Eight catalpa trees 25 years old. Total number of posts produced estimated 151.

Photograph by C. W. Waid.
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OHIO AGRICULTURAL EXPERIMENT STATION.

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The Bulletins of this Station are issued at irregular intervals. They are paged consecutively and an index is included with the Annual Report, which constitutes the final number of each yearly volume.
FORESTY INVESTIGATIONS: I.

SOME TREES SUITABLE TO PLANT FOR POSTS, POLES AND TIES, WITH CULTURAL SUGGESTIONS AND FINANCIAL POSSIBILITIES.

BY W. J. GREEN AND C. W. WAID.

The Experiment Station has been planting forest trees on a limited scale for a number of years, but public interest in certain phases of forestry has become aroused to such an extent that more extended and varied investigations must be undertaken.

For the present these investigations will relate chiefly to different species of trees, and to methods of growing post, pole and tie timber.

The scope of the work will be enlarged later, but it seems expedient to take up first such problems as are of most immediate interest. Particular attention will, in due time, be given to windbreaks and to the best methods of preserving and managing woodlots, and of reducing or lessening the damage done by washing of fields and banks of streams.

Much experimental work needs to be done before tree planting can be extensively practiced with assurance of success. Even in the simple matter of growing post and pole timber more knowledge is needed regarding the trees which are best suited to different soils and the distances of planting which will give the quickest and best results. We know that some trees may be grown with profit, but how to secure maximum results is yet to be determined. It is
evident that most of the planting which has been done has not
yielded the best possible results and there are indications that some
changes in methods could be advantageously made. Experimental
work of this kind needs to be done, not in one locality only, but on
many classes of soil and under various conditions. Because of the
increasing scarcity of timber, farmers have become greatly inter-
ested in tree growing; especially for posts, poles and railroad ties,
and one or more in nearly every county in the state have entered
into cooperative work with the Station in tree culture and are
helping to answer these questions. Under most conditions the
groves which are planted in this manner will yield a profit to the
farmers, while the Station is thus enabled to secure valuable data.
It is the purpose, as far as means will permit, to keep full notes on
these plantings and at the same time to make careful investigations
of groves which have been planted for a number of years. These
groves, mostly of locust and catalpa, in various parts of the state,
afford excellent opportunities for the study of tree growth.

Many of these groves have been visited, numerous measurements
taken and estimates made, and the data already secured show
valuable results. These notes are not completed and the full results
of the investigation will be given in future publications, but some of
the most important conclusions which can be drawn safely are stated
in this bulletin.

Bulletin 149 was devoted to the catalpa, as it was believed to be
important to bring out clearly the fact that Catalpa speciosa is the
only catalpa which can be planted with profit, and it is, on
suitable soil, the most profitable tree to grow for post timber.
There are other trees, however, which are suitable for posts, poles
and ties and there are still others which may be grown with
profit for different purposes.

Taking into account for the present, however, post, pole and
tie production only, it is worthwhile to consider the relative value of
black or yellow locust, Osage orange, mulberry and Catalpa speciosa.
Red cedar is valuable for post timber but its growth is very slow,
moreover, this tree will be given consideration under windbreaks.

Trees Suitable to Plant for Posts, Poles and Ties.

In the Yearbook of the Department of Agriculture for 1900, pp.
145-156, there is an article entitled “Forest Extension in the Middle
West,” by Prof. Wm. L. Hall, Ass’t. Supt. of Tree Planting,
Division of Forestry. In speaking of the timbers best suited for
fence posts, Prof. Hall says:
"Osage orange posts have been obtained from native timber and from old hedge rows, mostly from the latter source. This tree has been used extensively as a hedge plant in eastern Kansas, Missouri, Iowa and Illinois. Hedge rows sometimes turn out as many as 25 posts to the rod. It has seldom been planted except in this way, but will grow well in plantations. Its durability in contact with the soil is greater than that of any other wood commonly used, and it justly ranks high as a post timber. It requires from 12 to 15 years to reach suitable size for posts.

"Mulberry, especially the Russian type, has made a good record in some sections of the west. It grows rapidly, is usually more or less crooked, but lasts well in the ground. It does best in porous, sandy soils, and when grown thickly in the row. It can be used in ten years after planting.

"Locust (black or yellow locust) is a well known post timber. It grows rapidly, is well adapted to hard, stiff soils, and stands more drought than any other timber used for posts. These properties make it very popular in many parts of the west.

"The hardy catalpa has been more abundantly planted as a post timber than any other tree. It is especially popular, and deserving so, in eastern Kansas and Nebraska, where several large plantations have been made. It does best on deep, porous soils. Its durability in the ground has probably been overestimated by some but not fully appreciated by the public generally. When cut at the proper season its durability nearly equals that of the Osage orange, but if young wood be cut when full of sap it is subject to attack by a fungus which destroys it rapidly. If to its durability we add its rapid growth, good form, lightness, strength, elasticity, immunity from checking or becoming unduly hard, we have an array of good qualities that to many men of experience place it first among post timbers. It requires from 8 to 12 years to become large enough for use."

