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HORTICULTURAL DEPARTMENT.

ALBERT DICKENS, M. S., Horticulturist.
G. O. GREENE, M. S., Assistant.

Tests of Forest Trees.

ONE of the first experiments planned and carried out by the Kansas State Agricultural College was the planting of forest trees. A number of years previous to the establishment of the Experiment Station, many species of trees were propagated and planted. It is the purpose of this publication to give, up to date, the notes and observations concerning the growth and success of these plantings, as well as a report upon some of the comparatively recent plantings made by the Experiment Station.

A few quotations from the early College reports will serve to acquaint the reader with the conditions and purposes of planting.

In the Fifth Biennial Report, 1872, Prof. E. Gale, then in charge of the Horticultural Department, said in reference to the planting of that year:

“The land selected for this purpose (forest culture) is the least adapted to the cultivation of roots and cereals of any now broken up on the College farm.* This selection, all things considered, was thought best, for it is in general this quality of soil—the high, gravelly and broken ridges—which should ultimately be planted to forests. It is, then, a matter of interest to learn what may be expected as the result of forest culture on such exposed situations as the one selected. As was anticipated, the growth of the young trees has not been so vigorous as it would have been on lower and richer land, but still abundantly sufficient to give

*Now upper (or old) College farm.

the most encouraging promise of success. The planting consisted of European larch, White ash, Red ash, Green ash, Osage orange, catalpa, ailanthus, Black walnut, White hickory, Soft maple, and willow.

“Of the larch fifty per cent. died, most of them after the 1st of July. The White ash, one-year seedlings, have grown from two to three feet; the White and Red ash seed failed to germinate. The Green ash have grown from twelve to twenty inches from the seed. The Osage orange was planted with special reference to forest culture.”

In his report of 1874, Professor Gale says:

“Among those trees that are making good growth on upland may be mentioned the catalpa, Silver maple, Osage orange, ash, ailanthus, Black walnut, common cottonwood, and Lombardy popular. The European larch, after repeated trials, has not proved a success. The same may be said of the birches, beech, Sugar maple, and chestnut.”

The only species of this planting now growing are Green ash, Silver maple, Osage orange, ailanthus, Black walnut, and catalpa. The growth and success of the catalpa are recorded in Bulletin 108. In the following notes are quotations from the report of 1886, made by Professor Popenoe, professor of horticulture from 1879 to 1897, and from 1899 to 1901, now entomologist of the Experiment Station and professor of entomology and zoology.

It may be fairly said that the land occupied by the plantation of 1872 is now under forest conditions. The undergrowth contains many plants and shrubs found only in forest areas, and natural seedling trees of species not originally planted there are growing. Young trees of elm, ash, hackberry, Honey locust, Box elder, mulberry, cedar, and an occasional oak, are sufficiently numerous to insure succeeding crops of trees.

The gravelly soil is covered with a good cover of leaves, weeds and twigs in various stages of decomposition. There is no washing, such as takes place upon similar soil that is being cultivated.

ASH.

From Kansas Forestry Report, 1886.

“The ash plantation stands in the best part of the poor land occupied by the entire grove, being in a slight depression heading a small ravine, and facing the south. The trees stood originally in rows about five feet apart. Four years since, in response to an apparent demand for thinning, trees were cut out at such intervals as to allow those remaining to stand at about seven or eight feet apart. The trees cut out, trimmed and seasoned, furnished poles of great value for many purposes, being straight and tough, while some used as fuel proved equal in this regard to the best wood in our markets. Measurements with a tape line, at four feet from the ground, give, as an average of twenty-five specimens taken in succession while walking across the plantation, a circumference of 13 and a fraction inches. Seven of the twenty-five exceeded a diameter of 5 inches at the height given. The trees stood 25 feet high, straight and usually without forks. Ninety per cent. of them will furnish, now, serviceable poles twenty feet in length.”

The ash plantation continues to be first in condition and appearance. As with other species, rate of growth has decreased as the trees age. Many good poles have been cut for various purposes, and the plat, which contains 150 square rods, now contains 136 trees, the highest of which stands 43 feet.

The best trees average in diameter 11 inches at one foot from the ground, and 8 inches at five feet.

In all soils and locations on the College campus the ash trees have made very satisfactory growth, forming good trees. They seem less inclined to branch and form forks near the ground than most other species.

