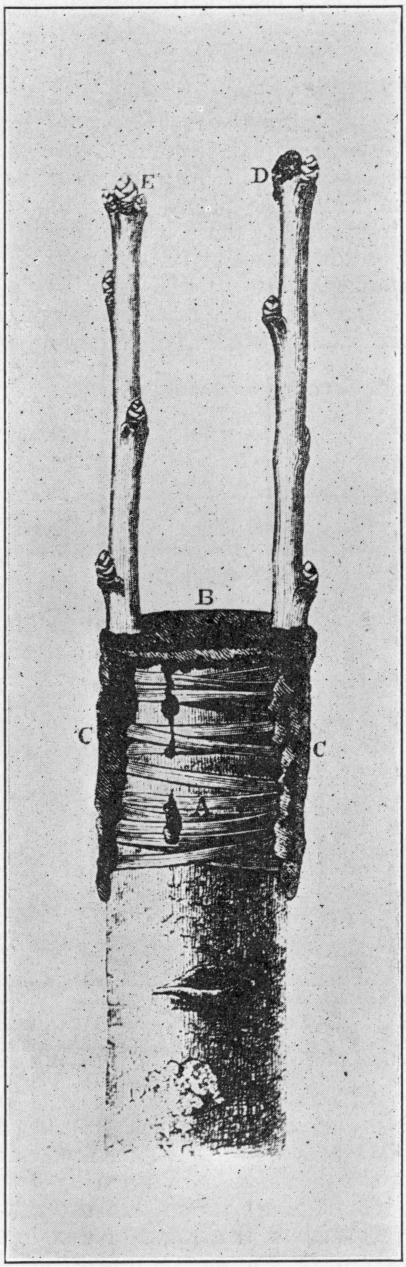


Figure 17. Graft Bandaged and Waxed. (After Gaugher.)

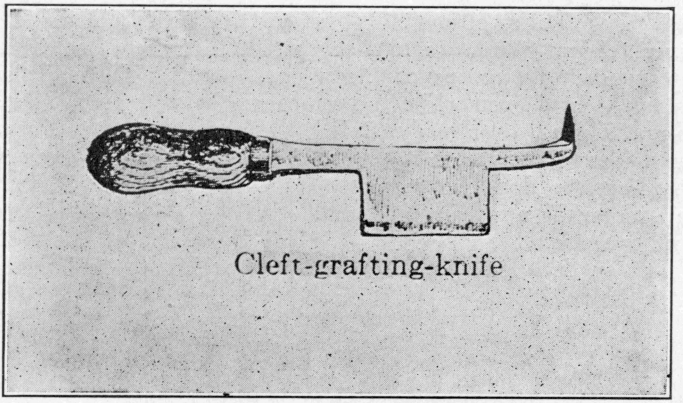


Figure 18. Grafting Cleaver.

sealed from the drying atmosphere by waxed bandage, or both bandage and wax as shown in Figure 17.

The scion, or scions, when grafted upon a large stock in this manner, soon covers the wound, due to the amputation of the stock, by an excessive growth in the thickness arising from the hip at the basal portion, which gradually spreads so as to form disk, or cake-like covering which, in time, extends over the entire surface of the wound until the cambium layer from both parts makes perfect connection through it.

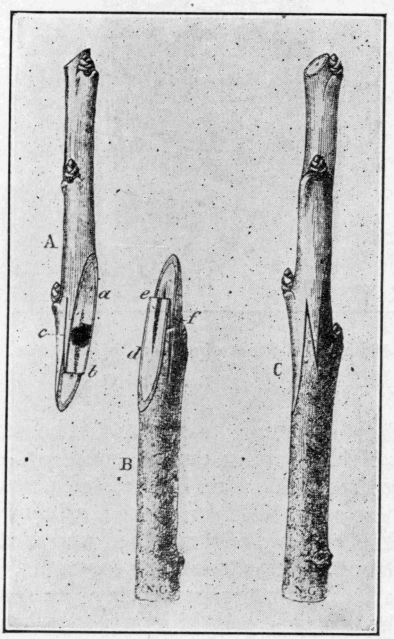


Figure 19. Whipgraft. (After Gaugher.)

For the performance of the cleft-grafting, a special tool called grafting cleaver (shown in Figure 18), can be obtained from dealers in garden implements. By means of the wedged hook at the end the cleft in the stock is held open while the scions are being inserted.

Whip-grafting is, as already stated, performed on small stocks of one year's growth, before they are transplanted into the nursery, and may, therefore, be done conveniently under shelter and at the bench, where all materials are ready at hand.

In this operation the stock is cut off at the collar of the root by a sloping cut an inch long, more or less, according to thickness. The

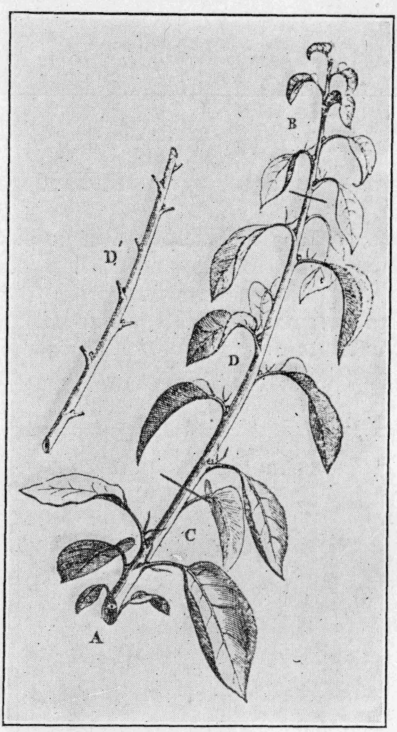


Figure 20. Shoot of a Pear Cut for Buds. Parts Beyond "B" and "C" Unusuable. "D" Ready for Use.

scion is cut in the same manner to match. The knife is then placed across the surface of this sloping cut at one-third of its length from the end and a split is made in each part, as shown in A and B of Figure 19. The scion and stock are placed in contact as shown in C. The union should then be carefully wrapped and tied with any suitable substance such as strong, soft cotton cord, or raffia.

If not planted immediately, the grafts may be stored in moist sand, where healing of the wounds and knitting together of the parts will take place, whenever the temperature is not too low.

BUDDING

The most common method is the so-called shield-budding. Only the buds showing sufficient prominence upon vigorous shoots of compact growth of the current season should be used. Immatured buds at the top of the shoot, or buds lacking in prominence at the base, are discarded, as shown by the cross lines in Figure 20.

In the peach, many varieties produce shoots with a large space, bearing only blank buds, that is, leaves developed in the first year without buds in the axil of the leaf stems. These blanks are most liable to occupy the upper part of the shoots, but in many varieties also the lower. If by a mistake these blanks be used in budding, they will grow to the stock but fail to develop shoots.

Two or three buds occur frequently in the axil of the peach leaf. The middle one of these, when three are present, is wood bud, the others being fruit buds. The presence of these fruit buds will in no way hinder the production of a shoot by the wood bud, if their matu-

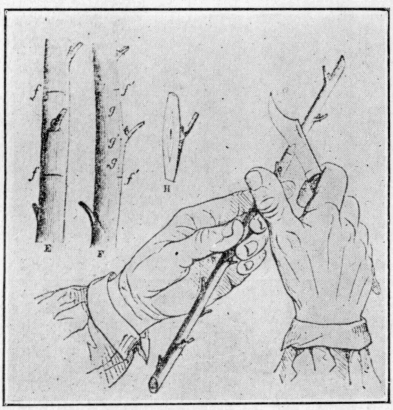


Figure 21. Manner of Cutting a Shield Bud. (After Baltet.)

rity is incomplete at the time of budding; but, if fully matured, as in the fall, they may flower before the wood bud commences its growth, and thus weaken it, or even prevent the formation of a shoot from the wood bud. The manner of cutting the bud is illustrated in Figure 21.

The cross cuts at *f* measure the length of the shield and make this easily detached with firm ends. A small portion of wood is left at the base of the bud, and the short end of the leaf stem attached is used as a convenient handle by which the bud is manipulated, when being inserted into the stock. Figure 22 shows the T-like cut of the bark of the stock, the inserted bud, and the bud tied.

After the T-cut is made and the corners of the split bark are raised, the ivory point of the budding knife is inserted and the bark raised from the wood on either side of the split sufficiently to start the bud, which is pushed to the bottom of the split by pressing it down and guiding it by the end of the leaf stem. In tying, it is especially neces-

sary to cover the corners of the split bark to prevent them from shrinking back in drying.

SIZE OF THE STOCK

The most convenient size of stock upon which to bud and which makes the neatest tree, is one-fourth to one-half inch in diameter. In order to obtain uniform stock, the young trees ought to stand no closer than one foot apart in rows, three and one-half to four feet apart.

Stock like the peach, which sets numerous branches close to the ground, should have the lower of these branches removed to give a free and smooth stem for budding. Such pruning preparation should be done in time to permit the wounds to be fairly well healed and the recovery of the plant from the disturbance by the time the budding is done.

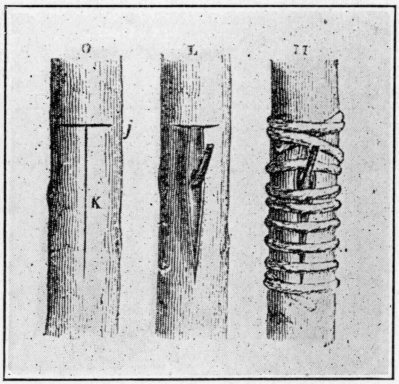


Figure 22. Insertion of the Bud.
(After Baltet.)

The buds should be inserted on the south or southwest side, that is, on the side exposed to the prevailing summer winds and midday sun. A shoot from a bud on that side will shelter with its foliage the wound caused by the amputation of the stock and thus prevent sun-scalding. A convenient height on the stock, at which to insert the bud, is about four inches above the ground. This distance will also place the bud beyond the damage from splashing mud during heavy rains.