Many miles of Osage orange hedge have been planted in certain sections of Ohio, but few individual trees or plantations of this tree are growing, as is the case in the west. Its great durability seems to be well demonstrated, but as yet there is little actual information available as to its behavior when grown in plantations. The limited experience with it growing under these conditions indicates that it is not as rapid in growth as either the catalpa or locust. The wood, when thoroughly seasoned, becomes so hard as to make the driving
of nails or staples into it very difficult. The prejudice held by many against this tree as a result of injudicious use for hedge purposes will naturally work against its extensive planting for fence post material. It is, moreover, a favorite food plant for the San Jose scale.

The mulberry has been planted in many places in Ohio as individual trees, but very few have been planted in groves or plantations. Thus the knowledge of its behavior under these conditions is very limited. Wm. Hanna, Champaign Co., planted a row of Russian mulberry, over 40 rods long, in 1885. The trees were planted six feet apart in the row. The first winter they were killed back to the ground, with the result that many sprouts grew from each stem, none from the roots however.

At the present time there are from two to six sprouts growing where only one would be growing had the tops not winterkilled. The row was intended for a windbreak, hence no pruning has been done. As a result of this crowded and unpruned condition the trunks are crooked and not very large. As is the case with the Osage orange, the mulberry can be used for posts when very small, it having very little sapwood. Mr. Hanna values this row of mulberries very highly, not so much because of the posts which could be secured from it, but "because it pays its way," the fruit being relished by hogs and also being a means of attracting large numbers of birds. Mr. Hanna has noticed a rapid decrease in the number of insects in his orchard and vineyard since the mulberries have been fruiting, the credit for which he gives to the birds.

Owing to the lack of knowledge of the behavior of the mulberry, when grown under conditions favorable for post production, we do not, at present, advise planting this tree extensively. But on account of the combined value of its fruit and timber, the mulberry, especially the Russian type, is worthy of planting in limited areas. If posts are the chief object sought in the growing of this tree, the seedlings should be planted in a grove and given careful cultivation and pruning. A row of mulberries planted on the windward side of a catalpa grove, and allowed to grow unpruned, will serve as a protection to the catalpa trees and coppice growth, and will, in a large measure, prevent the blowing away of the leaves, which should be allowed to remain and decay in the grove.

The black locust (also called the yellow locust) grows naturally in many parts of Ohio, especially on and among the hills of the southern and southeastern parts of the state. In view of the fact
that it has grown successfully under forest conditions, has been thoroughly tested for fence posts and has proven a good material for that purpose, it has been more extensively planted in Ohio for fence post material than has any other tree. The locust has many points of excellence to commend it for general planting. It grows rapidly and successfully, when not affected by the borer, even on thin soil and rough hillsides. The trees need but little pruning when set in groves, and the growth is usually tall and straight. The timber splits readily and is very durable when placed in contact with the soil, or exposed to the varying condition of the elements. Like many good things, however, it has its weak points. Its habit of sprouting from the roots after the trees are cut causes many to hesitate to plant it, for fear it will become a nuisance by spreading to where it is not wanted. When planted next to a field which it is desired to keep in cultivation some sprouts may spring up in the cultivated area immediately adjoining the plantation, after the trees are cut. Very few or no sprouts, however, will start from the roots until after the trees are cut, or injured seriously by borers.

This characteristic of the locust is much more of an advantage than disadvantage, as it enables the plantation to reproduce itself readily after the trees have been cut (see Fig. I). The sprouts come up so thickly, however, that a certain amount of thinning is often necessary to insure the most rapid and satisfactory growth. The thorny nature of the tree makes it more or less disagreeable to work with during its earlier stages of growth, but this is a matter of minor importance.

The chief and really only serious drawback to the growing of the locust is its susceptibility to attacks of the locust borer. While this is a very serious pest and may destroy a grove within a year or two after it begins operations, there is no reason why locust growing should be abandoned, even though no remedy is known. The locust thrives on soil where the catalpa will not make a satisfactory growth, and in such locations it is about the only tree which is likely to yield profitable returns within a reasonable period.

The locust may be made to yield very satisfactory results both in a direct and indirect manner. It has been observed, where locust trees are standing, not too closely, that the grass growing underneath the trees affords more pasture than the same area outside. One hundred and fifty to two hundred trees per acre, standing about a rod apart, will thus give considerable returns from timber and the pasturage will be improved. In case the borers attack the trees the timber should be harvested and a new set of sprouts will quickly give another crop of post timber.
Figure I.—Second growth locust trees 4 years old. Average height 20 feet. Average diameter of 20 of the largest trees, 3½ inches.

Photograph by C. W. Wald.
It may not be advisable to plant locust trees where the catalpa will make a satisfactory growth, but, in any case, the locust trees should have plenty of room so that a quick growth can be secured in order that the crop may be harvested before, or soon after, the borer begins operations. To crowd locust trees unduly and thus check the growth invites disaster.

Whether a close or wide planted locust grove will give the greater yield of post timber, provided the borer does not make its appearance, may be an open question, but there can be no doubt that there is less likelihood of failure in growing a short term than a long term crop. Four feet by four requires about 2,700 trees per acre, which is the number often advised. Planted so closely as this the severe struggle for existence results in the death of many trees and the time required for the remaining trees to come to a marketable size is usually 15 to 25 years. If no more than one-fourth, or even one-eighth as many trees per acre are planted, the crop may be harvested in 10 to 15 years, and possibly sooner, with a far greater probability of getting ahead of the borers. Locust trees are self pruning, even if planted 8 to 10 feet apart each way.