It is to be recommended for general planting. The wood makes fair fuel and the timber is strong and tough, though not heavy. One of the best ash trees on the campus, grown in fair soil, when forty years old measured as follows:

Height.....	58 feet.
Diameter at the base.....	17½ inches.
“ at 5 feet.....	12¾ “
“ at 10 feet.....	12½ “
“ at 15 feet.....	10½ “
“ at 25 feet.....	9½ “

The tree grew in a clump of mixed species and was straight and close-grained, making good timber. There was twenty cubic feet of cord-wood in the limbs and top.

Both Green and White ash are readily propagated from seeds gathered and sown in the fall, covering about one and one-half inches. Seed kept until spring is liable to become too dry unless packed in sand.

BLACK WALNUT. (*Juglans nigra*.)

From the report of 1886.

“Black walnuts, standing as planted, about 4x4 feet, have made a clean, straight growth, averaging over 15 feet high, and, at four feet from the ground, 8 inches in circumference. The plantation never having been thinned, the close stand of trees has resulted in the death and decay of all branches on the lower part of the trunk, promising straight timber when of larger size. A second plantation, apparently about three years younger, shows this process of self-pruning in progress. These trees, standing 4x1½ feet apart, averaging 12 feet in height and 1½ inches in diameter at four feet, carry no live branches below a height of about 6 feet, though the trunks are set with dead ones nearly ready to fall, through the decay of the branch at the base.”

The growth of the Black walnut since 1886 has been much slower than the other species. The trees have been thinned, as they seemed to require it. The smaller and less thrifty trees have invariably been removed, so that but little wood and practically no posts have been secured.

At this writing, the walnut plantation of 1872 contains 322 trees, 190 of which are of sufficient size to cut posts or poles. The best trees are 35 feet in height, with a diameter at the base of 8¾ inches, and, at five feet, 6 inches. The trees average slightly more than 20 feet in height and 5 inches in diameter at the base; at five feet, 4¾ inches.

A planting made in 1875 upon the same kind of soil has given results very similar to the 1872 planting. This planting contains 735 trees, 582 of which will cut posts or poles.

The best trees are 34 feet in height, 7½ inches in diameter at the base, 6½ inches at five feet. Where well thinned they are growing well, but where standing but four feet each way are dying or making very poor growth.

On the College campus, in good soil, the Black walnut has made very satisfactory growths. It is at best a slow-growing tree, but is perfectly hardy, of good appearance, and in every way worthy of planting. The trees have usually begun to bear light crops of nuts when from ten to fifteen years old.

Numerous observations have been made in regard to the growth of walnut trees. From an article based on these notes, published in the *Industrialist*, vol. 29, page 234, the following is quoted:

“The walnut is not a rapid-growing tree, as is shown from measurements of trees taken along the Kansas river bottom, in very rich, sandy soil, in which the roots could easily reach water, and where the trees were well protected from the winds on the south and on the west by the trees growing along the river. The following measurements were taken:

Age.	Diameter at stump.	Age.	Diameter at stump.
50 years.....	18 inches.	55 years.....	22 inches.
45 “	21 “	50 “	20 “
39 “	16 “	72 “	22 “
55 “	25½ “		

“A considerable number of smaller trees of the same age showed a much less average annual growth, while some of the younger trees showed a greater growth. The trees taken seem to represent the average growth. These trees grew under the best of uncultivated conditions; in fact, the conditions were better than they would be under average cultivation, as the soil was very loose and was well protected from the sun, and the water-table was not over twelve feet below the surface of the ground.

“Measurements of walnuts growing under very good cultivation alongside a corn-field and in a ravine, in very black and rich loam, where one might find the best of soils as well as the best of care, show the following growths:

Age.	Diameter.
26 years.....	13 inches.
33 “	11 “

The walnut has been successfully propagated by planting the nuts in the fall, or stratifying through the winter and planting early in the

spring. One-year trees may be transplanted readily, but older trees, unless previously transplanted, succeed but poorly.

Plate 1 shows a grove of Black walnut trees which stands on a farm adjoining the College farm. The soil is of good quality, for upland, and the tree growth is equal to any walnut timber in this locality, except that in the rich creek bottoms. The trees stand where the nuts were planted in 1869, and have been thinned occasionally, furnishing some fuel.

At present the trees average about eighteen feet apart, have good, straight trunks, and are vigorous, promising trees. They average 44 feet high; 9 inches in diameter at the ground, $7\frac{3}{4}$ inches in diameter at two feet, and $6\frac{3}{4}$ inches at six feet from the ground.