CARE OF THE INSERTED BUD

If the stock continues in fast growth after the insertion of the bud, the bandage of the bud must be watched and cut before it does injury by pinching. If at the time of such cutting there be any doubt as to the perfect healing of the wound, a new bandage must be applied, to remain until the union is perfect. When this is evident, and the season is early enough to give time for the growth of a matured shoot, the bud may be forced into growth. This is done by cutting off the top of the stock, leaving no more than one-third or one-fourth of its head to take care of the sap. Removing the entire top at once might result in the stagnation and fermentation of the sap, hence killing the whole plant. This removal of the larger part of the top of the stock will

make the sap act with greater energy in the buds of the lower parts; hence, not only the artificially inserted bud will be forced into activity, but also other buds. These, however, must be watched and rubbed off as soon as they appear.

As soon as the bud has made a shoot 10 or 12 inches long, or sufficient to take care of the sap, the top of the stock should be cut back a second time, and only a stump three or four inches long left above the insertion of the bud. To this stump the shoot should be tied to brace it and give it the proper bearing. After it has become rigid and reached a diameter nearly equal to that of the stock, this stump should be amputated as shown by the dotted line B in Figure 23.

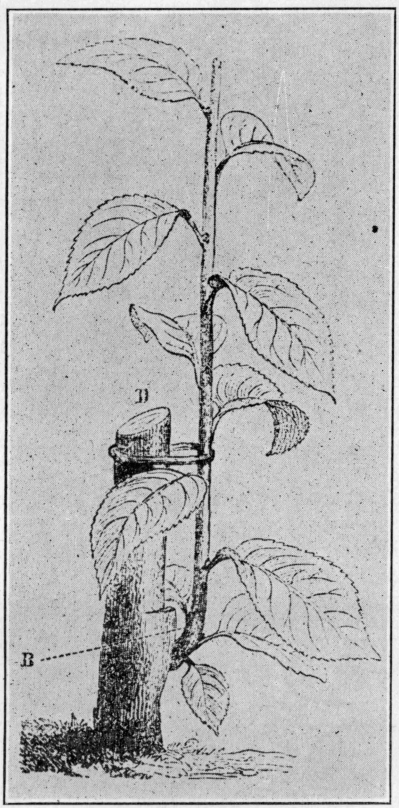


Figure 23. Care of the Shoot. (After Baltet.)

OTHER FORMS OF BUDDING

Two other forms of budding much resorted to in the propagation of the pecan are the flute or ring budding, and the patch budding. The flute or ring budding is used in the nursery on stock one or two years old, or of small diameter. In this operation, a ring of bark an inch or slightly less in width is removed from the stock and replaced with another ring of bark, containing a well developed bud, taken from a

scion of the same diameter as the stock. To be successful, the ring of bark taken from the scion must fit snugly into the space left by the one removed from the stock. The operation is illustrated in Figure 24.

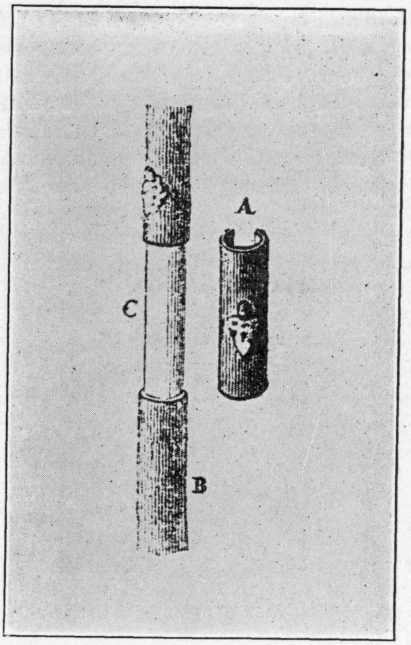


Figure 24. Ring Budding. (After Baltet.)

To secure a nice fit, and to perform this operation quickly, both of which are equally necessary to success, various forms of ring budding tools have been invented and are for sale by dealers.

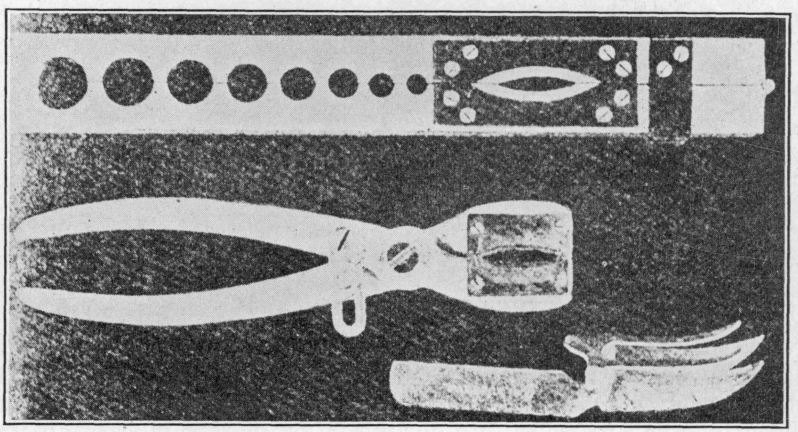


Figure 25. Ring-budding Tools. Nelson, Galbreath, White. (After Hume.)

In operating, the ring on the stock is cut and split opposite the bud. This ring is then removed by raising the bark from the wood along the edges of the split, after which it is readily removed by carefully and firmly twisting it loose from the wood. By the same process the ring is removed from the scion shoot to be quickly and neatly replaced on the stock. This work should be done so rapidly that the sap in the exposed wounds has no time for undergoing any change or discoloration; otherwise healing will fail, since the tissues intended for union will be separated from each other by a double film of dead matter.

After the insertion, the wounded parts should be carefully wrapped with a strip of waxed cloth, the bud being left free and protruding between the turns.

Patch budding is also made with a special instrument, which cuts a square or rectangular piece of bark from the stock to be replaced with one having a bud from the scion.

The operation and the care of the wound is very similar to the ring budding, but performed on older stock having a diameter too large for the ring bud; hence, it is much used in converting large, unprofitable seedling trees into varieties of desirable quality. The bandage of the wound, after-care, and manner of forcing the bud into growth is the same as for ring budding and shield budding.

PLANTING

Late fall or early winter is the most convenient season for planting deciduous trees in our State where, during the larger part of the winter, the temperature is so high that the growth necessary for the healing of wounds and the reparation of the injury to the roots, due to transplanting, can take place. For coniferous evergreens, the spring season is the best, after the buds have commenced to show signs of resuming their growth.

THE EFFECTS OF TRANSPLANTING

It may be stated as a general truth that the younger a tree is the more easily it will recover from the injury caused by transplanting. The life of a tree, at any age is, however, jeopardized by transplanting; but any method of treatment or culture that will most energetically and quickly revive the growth, will minimize this jeopardy.

No tree can be removed from the soil in which it has grown without losing a very large part of its root system, including the very roots most actively engaged in absorption. Before a tree can recover, these roots must be replaced by new growth, which has to be made at the expense of reserve food stored in the tissues previously to the transplanting. The smaller the surface of the tree upon which the action of this reserve food is concentrated, the quicker and the more effectual will be the recovery. Any lingering, or delay in the resumption of the growth, on the part of a newly transplanted tree, will either cripple or kill it.

PRUNING AT TRANSPLANTING

To secure a quick and vigorous start, a tree must, at the time of transplanting, have its top greatly reduced by pruning. This will

both concentrate the activity of growth and give a reduced surface for evaporation.

The various kinds of trees differ greatly in the facility with which they recover from transplanting. Trees which grow readily from cuttings, such as poplars, willows, sycamores, mulberries, etc., are generally easy to transplant because of their facility in producing new roots. In the transplanting of these trees only a moderate reduction of the top, or pruning back, is necessary. In all the hardwoods, such as oaks, pecan, and other hickories, walnuts, ashes, etc., repair of the injury to the root is made with difficulty, while decay is readily started during lingering.

Few acts in the culture of trees cause more losses and discouragements to the amateur than his irrational and stingy pruning at the time of transplanting. This is due to the belief that any retrenchment of the wood will result in a corresponding loss of time to the tree in attaining its size. This mistake, together with the common idea that the larger the tree when planted the sooner it will reach the size of usefulness, are among the principal causes why so many unsightly, dead poles occupy the places of growing trees along the streets and avenues in our cities and towns.

It must not, however, be inferred from these expressions, that the more severely a tree be pruned at the time of planting, the surer it is to recover its growth. Several things are to be considered; as, for example, the age of the tree. If several years old from the nursery, enough of last year's growth should be left to furnish prominent vigorous buds for the start of a new head. All buds on wood older than last year's growth are dormant and not liable to be forced into activity in a newly planted tree; or, at the best, such growth will be belated and feeble. A tree, delayed in its start, will be under a great disadvantage on the approach of our hot summer, since it will be lacking in roots, conductive tissues, and active foliage; hence, a sufferer from drouth, although there may be an abundance of moisture.

The retrenchment of the head of a tree at the time of transplanting must vary in accordance with the nature and development of the root system, the length and diameter of the shoots, and even the season and the moisture conditions of soil and climate during the time of transplanting. In general, the more unfavorably affected the tree is likely to be by the transplanting, the more severe should be the retrenchment.

Besides the above considerations, which regard only the safety of the young tree, there is in our fruit trees also the consideration of form irrespective of the safety of transplanting. The form that experience has everywhere in this country proved to be the most convenient for such of our fruit trees as peaches, plums, apples, and cherries, is the low standard; that is, a tree starting its lower branches 18 to 20 inches above the surface of the ground. To secure that form, a young tree must have its top headed back to a height of 24 or 30 inches at the time of planting. If a peach or plum tree be furnished with three or four branches at the proper height and position, these may be chosen as the frame-work for the future head and shortened back to correspond to the height of the main leader. But, if the branches at that height be soft and undignified, they may as well be pruned off in the peach and related stone fruits, since the stipular

buds, situated at their bases, will monopolize the sap to the exclusion of the soft branches, which will fail to make growth in a newly transplanted tree of that class. In the pear, pecan, and such trees, which branch sparsely during their youth, the stem must be headed back to that same height, if a low head be desired.

It is also desirable to start with a low head in the forest trees, although the ultimate form is to be one with a high, straight trunk free from branches for many feet. Though the literature on European arboriculture and the practice in the Northern States of this country prefer to start the young forest tree with a high stem at once, experience will prove that with us it is also best to start this class of trees with a low stem, and then slowly increase its height, by removing a few of the lower branches each year as the growth proceeds, until the desired height has been obtained. The advantages are obvious: (1) a stem pruned short will be forced to branch; (2) a young tree amply branched will furnish a much larger leaf surface than an unbranched switch, and because of the more abundant foliage the growth will be more energetic; (3) growth in a tree above the ground means corresponding growth below the ground; (4) the stem will be stouter, and, therefore, more rigid and more fit to resist a storm; (5) the low foliage will protect the stem from overheating and sun-scalding, and the roots will be benefited by being in a soil cooled by the same ample shade, which also lessens the evaporation from that soil.