The borers come few at first but quickly increase to larger numbers, and in a year or two their work may be so destructive as to almost completely destroy the plantation.

The work of the borer is peculiar in that while it seriously damages one grove it may leave another uninjured. This is liable to occur, even when the two groves are growing in the same neighborhood. A good illustration of this is the Egin and Mann groves. Although only a few miles apart, Mr. Egin's plantation has been almost entirely destroyed by borers, while Mr. Mann's trees have received very little injury. Why there should be this difference is a difficult matter to explain. It is the opinion of some men of experience that so long as the trees can be kept growing rapidly and thriftily the liability of attack by the borer is much lessened.

Observations made on the two plantations previously referred to reveal these facts: Mr. Mann's grove is planted in soil of more than average fertility; the trees were given sufficient space, having been planted 8 by 11 feet, so that little checking of growth has resulted from crowding; they have been well cared for in every respect, and the result is that the trees have made a healthy and rapid growth. They are in a thrifty condition at the present time, as figure VII clearly shows.
It is a difficult matter, owing to its present dilapidated condition, to give many facts concerning the Eggin plantation that bear on this point. However, the soil on much of the plantation is not as fertile as that on which the Mann grove is growing. Some of the trees were planted alternately with catalpa, being in this instance about 4 x 4 feet apart, while those planted alone were given more space. Orchard grass was sown among the trees when they were quite young. It is quite probable that from some unfavorable conditions the trees received a check in growth before or at about the time the borers started to work. Mr. Eggin said the trees were free from the borers until they were five or six years old. Whether this check in growth, in case it did occur, had anything to do with the working of the borers, is a question that cannot be satisfactorily answered.

In Bulletin 149 of this Station, the subject of "The Hardy Catalpa as a Farm Crop" is very fully treated. It is not necessary therefore that any very extended discussion be given it in this publication. It may be said, however, that the Catalpa speciosa is a tree of rapid growth; it is adapted to many uses, some of the most important of which are for posts, poles and ties, it being very durable when placed in contact with the soil or exposed to the elements. It also makes fine finishing lumber and is good for paper pulp; in fact it is adapted to any use where such qualities as durability, toughness, light weight, or ease of working are desired. It makes a good shade tree and may be planted along the roadside (see Fig II). It is beautiful when in flower, but is not as symmetrical as the hard maple nor as graceful as the white elm. Where a windbreak is desired in a short space of time the catalpa will be found to be satisfactory. This tree is adapted to all parts of Ohio so far as latitude is concerned, as trees of various ages are growing in a healthy condition in nearly every county of the state. It is very easily grown from the seed and very little loss is met with, as a rule, in transplanting. A stand of 98 per cent. is nothing unusual, even in five or ten acre plantations.

The catalpa does not send up sprouts from the roots as is the case with the locust, but from the stump, thus reproducing itself but never spreading from the roots. So far as is known it has but few serious insect or fungus enemies, although it is by no means immune. As is the case with the locust, this tree has its faults. Chief among these is its tendency to grow somewhat crooked. This may be overcome, in part, at least by proper treatment (see Cultural Methods, page 146).
Figure II.—Row of catalpa trees 25 years old. Trees were cut off at ground when two years old and have been kept pruned.

Photograph by C. W. Waid.
The catalpa will not prune itself to any great extent (see Fig. III).

Seedlings of the *Catalpa speciosa* cannot be distinguished from those of the *Catalpa catalpa* (*bignonoides*), which makes it easy for the dishonest or careless nurseryman to sell one for the other. As the seed of the *Catalpa catalpa* is much more abundant and more easily gathered than the seed of the *Catalpa speciosa*, there will always be danger of getting the wrong kind.

Too much stress cannot be laid on the importance of being certain that seeds or seedlings of the *Catalpa speciosa* type and not of the *C. catalpa* are the ones being planted. This is well illustrated in a
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A grove on Mr. Custis' farm, in which *Catalpa speciosa* and *Catalpa catalpa* are growing under similar conditions. Mr. Custis, in the year 1883, planted a catalpa grove of nearly two acres. He supposed they were all *C. speciosa*, as he had been so informed, but unfortunately about one-half of the trees are *C. catalpa*. Figure IV shows the growth of the *C. speciosa*, while figure V shows the growth of the *C. catalpa*. As the camera of necessity had to stand closer in the latter case than in the former, comparison in height should be made between the trees and Mr. Custis and not between the trees in the two photographs.

In the following table a comparison is made between the two species as to size of the trees, number of posts they will produce, and the value of the same.