The largest trees are around the edge and in the lowest part of the grove. A number of the best measure from 48 to 52 feet in height; from 12 to 15 inches in diameter at the ground, from 10 to 13 inches at two feet, and from 9 to $12\frac{1}{2}$ inches at six feet.

The poorest trees in the grove measure from 21 to 30 feet in height; from 4 to 6 inches in diameter at the ground, from 3 to 5 inches at two feet, and from 3 to $4\frac{1}{2}$ inches at six feet from the ground.

OSAGE ORANGE. (*Toxylon pomiferum.*)

From the report of 1886.

"The Osage orange plantation stands as made, trees three to four feet apart, in rows four feet apart. No systematic thinning has been made. The trees average over 20 feet in height, and, as shown by measurement at a height of one foot from the ground, over 10 inches in circumference. As will be understood, they are much more generally branched low and the trunk often divided at the height of one foot from the ground. The lower branches do not so readily kill out by shading as in other trees."

The later growth of the Osage orange plantation of 1872 has been such as to warrant its being recommended for general planting. It has readily replaced itself from coppice growth, when cut. Some of the trees now growing in the 1872 plantation show that two good posts have been cut in former years and the trees now standing would each make several good posts.

At the present date, 1903, this planting, containing somewhat less than one-half acre, contains 200 trees which would make 350 posts.

The trees of the original planting average 35 feet in height and 11 inches in diameter one foot from the ground. At five feet from the ground the average diameter is 7 inches.

For fuel and posts the wood is more valuable than any other grown in the artificial forests. The wood burns well even when green, and lasts well.

The posts are considered the most desirable that are grown. Posts set thirteen years ago in the vineyards are practically sound posts today. The only objection to the post is that, after drying, the wood becomes so hard that it is almost impossible to drive staples into it, and when stapled green the wood is liable to check and loosen the staple. This difficulty has been overcome satisfactorily by the use of smooth-wire ties, kept in place by a shallow notch.

The posts are very strong, and less liable than are most other posts to catch fire from burning grass.

The wood of the larger trees is valuable for purposes where strength is required, such as tool handles, tongues or other parts of vehicles or implements.

The question as to the desirability of hedges will not be discussed here, but general observations warrant the conclusion that the Osage orange is the best hedge-plant for our climate, and the further conclusion that it is a poor plan to attempt to maintain a hedge and grow posts with the same plants, as it nearly always results in a poor hedge, and the posts could be more economically grown in a compact block of ground. However, it is a common observation in many parts of the state that even in such an extravagant planting as a neglected hedgerow the wood and posts pay large rent for that land upon which no crops can be grown on account of the hedge.

When grown singly or in rows, for shade or ornamental trees, the Osage orange requires severe and frequent pruning, in order to form a symmetrical tree. With sufficient care fine trees may be grown, and in localities not well adapted to tree growth it is well worth while to plant and prune this tree.

Plate 2 shows a well-grown tree of this species, probably between thirty-five and forty years old, which measures:

Height	40 ft. 6 in.
Diameter at the ground	15½ inches.
“ at 5 feet	14½ “
“ at 10 feet	11 “
“ at 20 feet	5 “

Some measurements obtained from a number of old trees cut on the grounds adjoining the campus may be of interest. The soil was upland of fair quality. The age was determined by counting the annual rings.

Age.	Diameter at base.	Diameter at five ft.
30 years.....	13 inches.....	11½ inches.
29 ".....	11½ ".....	10 ".....
28 ".....	10¾ ".....	9½ ".....
29 ".....	11¾ ".....	11½ ".....
30 ".....	16 ".....	13½ ".....
22 ".....	7 ".....	5½ ".....
21 ".....	7½ ".....	6 ".....
26 " { two forks.....	6 ".....	5 ".....
{ at ground.....	6½ ".....	5½ ".....
24 ".....	6½ ".....	5½ ".....
23 ".....	9½ ".....	6 ".....
24 ".....	9½ ".....	8 ".....

The Osage orange has been readily propagated from seed. In one test in securing seed two methods used have given practically the same stand of plants. One lot of the fleshy fruit was put in a barrel, covered with water, and early in the spring the seed was readily washed from the softened pulp and planted immediately.

The other lot was dried through the winter and in the spring the seeds were secured by pounding the dry fruits into pieces with a hammer. The washing was the easier method.

AILANTHUS (TREE OF HEAVEN). (*Ailanthus glandulosa.*)

From the report of 1886.