PRUNING THE ROOTS

In a great many trees the root branches are abundant in its first, or seedling year. This is especially the case in the peach and the other stone fruits related to the peach. In the apple seedling, the branching of the root is less ample and in the pear still less, consisting generally of a single slender tap root.

Several years ago I whip-grafted two lots of one-year-old vigorous pear seedlings. In one lot the roots were cut back to a length of five inches; in the other they were left unpruned, that is, more than twice the length of the first lot. After a season's growth in the nursery, both lots were carefully dug up. In the first, the grafts had made a growth of 30 to 36 inches and had a strong, branching root system; in the second lot, the growth of the graft averaged less than 12 inches in length and the roots had barely fastened themselves to the soil, having made only a few slender and weak branches at the extreme end.

The same behavior will be observed in the hardwoods. If the long tap root be left unpruned, it will fail to branch, and the growth of the tree will be inert, even though the top may have been cut back.

The question naturally arises, how much should be cut back? In all cases it should be in proportion to the diameter. But in the oaks, hickories, and the walnuts it needs to be less than, for example, in the pear, because the tap root of the seedlings of these trees branch less easily in its upper parts than below the middle of its length. Roughly speaking, it may be said that, in the hardwoods, an ample root system can be produced by shortening the tap root of the seedling one-fourth of its length at the transplanting.

Long, slender root branches in the peach and other trees with branch-

ing roots, should be shortened according to their diameter; otherwise they will fail to make good growth. Root branches that accidentally have been cut too short, or cut to mere stumps in taking up the tree, will generally fail to grow, but more often decay; hence they might profitably be removed. In all cases lacerated ends of roots should be trimmed to a smooth cut with a sharp knife.

SETTING THE TREE

In soil of proper texture and preparation the holes for the trees need only to be large enough to easily accommodate the roots. In hardpan, dynamiting may be necessary to secure ample room for a vigorous start. For the same reason large holes are necessary in tight clay to give sufficient space for a root development that will make the tree independent of the unsuitable conditions for as long a time as possible. The bad subsoil taken out of such a hole should be replaced with good mellow loam containing plenty of coarse sand. No decaying matter, or manure of any kind, should be put in the hole, since it cannot be used by the tree until it has fairly recovered from the injury to its roots and made new leaves, whereas, it may induce decay. Manure may, however, be used as a dressing on the top or, in case of coarse litter, as a mulch.

For small trees, such as seedlings replanted into nursery rows, or even in forest planting of small trees, the holes may, where the soil is in good tilth, he dug with an ordinary post-hole digger.

In all cases the trees should be set at the same depth that they previously had in the seedling bed or nursery. The roots should be well spread out, and the earth tramped firmly against them, but left loose and smooth on the top as a mulch for retaining moisture.

In planting a tree one should bear the following facts in mind: the prevailing southern winds will in the summer retard the growth on that side; therefore, the tree should be leaned a little to the south; the strongest branches and the topmost bud should be on the southern side; and any bend or crook on the stem of the tree should have its convex side turned to the south.

DISTANCE AND ARRANGEMENT

In the planting of farm forests or woodlots and of windbreaks, the aim should be to secure as early as possible forest conditions, that is, an evenly dense shading of the ground. The trees require thorough cultivation for several years after planting, and thorough cultivation requires sufficient space for both single and two-horse tools. The most convenient distance for the trees would, accordingly, be not more than ten, nor less than eight feet apart in any direction.

For fruit trese of all kinds, the absolute need is a distance that will permit an unobstructed access of direct sunlight and free movement of the air to all parts of the full grown tree. For peach trees this distance is about twenty feet; for trees having a head of a greater or smaller spread, the needed distance will vary accordingly. For the pecan, cultivated as a fruit tree and other fruit trees similarly partaking of the nature of forest trees, the distance should vary with the

fertility of the soil. On moderately fertile upland soil forty feet might be sufficient; while on rich alluvium sixty feet may be necessary.

In laying out an orchard, two systems of arrangement are in common use, namely, in squares and equilateral triangles. In the first, the trees are checked, so that each corner of a square is occupied by a tree. The rows, therefore, cross each other perpendicularly, and cultivation can be made in two directions.

This system is well suited where the same ground is planted with trees differing in longevity and size; as, for example, pecan trees and peach trees. The pecan trees may be planted at a distance of forty feet apart and the peach, or any other trees of similar size and longevity, may be used as a filler, as shown in Figure 26.

After twelve or fifteen years these short-lived trees will have passed their usefulness and may be cut out; at the same time the pecan trees will be in need of more space.

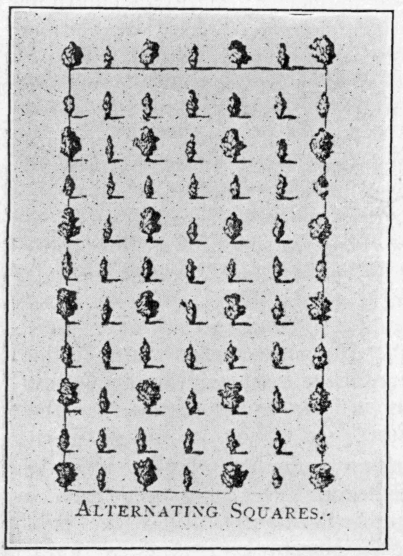


Figure 26. Trees Planted in Alternating Squares.

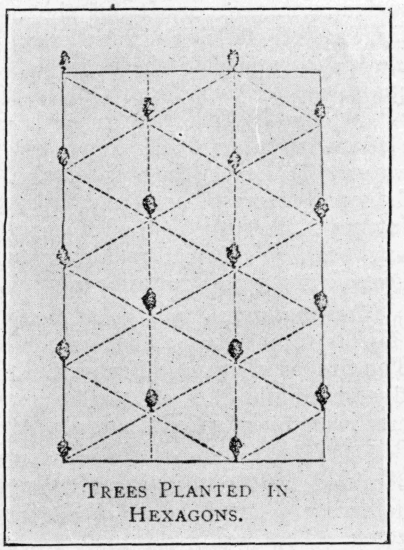


Figure 27. Trees Planted in Hexagons.

The second arrangement may be called the diamond or rhomboidal, because four adjacent trees may each be considered as occupying an angle of a rhomb. This arrangement is frequently called hexagonal. (See Figure 27.) It is obtained by setting the trees so that those of every alternate row fall into a line perpendicular to the middle point between the trees of the preceding row, as shown in the figure. To attain exact hexagonal lay-out, the trees should be set slightly farther apart in the rows than the distance between the rows. For example: If 20-foot planting is desired, the trees would be set 20 feet apart in the rows, but the rows would be only about $17\frac{1}{3}$ feet wide. If the rows are 20 feet apart, the hexagonal lay-out is approached and a 23-foot spacing secured, by spacing the trees 23 feet apart in the rows.

This arrangement has the advantage of permitting cultivation in three different directions and of distributing the trees more uniformly than when planted in squares. For windbreaks it presents a more solid obstruction to the winds.

Sloping land, liable to washing, should be terraced before planting. The rows should conform to the terraces and be laid out from the terraces toward the middle of the land included between any two terraces. In that way an economical use of the ground may require that the spacing of the trees can be observed only approximately.

PLANTING ON IRRIGATED LAND

Land intended for irrigation, if too sloping, should be terraced and the surface evened between the terraces before planting. In this case the terraces should be given a slight dip so as to permit an even flow of the water in the furrows or ditches, which are to follow the contour of the terraces and the rows of trees. The amount of this dip may be varied with the porosity of the soil from two inches per 100 feet, on tight soil, to four or six inches on more open, or leaky soils. The best method of applying the water is to open up furrows, four to five feet apart, and fill them from a main channel bordering on the upper terrace of each land. The flow in each furrow should be stopped by a series of dams at intervals of proper length for complete filling with standing water. To reach these intervals, cross ditches would have to be led diagonally across each land from the main to the upper end of each interval. By this method a very even watering may be secured, since any part of the soil requiring more water can easily be satisfied by keeping the water running onto that part for a longer time.

Planting should not be attempted until the land is in proper condition as to moisture; that is, thoroughly moist, but not water-logged. The proper state is indicated by the condition in which the spade, cultivator, or plow leaves it after working, mellow or adhesive,—the latter condition to be avoided for all operations.

The proper state of the soil for planting under drouthy conditions is obtained by, first, giving the land a thorough soaking; and then by deferring planting until the soil crumbles properly under the cultivator. That being attained, the planting should be rushed as rapidly as possible, followed by the cultivator to obliterate the water furrows and to leave a well pulverized and smooth layer of soil on the surface. This will break the capillarity and act as a blanket for the retention of the moisture.

Necessity for irrigation soon after planting should be avoided, since the water-logged condition that follows each irrigation is very injurious to the recuperation and healing of the roots. In fact, it is at all times as necessary to conserve, by cultivation, the moisture due to irrigation, as the moisture due to uncertain and irregular showers. Neglect of proper cultivation in irrigated districts has forced too frequent and too heavy application of water, which, in turn, has converted many valuable fields in such districts into practically worthless alkali swamps. Another precaution in the irrigation of trees is to allow the water to soak into the soil, occupied by the roots, from the sides rather than directly from

above, where it comes in contact with and may be injurious to the trunks of the trees.

PRUNING

No operation in the cultivation of trees is simpler than that of pruning; since every tree indicates by the nature of its growth the particular procedures necessary to incline it to our ideal, provided this is within a reasonable accordance with its habit of growth.