**Comparison between *Catalpa speciosa* and *Catalpa catalpa*, growing under similar conditions**

<table>
<thead>
<tr>
<th>VARIETY</th>
<th>Average diameter of tree (measured)</th>
<th>Average number of posts per tree (estimated)</th>
<th>Total No. of posts per acre (estimated)</th>
<th>Per cent of posts first-class (estimated)</th>
<th>Value of posts per acre (estimated)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Catalpa speciosa</em></td>
<td>14.3 inch's</td>
<td>9.3</td>
<td>2,027</td>
<td>80</td>
<td>$186.50</td>
</tr>
<tr>
<td><em>Catalpa catalpa</em></td>
<td>9.6 inch's</td>
<td>2.7</td>
<td>309</td>
<td>70</td>
<td>$51.78</td>
</tr>
</tbody>
</table>

The differences between the two species were pointed out in Bulletin 149, but in figure V the smooth bark of *Catalpa catalpa* and in figure IV the rough bark of *Catalpa speciosa* are plainly shown. *C. catalpa* will make durable posts but fewer in number than *speciosa*, as shown in the table. Quite a thorough canvass of the state shows that there need be no difficulty in securing the *C. speciosa*, or hardy catalpa seed, from bearing trees, although they are more numerous in the western than in the eastern part.

There are about 20,000 catalpa, 28,000 black locust, 10,000 Osage orange and 200,000 mulberry seeds in a pound.

**CULTURAL SUGGESTIONS FOR GROWING THE CATALPA, LOCUST, MULBERRY AND OSAGE ORANGE.**

**GROWING AND PLANTING THE SEEDLINGS.**

Catalpa, locust, mulberry and Osage orange trees are easily grown from seed, although the cost of growing a few is greater than to purchase them. The advantage of growing them is to have them at hand when wanted and, in case of the catalpa, to be sure of getting the correct species. The soil should be quite fertile but not excessively so. At the Station catalpa trees have been grown four feet tall the first season, on very fertile soil, and on a fairly good soil,
Catulpa speciosa 22 years old. Note tall, comparatively straight trunk and furrowed bark. (Rows 14 feet apart, trees alternate in rows.)

Photograph by C. W. Waid.
FIGURE V.—*Catalpa catalpa* growing in same grove as *Catalpa speciosa* shown in figure IV. Note comparatively short trunks and scaly bark.

*Photograph by C. W. Waid.*
one to two feet high. The latter are worth as much for planting as the former. Locust trees have grown to a height of six feet the first season, but trees one-third that size are just as good for planting. A poor, dry soil is unsuitable for the purpose. A soil that does not bake and form a crust should be selected, otherwise many of the young plants may fail to break through the crust. No shade is required for the young trees, as in the case of evergreens.

It is better to select a soil which has been manured in previous seasons rather than one that needs to be manured before the seed is planted. If manure is necessary it should be fine and well mixed with the soil. Thorough preparation of the soil is essential, and if lumps remain after harrowing they should be removed with a hand rake.

Seeds of catalpa, locust, mulberry and Osage orange should be sown in the spring about corn planting time. Catalpa seed may be kept over winter in the pods or in bulk and needs no treatment by soaking or scalding before sowing. The young plants make a satisfactory growth if they stand at an average distance of an inch apart in the row, and will grow very well in rich soil if still closer.

Often the seed is strewn in a broad row several inches wide, the plants averaging 25 or more to every linear foot of row. The result with very thick planting is unevenness in the size of the young trees. It is usually safe to place the seed about twice as thick as the trees are expected to stand. Catalpa seed should not be covered more than half an inch deep.

Locust seed may be kept in a dry place with safety, but usually needs to be soaked before planting. Sometimes it will grow well without this treatment, but success is assured by pouring hot water, nearly at boiling temperature, over the seed and allowing it to stand a day or two. In case the seed is very dry hot water may be used the second time. As soon as the seeds begin to swell they should be sown, and in the same manner as advised for catalpa. Osage orange seed is treated in the same manner as locust seed. Mulberry seed should not be covered more than one-fourth of an inch deep. If the seedlings are to be cultivated by hand the rows need not be more than two feet apart; for horse culture they may be 3 to 4 feet apart.

The rate of growth of the seedlings depends largely upon the thoroughness of cultivation. Some hand weeding needs to be done to prevent the trees being smothered by weeds.
In mild winters the young trees will stand in the seed bed with safety, but they are liable to be injured in severe winters. The safest plan is to take them up late in the fall and heel them in, choosing a dry spot and covering the trees, roots and tops, with mellow soil, which is easily done by placing the trees in a sloping position. In the spring they should be planted in the field as early as possible. Planting may be delayed later with the catalpa than with the other kinds, but early planting is advisable for all.

The ground where the young trees are to be planted needs careful preparation, the same as for corn or potatoes. The simplest way to plant is to use a spade, which is simply thrust into the soil the full length of the blade, and by working it back and forth an opening is made for the roots. The tree is put in place in the hole and the soil pushed against the roots by thrusting the spade into the ground again, a little to one side of the tree. Tramping around the tree with the feet completes the work of planting. The roots may need to be pruned, or shortened, to about eight inches before planting. Cutting off a good share of the tops of the trees increases the probability of successful transplanting. It is an excellent thing to dip the roots of the trees in thin mud, which prevents drying, keeping the roots in good condition for several hours.