Proper pruning, helpful to the well being of the tree and the purposes for which we cultivate it, is, therefore, dependent upon our knowledge of the laws that govern its growth, or, in the technical term, its physiology. Physiology of plants is a branch of botany and a technical subject, but, like all natural sciences, its principles are established by the experiences and observations obtained in practice. Very frequently nature volunteers to the cultivator a demonstration in plant physiology that for clearness in precept is more noteworthy than many a planned laboratory experiment carried on with very costly apparatus. Taking advantage of these lessons, the gardeners of the Old World have for a long time been experts in shaping both fruit and ornamental trees into most fantastic forms, apparently contrary to the nature of growth; for example, pear and peach trees are made to spread out in the shape of a perfect fan against a wall, or the branches are caused to be forked into repeated and regular U-forms, or the head of a tree is made to assume the form of a crown. These things have been accomplished without destroying the ability to produce an abundance of fruit regularly distributed on the branches.

In such severe methods of pruning and training, the slightest neglect or mistake in cultivation, fertilization, or watering would be fatal either to the life of the tree, or the imposed form, or both. The distribution of the sap to the various parts of such a tree, and thereby its growth, is so delicately balanced that only the most assiduous care can keep the equilibrium up.

This method originated in countries with a temperature too low for certain fruits, and by training the trees on the sunny side of a wall, enough temperature for successful fruiting was secured. From that purpose, the usage was adopted in other situations to furnish ornaments, or even to elicit admiration and astonishment at the gardener's skill.

THE FLOW OF SAP AND THE GROWTH

These two phenomena are so intimately associated in the theory of arboriculture that either may be considered the result of the other; therefore, the consideration of one is, for practical purposes, the consideration of the other.

There are in all the higher plants two currents of sap. One, which we may call the ascending current, is taken up by the roots and transmitted to the leaves through the ducts of the sap-wood. This current consists of the water as met with in the soil, holding in solution extremely minute traces of all the minerals the ground-water comes in contact with, and which are affected by it as a solvent. These minerals are in the form of salts, that is, acids and alkalis in combination.

The salts containing the following elements are materials which the plant uses directly or indirectly in the construction of its food: calcium, magnesium, potassium, iron, silicon, phosphorus, sulphur, and nitrogen.

In the leaves the greater part of the water is given off to the atmosphere in the process known as transpiration, while the salts in solution and a very minute part of the water are retained as materials in the construction of plant food.

The first step in that chemical process by which inorganic matter is converted into organic takes place inside of the chlorophyll corpuscles—the green granules which fill the cells in the blade of the leaf. These minute green bodies seem to be the apparatus, the sunlight the agent, water and carbonic acid gas the materials, and starch the first tangible product in the process. During daytime, the chlorophyll bodies become filled with granules of starch, but during the night the starch disappears to reappear in the cell-sap as sugar, which, in chemical composition, is closely related to starch. From starch and sugars, the principal hydrocarbon foods, as a beginning, more complicated products are made by the addition of the nitrates, sulphates, and phosphates brought from the soil by the transpiring current. These new substances are called proteins or albuminoids, because of the similarity in composition to the albumen of an egg. The place where they are formed is most likely in the bast cells of the veins and veinlets of the leaves. Their natures vary from free-flowing to viscid or slimy liquids in the conductive tissues of the bast to fine grains or even crystalline bodies, when stored in the seeds or tubers for future use. The food materials thus formed in the leaves, both of hydrocarbon and protein composition, are moved in liquid form through special ducts and cells in the bast to the place of usage. There they are either expended directly in new growth or stored for future growth in such organs as seeds, tubers, bulbs or buds.

A deciduous tree of advanced maturity consumes the larger part of the season in storing food for the growth of the succeeding spring; and before the fall of the leaves the greater part of all usable materials in them are returned to the stem. These reserve materials are distributed over the entire body of the tree during the dormant season. The young bast tissues are the principal containers, but much starch is also found in the sap-wood and the younger cells of the medullary rays. The tissues, touching immediately an outer and inner side of the cambium layer, are, therefore, the principal storehouse of reserve materials in the dormant season; while, in the season of active growth, they are the channels through which the two currents of sap are moved. As these tissues are replaced by younger ones from the activity of the cambium, or grow old without such replacement, they gradually lose their functions as conductors of sap or storehouses of reserve food. The sap-wood undergoes a change in color and texture and becomes hardwood, which serves only the purpose of rigidity and support. The bast tissues also die and become part of the corky layer, the functions of which are merely protective against extremes in temperature and loss of moisture.

IMPEDIMENTS TO THE FLOW OF SAP

In trees of vigorous growth the general tendency of the sap is to take the straightest path to the extremities of the branches neglecting the laterals: (1) Any branch or shoot declining from the perpendicular will, all other conditions being equal, receive less of the current of sap in proportion as it declines from the perpendicular. (2) Any crook or bend of a limb or shoot serves as an impediment to the sap. (3) Wounds from any cause, due, for instance, to the removal of lateral limbs on the trunk or stem, are impediments in proportion to their size and number. (4) Constrictions and pinching due to a hard bandage as well as girdling of the bark are hindrances. This is first indicated by the prepared sap which, descending in the bast tissues, gives rise to a tumorous growth above such a constriction.

Ample examples of the effects of these impediments are found in every orchard and nursery. Water shoots arise with special energy near a crook on the trunk, or the elbow of a limb, also in the vicinity of scars due to the removal of a lateral branch or shoot. Such water shoots result from dormant buds aroused into activity by an impediment to the free ascent of the sap at that point. If their growth be suppressed, the tendency will soon cease; because, by the activity of the cambium, new conductive tissues, taking care of the surplus flow of sap, will be formed.

This same phenomenon of water shoots is frequently seen in our fruit trees upon the resumption of growth in the spring. The cause is the same, namely, lack of capacity on the part of the conductive tissue to accommodate the sudden excess of the sap. It is especially common in all trees having received winter pruning, by which the outlets of the sap have been diminished or changed in their courses.

The behavior of the peach and many other trees, as they resume their growth in the spring, seem to indicate that the conductive tissues are not open to the flow of the sap equally and in all parts at the same time, but gradually from below towards the top; and that the activity of the sap is especially slow in reaching the top through slender and poorly matured shoots with weak lateral buds. Such shoots in the peach are liable to remain without foliage for a long time after the leaves are full grown on those of more matured growth and lower position. The resistance to the transmission of sap is also very evident in slender, switch-like stems left unpruned in newly transplanted trees. The small belated leaves and puny, withered shoots at the top bear evidence to the lack of sap, which becomes more and more impeded by the hardening of the conductive tissue. If, however, a shoot should start in proper time, from the base of such a tree, the chances for growth and vigor would soon become more evident.

THE PURPOSES OF PRUNING

The following are the objects of pruning:

(1) Obtaining and maintaining of desirable forms.
(2) Promotion of fruitfulness.
(3) The rejuvenescence and invigoration of the growth.

The first, obtaining and maintaining certain desirable forms, applies

equally to all trees under cultivation, whether for fruit, ornament, or other purposes. The operations with that object in view begin at the time of planting. The practice and principles applicable at that time have already been described under the head of Planting.

The form of the tree having been decided upon and the pruning done accordingly at the time of planting, there yet remains for the operator to secure that form by constantly watching and guiding the growth during the ensuing season. This guiding consists in pinching off with the fingers the tender extremity of every shoot that threatens to outgrow the proportions assigned to it, or to monopolize the sap at the expense of its neighbors. By the removal of the terminal portion of such a shoot, its growth is retarded, while the others are not only given a chance to catch up, but are, apparently, quickened in their growth by an extra supply of sap. If any lateral bud be aroused by this pinching, or from any other cause sets a shoot in an undesirable place, this shoot should immediately be pinched, or entirely rubbed off, according to the needs of symmetrical growth.

In thus regulating the growth, it should be kept in mind that the flow of the sap in a tree is similar to the flow of water led through a single main into a field, where this main is divided into many branches and sub-branches for the even distribution over the field. Just as the flow of water, when decreased by some obstruction in any branch of this system, causes a surplus in some other branch, so also in the shoots and limbs of a tree, when the growth is retarded by pinching off the extremity in one member, it is proportionally quickened and increased in another.

This view of the flow of the sap, and of the growth in a tree, makes its regulation obvious and very simple. As the water turned into a branching irrigation system must be constantly watched lest it dig some of the trenches deeper, and be thereby diverted from others, or, by the obstructions in some trenches dig new ones in undesirable places; so the growth of a vigorous tree in the spring season is liable to irregularities which will destroy its symmetry, unless constantly regulated.

Undesirable leaning from the perpendicular or crooks on the part of the main shoot or leader must be corrected by bracing or staking. Any backwardness in the growth of a leader can only be corrected by repeatedly pinching the competing branches without crippling their activity. The flow of sap and growth of the tree is also similar to a forky irrigation system in this respect, that the regulation becomes easier as the channels or conductive tissues in each part accommodate their capacity to the sap by their growth. It is, therefore, only during the earlier part of the growing season that this close attention is necessary.

If this pinching of the extremity of every too forward shoot, and the entire suppression of all shoots in improper places, be assiduously attended to during the growing season, no winter pruning, or removal of large limbs is necessary in the training of ornamental trees; except such removal of lower limbs, which is necessary to gradually increase the height of the bole or trunk of the tree.

Amputation of matured wood, or heavy pruning, is injurious in such plants as the fig, in which the pith and the ducts in the wood are so large and open as to cause desiccation of the tissues, instead of proper

healing of the wounds. In the fig, therefore, heavy winter pruning should be avoided, or reduced to a minimum, and pinching of the soft summer growth resorted to in regulating both the rate of the growth and its form. Shortening the length of the stem to balance it with the roots at the time of transplanting is, however, to be done in the fig as in other trees.

PROMOTION OF FRUITFULNESS

Pruning to induce fruitfulness is, of course, only applied to our pome-bearing and prune-bearing fruit trees. To the first mentioned class belong the apple, pear, and relatives; to the second, peach, plum, and all other trees bearing stone-fruits.

Pruning to induce fruitfulness depends on the principle that, if a tree from any cause be prevented from applying its food materials directly in the production of growth or addition of tissues, it will store and reserve them for fruit-production.

While a tree is young, all its conductive tissues are open to an unimpeded flow of the sap, which, if the season be favorable, will be continually used as fast as it is made available for new growth. The vital activities of any part of a young tree are much greater than those of the corresponding parts of an old, matured tree. As a tree becomes older, the activities leading to mere growth become slower. The older conductive tissues in the wood and bast gradually lose their first functions. Even the leaves transpire less actively, and the quantity of water absorbed by the roots is correspondingly reduced. The growth ceases to be continuous and becomes periodic. Even the periods of growth exhibited throughout the summer become reduced in numbers, and are finally in old trees confined to one,—that in the early part of the season.

This periodic, or intermittent nature of the growth is very obvious in many trees. For example, a young oak starts its first period of the season by very rapidly producing a shoot, sometimes a foot or even more in length; then, apparently, there is a recess, in which the growth is confined to the enlargement of the diameter and hardening of the tissues, the completion in size, form, and texture of the leaves, and the formation of a new terminal bud. When this terminal bud, which contains in embryonic state every organ to be borne upon the extension of the shoot in the next period of growth is completed, a new period of growth in length takes place.

Such periods of alternatingly extending and maturing the shoots of a season are obvious in many trees; and it is also obvious that the growth of each period becomes shorter as the season advances, until no growth in length is perceptible. The food is then being stored as shown by the increase in, and filling out of the diameters of the shoots, the enlargements of the buds, and their differentiation into fruit and wood buds.

According to the kind of shoots, upon which the fruit is produced, our fruit trees may be divided into two extreme classes with intermediate forms grading into either. One of these extremes is represented by the pear and the apple, and the other by the peach and the grape. On each class the effect of pruning will differ with the nature of the fruit-bearing shoots.

THE FRUIT-BEARING SHOOT OF THE PEAR AND ITS MANAGEMENT

The pear may be taken as the best type of the first class. Its fruit is most generally produced on dwarf, lateral shoots on the lower parts of leading branches several years old. These shoots, which are called fruit spurs because of their divergent position and abrupt rigidness of form, require in the pear a growth of several years to reach bearing maturity. As early as in their second year, they are easily recognized by the crowding of the leaves upon a very short axis. This becomes each year of its development more wrinkled and gnarly, on account of

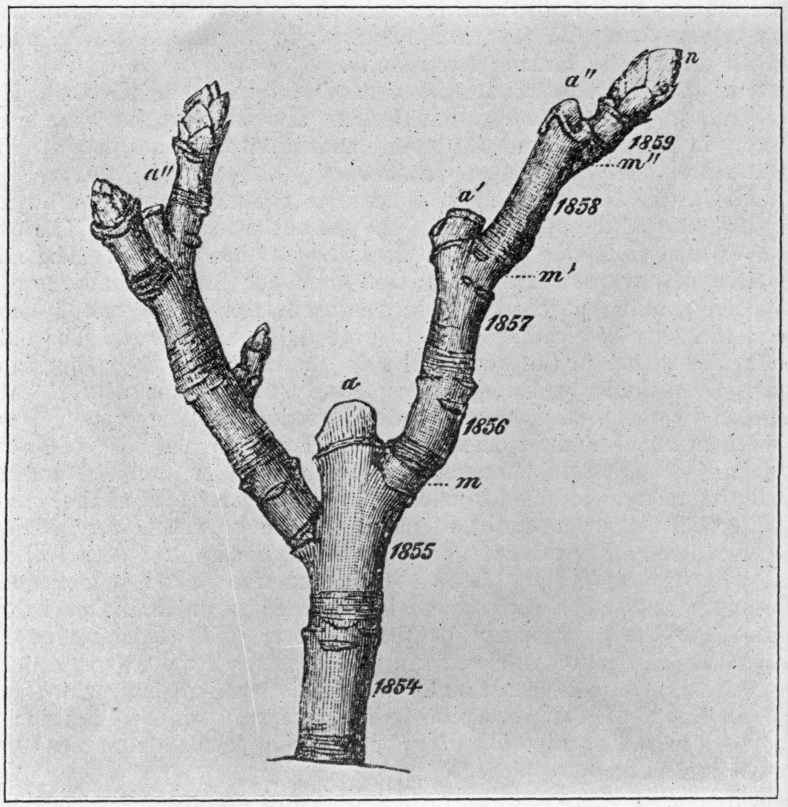


Figure 28. Six-year-old Fruit Spur of a Pear. (After Warning.)
"M", "M'", "M''", scars after bud scales. The other scars from leaves.

the scars of bud-scales from preceding seasons. Finally, after a number of years, varying from three to five, with the variety and the external conditions, the bud will produce fruit. This will stop the terminal development of the spur, but not exhaust it; for, while developing its fruits, it will branch below the fruit cluster. Such a fruit spur may continue to branch and bear fruit from the terminal buds of its branches for several years in succession, or in alternate years, before becoming exhausted.

The continuation of the productivity as well as its regularity of bear-

ing may be greatly prolonged by proper pruning. This is done by cutting off the outer and older branches, and thus reducing the fruit buds to a supportable number.

The production of fruit spurs, though arising naturally upon the matured wood in pear, apple, plum, and cherry, may be promoted artificially by summer pruning or pinching. Any lateral shoot arising upon one of the main channels of sap will become dwarfed, if its growth be stopped by pinching at the proper time as shown in Figure 30. If

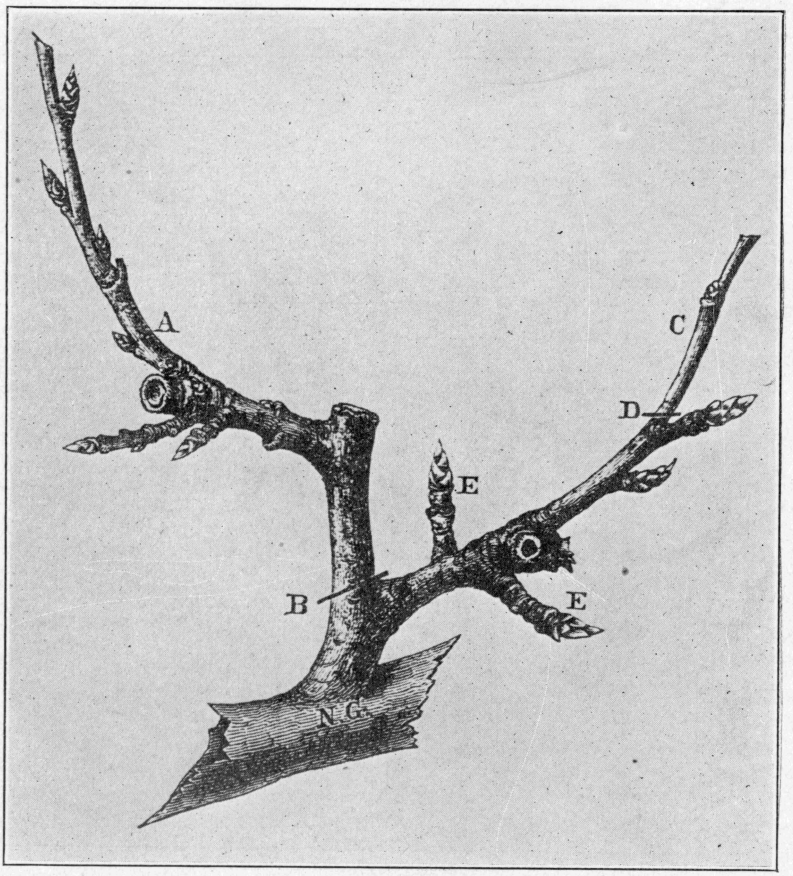


Figure 29. Old Fruit Spur from an Apple tree. (After Gaugher.)
Cuts for renewal to be made at "B" and "D".

one pinching should be insufficient, a second, or even a third, may be applied to the first or second internode of each new growth. This will usually result in the dwarfing of the shoot and the hardening of the tissues, and produce the proper maturity for the development of a fruit spur.

The shortening of strong, one-year-old shoots to one-half or less of their length by winter pruning, has the effect of turning the sap into the lateral buds, which, if not stimulated too much by it, will grad-

Figure 30. Lateral Shoot of a Pear Pinched to Force Maturity for Fruiting (After Gaugher.)

ually develop into fruit spurs. Too heavy winter pruning will force them into fast-growing shoots, which, however, can be converted into fruit spurs by pinching off their terminal growth, as above described.

THE FRUIT-BEARING SHOOTS IN THE PEACH AND GRAPE AND THEIR MANAGEMENT

The fruit buds of the peach are developed exclusively on one-year-old shoots, or shoots of the previous season's growth. In the grape, the clusters of fruit are produced on shoots of the current season from buds of last season's growth. Hence, in both the peach and the grape we look upon last season's shoots as the fruit-producing wood. The winter pruning in both species follows the same principle, namely, the renewal of the fruit-producing shoots and their retention as close to the base or center of sap distribution as possible. The tendency of the growth in both of these plants, when left unpruned, is each year to remove the fruit-bearing shoots further and further away from the base of sap supply. At matured age, they both exhibit a tendency to counteract this by the production of water-shoots in the lower parts of the main branches. These water-shoots are due to the increasing resistance offered to the sap in the early spring by the constant lengthening of its channels. If the water-shoots be permitted to grow, they will monopolize the sap and starve the fruit-bearing tops.

Two objects must be kept in view in the pruning of the peach, namely, the constant thinning of the head and the retention of the fruit-producing wood as far back on each limb as possible. Both of these objects are attained by going over each limb and each twig with the pruning shears and by cutting it back to a lower lateral shoot of last season's growth. If the trees have been properly started, and the pruning maintained every year in the proper manner, very little amputation of heavy limbs is needed at any time, although the head of the tree may at every winter pruning be relieved of one-third or more of its upper branches and twigs. This pruning must not be so done as to leave stubs and stumpy ends on the branches, but every cut must be made to a strong bud or a healthy lateral shoot, by which the bearing wood of the next season is to be continued. The operator must also exercise his judgment in regard to the proportion of leaf-bearing shoots, or the amount of foliage necessary to take care of the sap of a limb having a certain diameter. For example, if a limb be left with too small amount of foliage to take care of the sap, that limb will either be stunted by the hardening of its conductive tissues, or too many of its buds will be forced into shoots and thus produce a dense brush. What may take place under these circumstances will depend on the vitality of the tree and the conditions for growth at the opening of the season.