Where planting is done on a steep hillside, or in newly cleared woodlots, where plowing is impracticable, a grubbing hoe may be used to loosen the soil for a space of a foot or more on each side of the tree. Planting in a sod is not likely to give good results, unless each tree is mulched quite heavily at planting time, and more mulch added each spring until the trees get well established. Small trees planted in the shade of larger trees usually perish at once, or make a feeble growth. Catalpa and locust, because of rapid growth, are as well adapted as any trees for filling up spaces in young forests and may do fairly well in openings, among young growth, especially of the slower growing species, but not in thin forests under the shade of large trees. Young trees may be planted with success in land where the forest trees have all been recently cut, and, in this case, the work will be more successful if the planting is done the first season after the removal of the forest and before the grass gets well established. In most cases it will be impossible to plow the ground, but this is immaterial if the weeds and sprouts are kept in subjection.
CULTIVATION OF THE TREES.

Young trees need to be cultivated or mulched for two or three seasons after planting. The first season a crop may be grown between the rows, although the trees will usually do better if the entire ground is given up to them, at least during the early part of the season, and a crop of soy beans or cow peas grown during the latter part of the season. Potatoes grown between the rows are less liable to injure the trees than corn.

The ground may be put in better condition at the beginning of the second season with a disk harrow than by plowing. It is better to keep the surface of the soil in order with a harrow than to attempt to grow a crop during the first part of the second season. Beans or peas may be grown the second season as before. If the trees are cut off at the ground at the beginning of the third season it will be possible to cultivate or harrow, as before, but this will be about as long as cultivation of any kind can be practiced.

If it is possible to mulch the entire surface of the soil heavily at the beginning of the third or fourth season the result will be highly satisfactory, but clover seed may be sown and if a crop is secured it may be left to enrich the soil. Strawberry plants might be set between the young trees and while the trees would shade the plants considerably the crop of fruit would not be greatly lessened and the conditions for the trees would be excellent, especially if the entire surface of the soil were mulched. If clover straw or chaff were used for mulching material the conditions for the trees would be ideal. A moderate expenditure for the good of the trees at the period when cultivation ceases is likely to yield good returns, for a check in growth means a lessening of profits.

DISTANCE APART TO PLANT THE TREES.

The proper distance apart to plant for the quickest and most satisfactory growth of forest trees, which are grown for post and pole timber, is one of the most important questions in farm forestry at the present time.

In many of the catalpa groves growing in various parts of the state, which are of sufficient age to produce fence posts, the trees have been planted 4 by 4 feet apart, some even closer. In a few groves they have been planted farther apart.

Observations and measurements made show, that in every case where the trees are four feet or less apart, those in the interior portion of the grove have not made nearly so good a growth as have
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those which are on the outside of the grove. In some cases the average diameter of the trees growing in the outer rows is twice that of those growing in the interior of the grove and there is a still greater difference in the number of posts which they will produce. In most cases many of the trees have died before reaching sufficient size to be used for posts and often this amounted to fully 50 per cent of the total number of trees planted.

In groves where the trees have been planted six feet or farther apart they average nearly or quite as large in the interior of the grove as in the outer rows. There is also a better stand and so far as it can be determined the trees are fully as tall, and in some cases taller, where they were planted more than four feet apart than where they are four feet or less apart.

In a grove planted so that the trees stand about 15½ by 15½ feet, there is very little difference in the average size of the trees in the interior and on the outside portions; however, the difference in the diameter of the trees near the ground and 10 feet or more above it is greater in this grove than where the trees are planted considerably closer (see Fig. IV). That is, there is more taper to the trees in wide than in close planting. The trees in this grove would produce a larger number of posts per tree but the greatly reduced number of trees per acre, as a result of wide planting, does not give a yield of as many posts per acre as some of the closer planted groves.

The trees in two groves where they were planted 6 by 8 feet grew straight and tall and the difference in the diameter of the trunks near the ground and 10 feet or more above it is comparatively small (see Fig. VI). These groves also give the highest estimated yields of posts per acre of any of those inspected. No groves were found where the trees were planted 8 by 8 feet.

The result of this investigation shows clearly that for most of the soils and conditions of Ohio, trees planted 4 by 4 feet will not give the best results in post production. So far as we were able to get an expression from the men upon whose farms the trees are growing, none who have planted 4 by 4 feet would plant so close if they should plant again. Among the groves inspected which were planted close the one on the Quinn farm has grown under the most favorable conditions of soil and treatment, including thinning by removal of trees as they became large enough for posts. The following is an extract from a letter written by Mr. Quinn:
FIGURE VI.—A catalpa grove in which the trees were planted 6 by 8 feet, age 23 years. Note tall trees with uniform-sized trunks.

Photograph by C. W. Waid.
"The soil is a black loam with a clay subsoil and with no immediate
drainage. In the spring of '82 I put out 2,000 plants, four feet apart each way.
They were cultivated twice the first two years, once each way; no cultiva-
tion thereafter. The first posts, which were cut in '97, were from trees growing
on outer edge of plot. In '99 there were some 700 posts cut which exhausted
all the trees large enough for posts. Three posts were the most gotten from one
tree. My opinion is that if the trees had been set six feet apart they would have
been large enough for posts several years sooner.