Very heavy pruning, called "dehorning," has sometimes been resorted to for the purpose of rejuvenating trees subjected to long neglect. It consists in removing the entire leaf-bearing crown of the tree and leaving only the main branches as stumps. The result in the following season is an exceedingly strong growth of several branches from each

stump; so that the tree seems almost to have renewed its head in a single year. This vigor is, however, of short duration. Large wounds heal poorly in the peach, even if protected from decay. New soft wood and bast tissues are not made in the old trunk in proportion to rapid growth of the branches which form the new head; hence, even in the second year, a withered, sapless condition makes its appearance, and the tree is likely to die without being able to produce another crop. All heavy pruning that reduces the branches to stumps has a tendency to produce this result in the peach in proportion as it approaches "dehorning."

The peach is a rampant growth which, if not regulated by yearly pruning, will show a decided tendency to produce a dense overgrown head that overbalances the capacity of the roots; therefore, the sudden collapse after dehorning and improper pruning.

THE GRAPE

What is stated in regard to the rankness and the tendency of the growth in the peach is true to a much greater extent in the grape. Of all our cultivated fruits the grape vine produces the greatest excess of wood beyond the needs of fruit production. In fact, if this wood-growth be left uncontrolled it will not only be made at the expense of the fruit, but it will gradually, as the proportion of old wood to the new increases, lose its vigor until it becomes too weak for anything but a scanty amount of small and inferior fruits. Therefore, the renewal of the wood in the grape is necessary to maintain its vigor, and the control of its growth is necessary to the production of fruit.

CARE DURING THE FIRST YEAR

The grape vine is generally transplanted from the nursery to the vineyard after one season's growth from the cutting, or, if grafted, after one season's growth from the graft. At planting, all branches are pruned off except one cane, and this is cut back to two or three buds. All other buds are carefully rubbed off, and any shoots appearing below these buds are suppressed. In planting young grafted vines it is well to leave the union entirely above the ground; otherwise surface roots will constantly be appearing from the scion. If the union be buried several inches in the ground, the roots from the stock may eventually be discarded for surface roots from the scion; in which case the grafting has not only failed its purpose, but has become a great hindrance to the successful growth and longevity of the vine.

If trellises upon which to train the vine have not been constructed before planting, it is well to put a temporary stake by each vine to support it and keep it in an erect posture until it can be tied to the trellises. The main care during the first two or three years after planting should be directed towards securing a stout, straight and erect main stem for the support of the future bearing wood. Only a moderate number of branches should be allowed in the first year, and these are to be kept strictly subordinate in vigor to the leader. The control of the growth is, as already described, kept by pinching off the extremity of any shoot to be held in check.

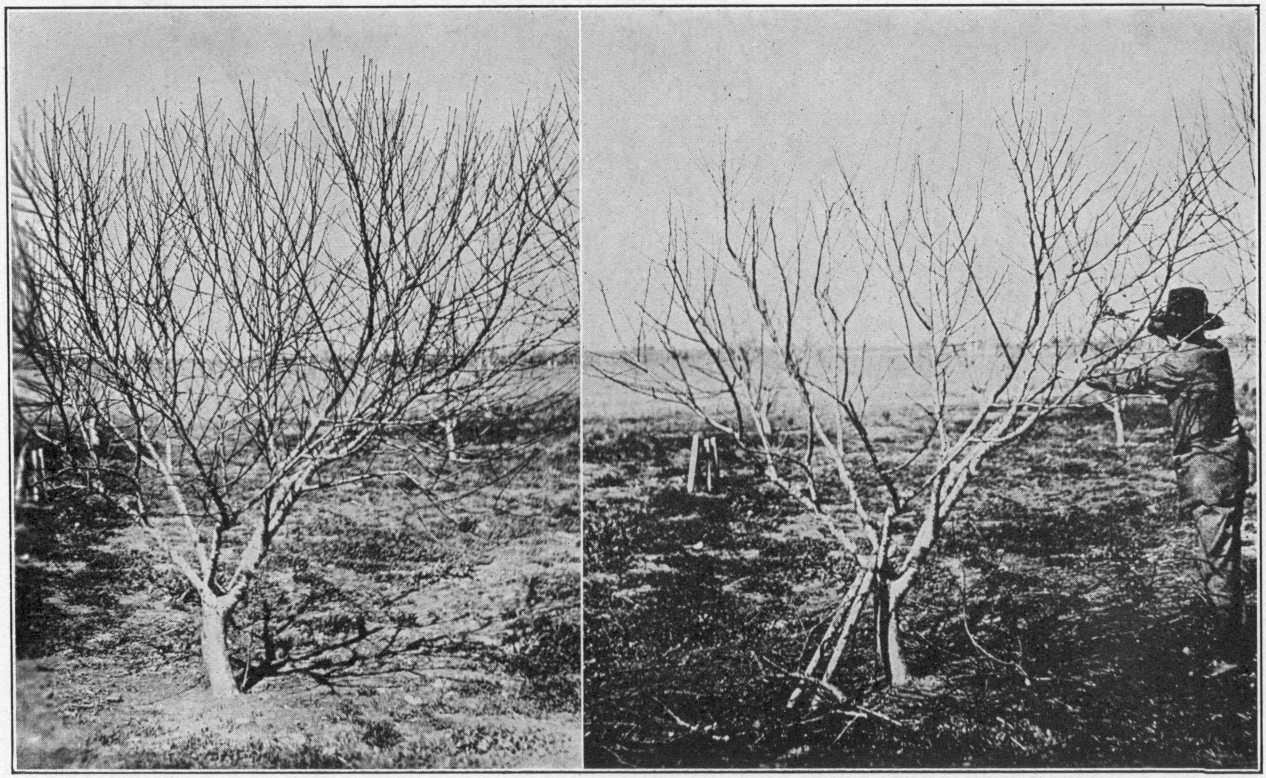


Figure 31. Peach Tree Before and After Pruning. The Same Amount of Pruning Having Been Given Yearly. Notice the Waste on the Ground. This Tree was Pruned in the Same Manner the Year Before.

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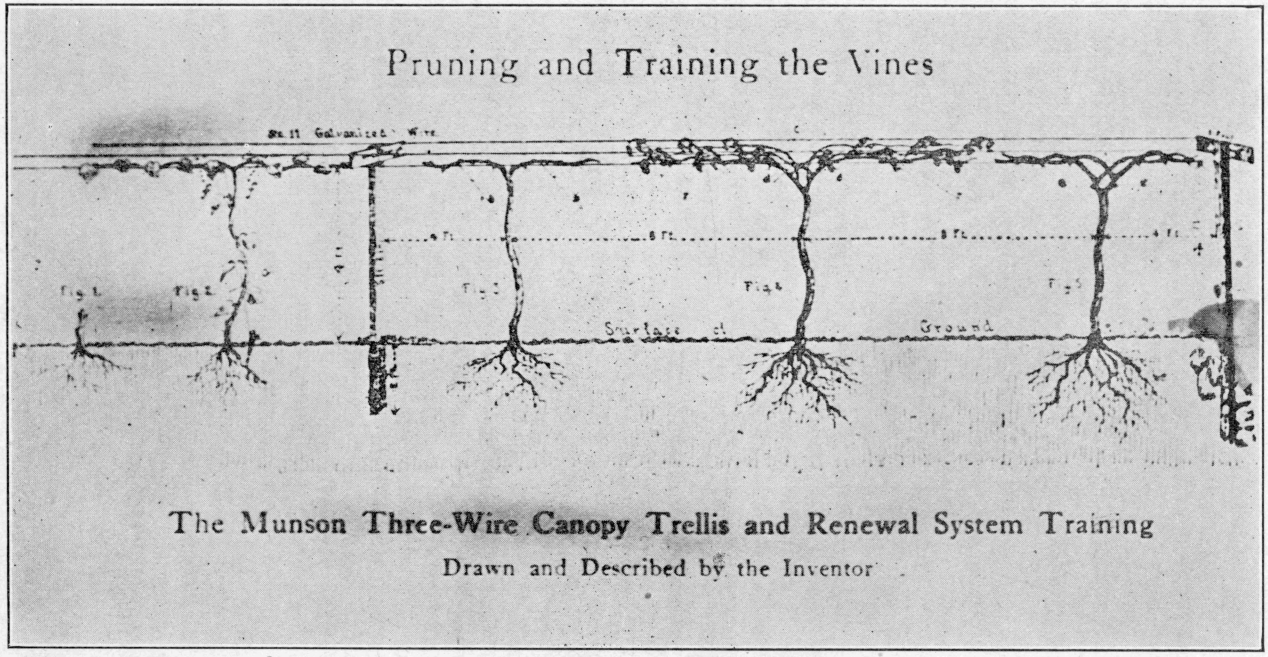

Figure 32. The Munson Three-Wire Canopy Trellis, Representing from Left to Right Three Years of Progress after Planting. (After Munson)

CARE DURING THE SECOND YEAR

In the winter, after the first season's growth, the vine is again, by the removal of the lateral branches, pruned to a single cane and given a length in proportion to its vigor. If the growth be strong, the cane may be left high enough to reach the middle wire in the Munson system of trellising, that is, three and one-half to four feet; if not, it should be pruned to a lower height, adding to its length only a few joints of last season's growth, and thus increasing its stockiness.

TRELLISES

Two systems of trellises may be mentioned. One consists of two or three wires attached directly to the posts and arranged horizontally one above the other. The distance from the ground to the first wire ought to be about 20 inches, and a lesser interval, 16 or 18 inches should be left between each of the wires.

The second, or the Munson system, consists also of three wires, two of which are fastened to the ends of cross arms, each two feet long, attached to the top end of each post, which may be four and one-half or four feet high. The third wire is attached directly to the posts six inches below those on the cross arms.

*Munson says in describing this system: "The vine in nature invariably tries to make a canopy of its foliage over its fruit, body and root, and yet above the ground sufficiently to allow ventilation and diffused light enough to favor the proper development and ripening of the fruit. This was the key to my invention."

This system has the advantage over all others in the ease and simplicity of training and pruning, ease of applying a spray, and the protection of the fruit against sun-scalds.