I consider the plot very valuable indeed, as for all time to come it will afford
a large number of posts, providing each stump is allowed to grow but one sprout.
From my observation I think the posts very durable; fully as much so as locust."

Mr. Custis, on whose farm catalpa trees are growing 15½ feet
apart, will plant more trees soon and he intends to plant 8 or 9 feet
apart; he prefers 9 feet.

At this stage of the investigation we have no reason for
recommending a different distance apart to plant from that which
was given in bulletin 149. It may be more convenient in some
cases to plant the rows farther apart than eight feet and the trees
closer in the row. No mature groves have been found planted in
this way, therefore we withhold our opinion as to the advisability
of planting in this manner until we secure further data.

When trees are so planted care should be exercised not to plant
the rows so far apart nor the trees so close in the row as to induce
a zigzag growth; that is, one tree leaning one way and the next
the other way. The tendency to grow in this manner is stronger
with the catalpa than with the locust.

In a general way the statements that have been made in
reference to the distance apart to plant catalpa trees will apply to the,
locust as well. The groves inspected, in which the trees were planted
4 by 4 feet, did not show so great a difference in size between
the inner and outer trees as was the case with the catalpa;
however, a large number of trees were killed as a result of crowding;
in one case over 50 per cent by actual count. The remaining trees
were very slender and few of them suitable for first-class posts.

The best locust grove seen was planted 8 by 11 feet. The
trees in this grove are very tall and straight; estimated height
of trunks 40 to 45 feet (see Fig. VII). The diameter of the trees
near the ground is not much greater than that 10 or 20 feet above
the ground. The trees pruned themselves as well as when planted
much closer. This demonstrates that, at least on soil of high
fertility, locust trees do not need to be planted closer than 8 by 11
feet to get them to grow tall and to prune themselves. As we have
seen no groves in which the trees were planted at an intermediate
FIGURE VII.—A locust grove 18 years old, in which the trees were planted 8 by 11 feet apart. Note height of trees, straight and uniform-sized trunks.

Photograph by C. W. Waid.
distance between 8 by 11 and 4 by 4 feet, we withhold until later the expression of an opinion as to the advisability of planting closer than 8 by 11 feet. We do not hesitate to say, however, that 4 by 4 feet is too close for best results with the locust as with the catalpa. One case is known of a self-sown locust grove, 29 years old, where the trees average 13 feet apart, and will cut 1,200 posts per acre. The diameter of the trees is very uniform, there being but little taper, and the trunks of the trees are clean. The pasture in this grove is much better than on the same quality of soil outside.

In the Weltz-Madden plantation shown in Figure IX the rows are from 9 to 10 feet apart and the trees from 3 1/2 to 4 feet apart in the row. Mr. Weltz says if he were to make any change in planting again he would set the trees a little farther apart in the row. From present knowledge we would advise those who follow this method not to plant closer than 4 1/2 to 5 feet in the row, when the rows are 9 or 10 feet apart.

The evidence at hand indicates that where catalpa and locust trees are planted as close as 4 by 4 feet, growth almost ceases or becomes very slow after the trees are 8 to 10 years old.

It is true they stretch upward toward the sunlight but the trunks expand very slowly. Many trees in such groves are not more than 3 or 4 inches in diameter at twenty-five years of age. In the struggle for existence large numbers die, but the mortality is not great enough nor is the thinning done soon enough to give the survivors a chance to make a rapid growth. If thinning is not practiced a grove of this kind would yield but few, if any, railroad ties within 50 years. It is evident that this fierce struggle for existence is a very costly one for the owner of the grove. He may know that he ought to thin the trees, but there is little encouragement to do so when the trees which ought to be cut out are not large enough for posts. There is a waste in such thinning and a greater waste in allowing the surplus trees to stand.

When the useless trees finally die or are removed the harm which has been done to those remaining can never be repaired. A tree should be kept growing continuously. It is the nature of a young tree to grow if it has a chance, but if held in a half dormant state for a number of years it soon reaches a condition where rapid growth is impossible. It may be advisable, for various reasons, to plant so closely that some of the trees will, sooner or later, need to be removed in order to give those remaining a better chance, but if the crowding is so excessive as to cause many trees to die and to seriously check the growth
of the survivors the loss is greater than any possible gain. Let the space between trees be such that thinning will not be absolutely necessary until the trees which need to be taken out can be utilized. If this plan is followed the work will most likely be done at the proper time. Catalpa and locust trees, and most likely mulberry and Osage orange as well, will not continue to make a vigorous growth for more than 5 or 6 years if given no more than 16 square feet each. In fact, there is a perceptible check even earlier. If given 50 or 60 square feet per tree a very satisfactory growth is maintained for 8 to 10, or possibly 15 years in some cases, at which periods the thinnings can be utilized. Taking into consideration the second growth and the increasing demands of the uncut trees it is probable that a still larger area per tree is advisable, but the demonstration of this must await further experiment.

The crowding of trees may be necessary in forests, but the same principles do not apply with equal force in post and pole groves. A farmer who plants a grove of trees for posts can afford to give the needed space and spend a little time in pruning in order to secure quick returns. He cannot afford to let nature take years to do a little pruning which he might do in a few days.

Nature will, however, prune locust trees very satisfactorily even when they are given a space of 100 to 200 square feet each, but she will not prune catalpa trees in a satisfactory manner within 25 years, even if as close as 4 by 4 feet. The side branches die but dry up and do not drop for many years, leaving stubs and entering places for fungi, therefore the prime object of close planting cannot be attained in the case of the catalpa. When the catalpa is grown for posts, pruning must be done in any case by hand, hence there is no need of close planting. To plant the trees sufficiently close that they will grow tall instead of spreading, and yet not so close as to seriously check growth, is the problem which presents itself. It seems safe to set 50 square feet per tree as the minimum, but the maximum has not been determined. It is known that very good results have been secured with 100 square feet per tree, hence it seems reasonable to set the extremes for the catalpa at 50 and 100 square feet per tree.

Locust trees are particularly liable to suffer from close planting, because the longer the period during which trees of this species are exposed to the attacks of the borers, the greater the danger. Locust trees have been known to give very satisfactory results where each tree had considerably more than 100 square feet of space.

The side branches of the Osage orange, like the catalpa, are very persistent. Close crowding may kill them but does not cause them to drop, hence this tree should be treated the same as the catalpa.
The mulberry makes only a moderate growth at best, and the Kansas Station reports that it will not bear close planting except on rich soils. On poor soils it makes a feeble growth if crowded. The effect of over crowding becomes apparent more quickly on poor than on rich soil, but the final result is the same in both cases.

PRUNING THE TREES.

The catalpa and locust differ in that the locust will prune itself more completely than the catalpa. When planted very close the catalpa will prune itself to a certain extent in time, but it is more liable to grow as shown in Figure III. In order to insure a satisfactory growth for post production it is necessary to do a certain amount of pruning. It is a good plan to cut the trees off near the ground two years after planting, allowing but one sprout to grow per tree. The cutting back should be done in late winter or early spring. Very little pruning need be done previous to that time, and none will be needed the first year thereafter, except to remove surplus sprouts. After the trees have reached this stage of growth the lower branches should be removed as necessary, none being allowed to attain sufficient size to leave large wounds when cut off. When it is not the intention to cut the trees back pruning should begin the first season. For the first year or two only those branches should be removed which have a tendency to cause a forked trunk and those that grow low down. The aim should be in either case to have a leader and sufficient side branches to insure a good leaf production, without which a strong growth is impossible. Side branches help to increase the size of the trunks, and should not all be removed at one time, nor should they be allowed to attain any considerable size. A large chisel with a long handle is a good tool to use in pruning.

While it is true that the locust prunes itself to a considerable extent, a certain amount of hand pruning is necessary to avoid double or forked trunks. Figure VIII shows young locust trees where no pruning has been done; the forked trees are numerous. Figure IX shows trees in the same plantation where a sufficient amount of pruning has been done. All the pruning that is necessary is to remove such branches as have a tendency to form forked or double trunks. The smaller branches will die and fall off of their own accord, as they are already doing in the plantation in which the photographs previously referred to were taken. The Osage orange should be treated the same as the catalpa and the mulberry the same as the locust.
FIGURE VIII.—Locust trees four years old. No pruning has been done in this part of the plantation. Note forked trunks and compare with figure IX.

Photograph by C. W. Wald.
FIGURE IX.—Locust trees in same plantation as those shown in Figure VIII. The trees have been pruned sufficiently, as the straight trunks indicate.

Photograph by C. W. Waid.
COPPICE GROWTH.

The Quinn grove is a good example of what can be expected of coppice growth or reproduction from the stump. The trees in the interior of the grove were cut in '99. From one to three sprouts have grown from each stump (see Fig. X). Many of these measured over four inches in diameter and 50 averaged over three inches in diameter. Mr. Quinn realizes the importance of not allowing more than one sprout to grow from each stump, as was shown in the quotation from a letter written by him, which was given on a previous page in this bulletin. He has not had immediate supervision of the grove, therefore this matter has not been carefully looked after, as the photograph shows. If only one sprout had been allowed to grow from each stump and the sprouts pruned the result would have been more satisfactory.

A sprout from the stump of a tree, which grew in a row along the roadway on Mr. Hanna's place, measured 13.3 inches in diameter and would produce four good fence posts from the butt cut. Mr. Hanna says that this sprout is not over 11 years old. Sprouts from other stumps in the same row grew almost or quite as rapidly. Mr. Hanna threw a few shovels of earth around the sprouts when they first started to grow, to keep them from breaking off by the force of the wind and to give them an opportunity to take root. This no doubt helped to make them grow more rapidly. It is an excellent idea and worthy of being followed by others.

FINANCIAL POSSIBILITIES OF GROWING THE CATALPA AND LOCUST FOR FENCE POSTS.

The men who set out groves of catalpa or locust 15 to 25 years ago did not have the advantage of the present knowledge as to the best methods to employ in the growing of such trees. It is not strange, therefore, that many of them made mistakes which, if they were to plant again, their own experience, together with that of others, would enable them to avoid.