In pruning the growth of the second year for the Munson system, the vine is cut back to slightly below the middle wire fastened to the posts. Two branches are selected at that height for the main arms of the future frame-work of the canopy and fastened to that wire. In the cutting of these arms to their proper length it must be kept in mind that every bud upon them, with perhaps the exception of one bud nearest to the crotch of each arm, should be forced into a strong bearing shoot. The number of such shoots on each arm may vary with the vigor of the growth from three to five. The terminal one on each arm is to be trained to the same wire, thence to continue the length of the arms; while the shoots from the lateral buds are directed in an equal number and alternatively to the two lateral wires. If at the start the shoots of the terminal buds should take more than their due portion of the sap, and thereby starve those behind them, their extremities should be pinched off. All shoots arising from any dormant bud, or any bud except those at the nodes of the arms, should be rubbed off as soon as noticed; and all growth strictly confined to the shoots from the buds of the original designation. During the early part of the season repeated pinchings may be necessary to maintain the equality of the growth in the corresponding branches. One to several clusters of fruit will be produced by each branch of this, the third season's growth.

*Foundations of American Grape Culture, p. 224.

The perfection of the fruit can be enhanced by pinching off the branch two or three joints beyond the last cluster as soon as the fruit is set.

CARE DURING THE FOURTH YEAR

The winter pruning of the growth made during the third season after planting, and the first in producing fruit, is made as follows: The lateral branches upon the two arms are cut back to the second bud from the base, leaving what, in the vineyardist's language, is called a spur with two buds upon it for each branch. The terminal shoot from each arm is left longer by several joints, all according to the nature of the growth of the variety and the vigor of the individual vine. But in no instance must this extension to the arms be left so long that the sap fails to force any of the lateral buds into vigorously growing and bearing shoots; hence within a range of three to five buds.

As the vine becomes older, dormant buds increase in number at the bases of the spurs and near the crotches of the arms. These dormant buds are, because of the winter pruning, readily aroused into growth in the spring. All such volunteer growth, wherever it occurs, should be rubbed off; since it robs the fruit-bearing branches of vigor and thereby reduces the quality and quantity of fruit. It also does much harm by disturbing the equilibrium of the legitimate growth, which makes future training difficult.

The entire problem of summer pruning will consist in preventing unintended or volunteer shoots from arising, regulating the growth of the intended or legitimate shoots by pinching those too strong, and regulating the number of fruit clusters by shortening the bearing branch back to within two or three leaves of the last cluster allowed. The winter pruning following the third season's growth will consist of the following process:

From each spur left upon the arms of last year two bearing branches were produced. The outer of these is entirely removed; the inner one, from the lower bud, is pruned back to two nodes or buds, which again will give rise to two fruit-bearing branches.

All future pruning of lateral branches will be a repetition of this method; that is, two branches are allowed to grow each year from each spur, and in the following winter the outer is removed and the inner cut back to the second joint from its base. The arms are permitted to lengthen each year by a few joints; and, as the root-system increases in amplitude and the trunk in diameter, additional or secondary arms should be started. The first of these are made from the basal branches of the two first, or central arms. To keep the growth symmetrical, four such secondary arms should be added at a time, namely, one to each lateral wire from each central arm.

The length of these, as in the primary arms, is to be proportionate to the supply of sap; that is, to have no more buds than can be forced into strong, fruit-producing shoots.

In time, renewal of the arms will become necessary. This is done by shortening the old arms back to strong branches of young wood arising from lateral spurs. Proper and careful pruning requires that the increase in the proportion of the old wood to the new be made with great economy, that is, gradually, and as slowly as possible; and that

a systematic retrenchment of the old wood, with a corresponding increase of the new, be instituted whenever the economic amplitude of the vine seems to be reached. This will, of course, vary both with the variety and the conditions for growth.

There are records of single vines from various Vinifera varieties which have reached gigantic proportions in size and fruit bearing, both in Europe and in California.* For example, a single vine of the Mission variety at Montecello, near Santa Barbara, California, is reported to cover an area of 10,000 square feet and produce annually 10,000 to 12,000 pounds of grapes. Other single vines of related varieties, grown under glass in England, are reported to be even more ample in size and greater producers. Such great age, size, and fruiting capacity, on the part of the grape vine, is mainly due to very skillful management on the part of the cultivator.

The varieties of the Vinifera, or Old World species of grapes, so extensively grown both for table use, raisins and, up until lately, for wine in California, will thrive excellently under irrigation in the arid regions of West Texas. At Balmorhea, a little town in Toyah Valley, about thirty miles south from the city of Pecos, I saw a small vineyard containing several of the more common table varieties of Vinifera grapes. It was in the early part of August, as the fruit was maturing. The vines were four or five years old, and were heavily loaded with large regular bunches of as fine fruit as can be produced anywhere in California. No diseases or blemishes of any kind were visible on the Vinifera varieties; but several American varieties in the same vineyard appeared sun-scorched and suffering in every way. Perhaps the dry climate, which is a delight to the Vinifera varieties, was hurting them. The American grapes were trellised, but the Vinifera varieties were grown in bush form, as is the common method in California. The varieties of the Vinifera species are more short-jointed and stocky in their growth than the varieties from our American species; and this habit is intensified in dry regions, so that trellising becomes superfluous.

The training for this system is very simple. The vine is tied to a stake four feet high to support it for the first three or four years after planting. After that the trunk becomes stout enough to be self-supporting. At the end of the second or third season's growth, varying with its vigor, the vine is pruned to four spurs at the top instead of to two arms. These spurs are managed as described for the trellising system, so that they furnish the bearing wood for each year, and, by their gradual elongation, become short branches or arms for additional spurs, as the increasing diameter and rigidity of the trunk will permit.

A FEW GENERAL RULES FOR PRUNING

(1) Start the frame-work for the head of a fruit tree with three or four branches during the first season after planting. Let the lowest of these be 16 or 18 inches above the ground, be the strongest, and turned towards the south or southwest.

(2) Do not allow any limb which is a part of the frame-work of the head to cross the center of the head or to cross another large limb, or to run parallel in close proximity to another limb.

*Journal de la Societe National D'Horticulture de France, Vol. X, 1888, p. 577.

(3) Keep the head of the tree so open by thinning that the direct sunlight, at some time in the day, may fall on any fruit-bearing branch.

(4) Permit no water-shoot to grow, unless it becomes useful in filling out a vacant space in the head, when its growth should be guided as to its direction, and controlled as to the maturity of its wood.

(5) Allow no limb of the main frame-work in a young tree to assume too low or too leaning direction, because the tendency of the limbs is to be pressed downwards as they grow older.

(6) A limb cut back to a lateral bud on the outer or lower side, will continue its direction from the shoot of that bud; but will set a shoot diverging from that direction, if cut back to a bud on the upper side.

(7) All terminal amputations should be made by a sloping cut behind a lateral bud or branch, and so near to its base that healing of the wound takes place without injuring the conductive tissues of the bud or the branch, or leaving a dead stump beyond. In the grape vine a terminal amputation should, however, be made a half inch or more beyond the bud, because of the porosity of the tissues.

(8) The removal of a lateral branch should be made by a cut through the swelling at its base in a plane nearly tangent to trunk upon which it is borne.

Any wounds from such amputation large enough to need a whole season for healing should be painted with asphalt-paint, which will protect it from decay and greatly facilitate the healing.

(9) Crooked, or leaning trunks and central leaders can, at an early age, be straightened by stakes or braces. In case of the loss of such a leader, the next lateral branch may be braced to take its position, and will soon become habituated to it.

(10) Heavy pruning, for the purpose of shaping, renewing, and thinning the head of a tree or any part of it, should be done during the season of dormancy; light pruning for directing the growth, or promoting the maturity of wood and fruitfulness, should be done during the growing season and on soft, herbaceous shoots.

Shoots of the current season of the blackberries, dewberries, and raspberries may be cut back at any time during the growing season, whenever their growth becomes cumbersome to cultivation and the cut may be made at any desired place.

ADAPTATIONS OF VARIETIES OF FRUITS

The question concerning the adaptation of any given variety of fruit trees, for example, the peach, to any given locality or soil is a frequent one; and it implies that any two varieties, although pure descendants of the same species, may require very different conditions for attaining vigor and fecundity. But in spite of the fact that this implied idea is very general and very old, a comparison of lists containing the names of the standard varieties of apples and peaches from all regions of the United States, wherever successfully grown, will show a remarkable repetition of the same names for the various regions. Such varieties of peaches as Belle, Carman, Champion, Elberta, Salway, Smuck, Stump, and Triumph hold as important a place in the

fruit catalogues of New York, New Jersey, and New Mexico as they do in those of Texas and Georgia.*

This same phenomenon holds good also for the apples. Farmers' Bulletin No. 208, "Varieties of Fruits Recommended for Planting," gives as "Highly Recommended" for the seventh district, which includes northern Mississippi, northern Louisiana, southern Arkansas, and the northeastern half of Texas, the following varieties of apples:

Duchess of Oldenburg	Mammoth Black Twig
Fall Queen	Red Astrachon
Gano	Red June
Kennard	Shockley
Horse	Summer Queen

Comparing the above with the small lists given for the eleventh and twelfth districts, we find several of the same varieties repeated, together with other well known varieties given for the seventh district under the heading "Recommended."

The eleventh district of the chart, given in the above named bulletin, comprises approximately that part of Northwest Texas which lies between the 30th and 35th parallels, west of the 99th meridian, exclusive of the Trans-Pecos region, which, together with the southern half of New Mexico, constitutes the twelfth horticultural district, according to the same chart.

As Farmers' Bulletin No. 208 was published seventeen years ago, the list of varieties, not only of apples, but of other fruits, such as grapes, peaches, pears, plums, and apricots can be greatly extended for these two districts in Texas. Since the time of its publication plantings have been made which, although on a small scale, have proved that in both of these districts there are localities where fruit-farming may be made a specialty with both profit and pleasure. This is especially true for the valley lands of the Trans-Pecos wherever water for irrigation can be had, either directly from streams or pumped from wells, for which there are many opportunities. In the vicinity of Fort Davis there are apple and pear orchards which for regularity of the crops, abundance and quality of the fruits, are not surpassed by the famous apple orchards on the Pacific Coast.

Most likely the same would hold good for the same kinds of fruits on the north side of the Davis Mountains. The thriftiness of the Vinifera varieties of grapes in Toyah Valley has already been referred to. From the indications of the small plantings of European varieties of pears, apples, peaches, apricots, and quince made in that same locality, these fruits promise a success similar to that of the grapes.

Besides a suitable soil in many localities, this region has the advantage of great freedom from fungus and insect enemies.