In most cases the trees were planted too close; in some, too far apart. The soil selected was not always such as would give the best results. Very little or no cultivation was given, in many cases. The trees in some groves were never pruned, in others they were not pruned sufficiently nor in the proper manner. No thinning was done in most cases. Hence it is apparent that the best results could not be expected. It should be stated, however, that some of the groves planted years ago were put out for the purpose of securing wind-breaks for buildings, or for stock shelters, rather than for the
FIGURE X.—Coppice or second-growth catalpa 6 years old. Fifty trees averaged 3 inches in diameter.

Photograph by C. W. Wald.
production of post material, and for that reason the trees were closely planted. It should also be stated that, so far as it was possible to do so, the exact age of each grove was secured, and where there was any doubt as to the age, the earliest date of planting given is the one used in the table on page 164.

Conservative estimates were made as to the number of posts these various groves have produced up to the present time, and the yield per acre computed therefrom. In calculating the value per acre from these estimates, first-class posts were valued at 10 cents and second-class at 6 cents. As posts are at present retailing at more than twice these prices in many parts of Ohio, it will be seen that the estimates made are sufficiently low to guard against any extravagant statements, which might otherwise be indulged in by over-enthusiastic individuals who may read this publication and quote from it.

Eight catalpa groves from 21 to 25 years old, from which estimates were made according to the previously stated method, gave an average of 2,777 posts per acre, 63 per cent of which were first-class, with a total value of $238.08 per acre; the lowest estimated yield being 2,040 posts per acre, 30 per cent of which were first-class, valued at $146.60, and the highest, 3,396 posts per acre, 90 per cent of which were first-class with a value of $326 per acre.

The average value of the production of these groves, calculated per acre for each year the trees have been growing, is $10.30, the minimum being $5.84 and the maximum $14.17. These estimates do not take into account the first cost, the rent of the land, nor the interest on the investment.

It is safe to say that these estimates would not have been correspondingly reduced had they been made five or ten years earlier, as a large per cent of the trees in some groves have not made much growth during recent years, owing to unfavorable conditions for growth, mainly due to over-crowding.

The Lemar grove, a part of which is shown in Figure VI, is on fair but not good soil and the trees were not pruned until they were nearly as large as they are now. The trees were planted 6 by 8 feet apart, however, and they have made a very good growth, as the photograph indicates. This grove is the one that gave the maximum production shown in the previous estimates. The Conklin grove, which is on the adjoining farm, was planted at the same time and the trees were set the same distance apart. The growth has been nearly as good as that in the Lemar grove.
There is no reason why the results secured on these two farms can not be duplicated on a very large percent of the farms of Ohio, at least in the better agricultural portions of the state. We feel safe in making the statement that catalpa trees planted on soil sufficiently rich to grow a fair crop of corn, and far enough apart so that each tree may have about 60 square feet of space; given sufficient and proper pruning and a reasonable amount of cultivation, will, in from 12 to 15 years, produce a crop that will give a return of at least $10 per acre for each year from the time of planting to that of harvesting the trees, and, in some cases, even better and quicker returns can be secured.

Estimates were made of the trees in but one locust grove, a section of which is shown in figure VII and is 19 years old. The estimated number of posts produced per acre is 3,560, ninety percent of which were first-class and valued at $341.76. This is at the rate of $17.98 per year for the entire period.

This is a larger and quicker return than has been secured from any of the catalpa groves previously mentioned, but none of them has grown under as favorable conditions for the catalpa as are furnished in this grove for the locust. If as good results could be secured every time the locust would be a better tree to plant for post production than the catalpa. The other locust groves inspected, owing to unfavorable conditions for growth or to the ravages of the borers, did not show nearly as good results as this one and in a few cases were total failures. More data must be secured, especially on the locust, before a safe comparison can be made between the catalpa and locust as to their respective values as post producing trees.
Table giving the location, extent, kind and age of trees, and name of owners of some of the groves or plantations from which data were secured, together with the fertility of the soil and distance apart the trees were planted.

<table>
<thead>
<tr>
<th>Location by county</th>
<th>Kind or kinds of trees growing</th>
<th>Age of trees in years</th>
<th>Area given in acres or fractions of an acre</th>
<th>Distance apart planted given in feet</th>
<th>Quality of the soil</th>
<th>Owner or owners</th>
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<tbody>
<tr>
<td>Clinton</td>
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<td>6 x 8</td>
<td>Fair</td>
<td>T. W. Conklin</td>
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<td>2 1/2</td>
<td>15 1/2 x 15 1/2</td>
<td>Fair</td>
<td>C. E. Custis</td>
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<tr>
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<td>6 x 8</td>
<td>Fair</td>
<td>S. K. Lemar</td>
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<td>1 1/2</td>
<td>8 x 11</td>
<td>Good</td>
<td>Wm. Mann</td>
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<td>Mostly poor</td>
<td>Lowry Erwin</td>
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<td>15, 10</td>
<td>by 9 to 10</td>
<td>Mostly fair</td>
<td>Mrs. Madden</td>
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<td>3 1/2 to 4</td>
<td>by 9 to 10</td>
<td>Variable</td>
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<td>Fair</td>
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<td>Very good</td>
<td>Simeon Taylor</td>
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<td>Very good</td>
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