From a comparison of lists representing the varieties of apples and peaches grown in the various districts of the United States, this general statement may be formulated in regard to those two classes of fruits: Within the various districts of possible culture, the great individual vitality and merits of any variety in any district make its success general in all districts; and the case must be referred to the

*Farmers' Bulletin No. 633, U. S. Dept. of Agriculture.

exceptional in which a variety would prove itself strong in one region and weak in another.

The apple and the peach are the most widely cultivated fruits in the United States. The numerous varieties in cultivation of each class have, with few exceptions, arisen on our own soil as descendants from European or Asiatic importations, which, through their superior qualities they have superseded.

The climatic zone in which the apple reaches its perfection is more northern than that of the peach, but as higher altitudes compensate for lower latitudes, apples can be raised with success in many localities, even as far south as in Mexico. The apple-growing regions in Texas are, therefore, located at altitudes of 1500 to 3000 feet, or even higher.

PEARS

What is stated above concerning the wide adaptability of our standard varieties of apples and peaches does not hold good so broadly for the varieties of other classes of fruits. The choicest varieties of pears, which are with few exceptions of European origin, are limited by the pear-blight to the two western districts in Texas. This limitation excludes these same varieties also from the rest of the Southern States to the east. The only variety in all the region liable to resist the pear-blight sufficiently to be of profitable culture is the Keiffer, which is a natural hybrid between the Chinese sand pear and a variety of the European pear. The Keiffer pear, though not immune to the pear-blight, is sufficiently resistant to escape destruction and be enabled to produce quite regularly large crops. It is very prolific and hardy even on soils unsuitable for a profitable cultivation of other fruit trees. Its fruit is large, coarse-grained and of poor quality, except for preserves, for the making of which it is excellently suited.

There are a few other varieties of pears of the same or very similar hybrid origin. Of these, the Le Conte and Garber have been in existence long enough to be well known. The Garber is a shy bearer in many places; therefore but little planted. The Le Conte is a very strong grower and very prolific; its fruit is of medium to large size, and of handsome appearance and fair quality; but the tree is very susceptible to blight, especially in rich, well cultivated soil. It is more resistant under conditions ordinarily unfavorable to tree-growth, such as hard-tramped and uncultivated soil, or even on a lawn of Bermuda grass. In the last situation it will be able to thrive and fruit, if it has a fair start of the grass, and the soil be deep and well drained.

PLUMS

The difficulty experienced in the cultivation of the European pears in the eastern half of Texas and the entire seventh horticultural district (Farmers' Bulletin No. 208) is equalled by that of cultivating the European plums and prunes, as well as the apricots. The plums of European origin grow fairly well in New York and New England States. Their perfection is, however, reached in California, where, together with the apricots, they assume an importance in commercial orchards scarcely inferior to that of the peach. In that region the curculio and plum-knot pests, so destructive to both the fruit and the

trees in the East, are absent. Indications are that the same class of plums with the apricots are well adapted to the twelfth district, which includes the Trans-Pecos country in Texas.

Instead of the European plums, the seventh district, to which the eastern half of Texas belongs, cultivates Japanese varieties and varieties originated from our own native, wild species. There are three such species widely distributed throughout the forests of both the Northern and Southern States. They are:

(1) *Prunus Americana,* which is recognized by its large, veiny, serrate-margined leaves, stout twigs and pale yellowish to bluish round fruit, which is about the size of small marbles. This species has given rise, among others, to Black Hawk, Deep Creek, De Soto, Forest Garden, and Weaver.

(2) *Prunus hortulana* has given rise to the Wild Goose, which may be taken as the type. From this species we have also obtained other well known varieties such as: Wayland, Miner, Whitaker, and Golden Beauty, the last two having originated in Texas.

(3) *Prunus Angustifolia,* or Chickasaw plum, is the species that makes most of the plum thickets throughout the State. It is a bush somewhat taller than a man, with slender, crooked twigs, and small lance formed, shining leaves. The fruit matures in Central Texas in May, is of a yellowish to reddish color, and of about the same size as that of the Prunus Americana or hog plum. The best known domesticated varieties of this species are: Caddo Chief, Lone Star, and Yellow Transparent.

The fruits of all the varieties of our native plums are poorly suited for consumption in a natural state, but make excellent preserves and jellies. The Japanese varieties, of which Abundance, Burbank, Kelsey, Satsuma, and Wickson are well known through the seventh district, are excellent table varieties and fairly reliable bearers.

THE METHLEY PLUM

Of late years the Office of Seed and Plant Introduction of the National Department of Agriculture has introduced a plum from South Africa under the number 31652. It is known as the Methley plum, and is a hybrid descending from the following cross: Prunus salicina X Cerasifera myrabolana. Four characters combine to make it a very promising variety, namely: great vigor, earliness, abundance, and fine quality of fruit. The fruit is about the size of that of the Burbank plum, clingstone, with dark red, juicy, fine-flavored meat, and dark red, glaucous skin. It matures at College Station during the last of May and the first days in June. The fruit is borne in dense clusters on spurs upon the lower parts of the main branches. This variety, the fruit of which is equal to the best of the Japanese in quality, has, so far, excelled all other varieties of plums, tried on our soil here at College Station, in robust growth and abundant bearing. Its time of blooming is rather early, as it is liable to precede that of the standard peach varieties by a week or ten days.

GRAPES.

Mr. Munson divides the United States into eight grape-growing zones,* all according to the adaptation of the various species and their varieties in cultivation. In this division at least five of these zones, or regions, extend over the territory in Texas. Zone 5 he calls the Vinifera zone. "It includes California, south of Redding, southern Nevada, Arizona, New Mexico west of the Rockies, all of Texas south of New Mexico and southwest of a line drawn from Colorado, Texas, through San Antonio to Aransas Pass."

The following Vinifera varieties are named by Mr. Munson as successful in this zone wherever the soil is suitable and irrigation can be applied: "(All Vinifera varieties endure limy soil.) Calabrian, Chasselas de Fountainbleau (Sweetwater), Fehr Szagos, Flame Tokay, Griesa de Piemont, Muscat of Alexandria, Perle de Anvers, Pense (Malaga), Quagliano, Red Chornichon, Rose of Peru, Semendia, Sultaniana (Thompson's Seedless), Verdelho, Violet Chasselas, Muscat Rose."

The Vinifera varieties of grapes are intolerant of moist heat; they are, therefore, especially in America, both North and South, confined to the drier regions. Their cultivation reaches the highest state of perfection on the Pacific coast, where they constitute one of the main horticultural products from northern California south to Chile. East of the great plains region, where their existence becomes precarious and uncertain, their place is filled by varieties descended from our native American species and their hybrids with the Vinifera forms.

That part of Texas lying east of the 97th meridian Mr. Munson allots to two different viticultural zones, namely, zone 7,† north of the 35th parallel, and zone 8 to the south of it. As having adaptation common to both of these zones he names the following varieties, all of which, however, need to be diligently sprayed with bordeaux mixture to save the fruit from the black rot:

Agawam	Carman
Amethyst	Catawba
America	Delaware
Armalaga	Dimond
Brighton	Krouse
Brilliant	Niagara
Captain	Norton

For zone 7 he recommends also the Vinifera varieties for high, well drained ground, if grafted on stock of a strong phylloxera resistant, native species and diligently sprayed from early spring until the fruit is nearly full grown.

As stock for this purpose, I have tried Vitis Champini and found that it greatly increases the vigor and vitality of the Vinifera varieties; so that, on the stiff, poorly drained soil on the grounds of the Main Experiment Station, they become as long-lived as the hardiest of the American varieties mentioned above,—and much greater producers. In planting such grafts one must see to it that the union of the graft be left above the surface of the soil; otherwise the scion will set its own

*Foundations of American Grape Culture.
†Foundations of American Grape Culture, p. 218.

roots and discard the root of the stock, thereby defeating the purpose of the grafting and producing a very unfit plant.

In zone 8, the gulf zone, and wherever the muscadine grapes grow wild, the Scuppernong and its hybrids with cultivated forms of other species can be planted with great advantage.

There are now in cultivation several hybrids between the Scuppernong and hybrid varieties of other species. They are all due to the efforts of Mr. Munson, who, by this work, has led the way to the production of an entirely new class of grapes able to withstand the grape diseases incidental to the moist summer heat of the gulf region. The following are the principal of these hybrids left us by Mr. Munson:

LaSalle, San Jacinto, Sanalba, Sanmelaska, Sanmonta, Sanrubra.*

The sugar content, tenderness of skin, and number of berries per bunch have been increased in all of them above that of the Scuppernong parent, and, in general, the quality has been greatly improved for all purposes.

FIGS.

Commercial orchards of figs have been attempted with more or less success in the immediate coast region of Texas. To thrive, the fig needs a well drained, pervious subsoil, a surface soil of fair depth and with enough humus to supply plant food and retain the moisture. Another condition necessary is moderately dry weather during the season of ripening, as heavy showers at that time are apt to cause scouring and fermentation of the fruit. The greatest danger to be encountered in fig culture in Texas is late freezes, since the fig is one of the first trees to start growth in the spring. For this reason only a few varieties of proven hardiness towards frost are cultivated in Texas. Of these, Magnolia is best known and most common in the coast country, while the Celeste is cultivated, almost to the exclusion of the other varieties, in the interior parts of the State. The Celeste is common in family orchards all over East Texas, where it produces crops quite regularly as far north as Rusk County and, perhaps, even to the northeast corner of the State. At this northern limit of its culture, it is generally planted where protected from the direct blizzards by the forest, or, in the case of a few trees, where buildings may serve the purpose of windbreaks.

Besides the two varieties mentioned above, the following have proved themselves nearly as hardy on our grounds here at College Station: Adriatic, Brown Turkey, Mission (Black California), White Genua. On our very unsuitable soil Mission is not a robust growth; yet its fruit is not only abundant, considering the state of the trees, but also the largest and finest in quality of any variety tried. This fig is very popular in California and would, except for its black color, furnish a large bulk of the figs dried for commerce.

In the citrus growing district of the Rio Grande Valley and the neighboring regions, where the severity of late frosts are reduced to a minimum, all the varieties of figs popular in California ought to do as well. The same expectation may justly be held for the same region in regard to English walnuts, almonds, and olives, all of which are limited to regions of very mild winters, chiefly because of their sudden and early resumption of growth in the spring.

*Foundations of American Grape Culture, p. 209.