"The ailanthus grove, on the highest ground, is now a thicket of all sizes, down to last year's sprouts. The trees have not been thinned out, and were evidently planted at about 4 x 5 feet, though the rows are filled up by sprouts, some of which are nearly as large as the original seedlings. The trees selected as the oldest in the grove averaged 18 feet high and have a girth at four feet of 11 inches. On the outskirts of the grove occasional trees have twice this circumference."

The ailanthus does not seem likely to form trees of any considerable size. It grows rapidly for a few years, but later seems much less vigorous. They have frequently been severely injured by cold. During the severe winter of 1898-'99 numbers of the trees were killed to the ground, and all were severely injured. The trees possess considerable recuperative power and have usually formed new tops in a short time. The killing back has been followed by excessive sprouting, thickets of young trees being formed. As grown here, the wood is of low fuel value and almost worthless for other purposes.

Upon the College campus the ailanthus has been sparingly planted. The best specimens, now about twenty years old, measure 32 feet in height, with a diameter at the base of 11½ inches; at five feet, 8 inches.

For ornamental purposes, the most satisfactory results are secured by cutting back frequently, the strong growth secured having a rich,

tropical appearance. A growth of eight or ten feet is often made during one season. A seedling on the campus measured at three years 18 feet in height; diameter at the base, 4¼ inches; at five feet, 2¾ inches.

The ailanthus has been readily propagated from seeds and sprouts.

WHITE OR SOFT MAPLE. (*Acer saccharinum.*)

From the report of 1886.

“The White or Soft maple is growing upon about as high ground as the plantation affords, but, owing to the mutual protection of the closely planted trees, this grove on a sterile southern slope shows an excellent growth. The trees stood originally about four feet apart each way, but were thinned four years ago to eight feet apart. They stand over 30 feet high, with straight, unbranched trunks, and show an average girth of over 15 inches at four feet from the ground. At least 95 per cent. of the trees would furnish straight poles over twenty feet long.”

The later growth of the Soft maple trees in this plantation has not been so pleasing. The rate of growth has been much slower. Few of the trees have attained the height of 40 feet. The best trees have a diameter of 10 inches at 4 feet from the ground. Many trees of the original planting have died and more are making a feeble growth. The Soft maples have produced a greater amount of cord-wood than any other species in this planting, and while the wood is not as good fuel as the ash or Osage orange, or even the walnut, the greater amount produced has much more than compensated for the lower fuel value. The growth of sprouts from the stumps has been much more vigorous when the trees have been in a vigorous state of growth than where the tree has become feeble before being cut.

Grown upon the campus as a shade and ornamental tree, the Soft maple has been satisfactory. As the trees age the wood seems to become more brittle and the branches are frequently broken by winds that do no damage to trees of other species. On rich soil the trees give promise of attaining a considerable age, but on high, dry land they seem to be short-lived.

The following measurements, taken as averages of trees of various ages, growing in different locations, will give an idea of the rate of growth. Trees nineteen years old, grown in good, rich soil, gave the following average measurements:

Height.....	41 ft. 6 in.
Diameter at base... ..	11½ inches.
“ at 5 feet.....	11 “
“ at 10 feet.....	7 “
Amount of cord-wood in branches, 15½ cubic feet.	

This rate of growth has decreased as the trees aged. Trees forty six years old, planted in similar soil, give the following measurements:

Height.....	55 feet.
Diameter at base.....	16½ inches.
" at 5 feet.....	14½ "
" at 10 feet.....	14 "
" at 20 feet.....	10 "

Cord-wood in top and branches, 40 cubic feet,

On higher ground and poorer soil, trees the same age, forty-six years, branched lower, were less vigorous and not as fine in appearance. The measurements are:

Height.....	37 feet.
Diameter at base.....	14 inches.
" at 5 feet.....	12 "
" at 10 feet.....	9 "

Cord-wood in top and branches, 25 cubic feet.

The Soft maple is very easily propagated by seeds, which must be sown and lightly covered soon after they fall. The trees transplant easily.

Wier's Cut-leaved maple is a variety having very finely dissected leaves and a graceful, rather drooping habit of growth. It has been less rapid in growth, but compares well for vigor and hardiness.

HARD MALE. (*Acer saccharum.*)

This species, also known as the Sugar maple, has been more difficult to propagate and transplant, and has been much slower in growth. It has a handsome head, and seems to be worthy of planting in rich soils in the eastern part of the state. It is liable to be injured by sunscald, unless protected after transplanting. On the College grounds, it has given good results when planted among more-rapid-growing trees.

Trees set in 1888, now growing on the campus, in rich soil and sheltered localities, give the following measurements:

Diameter at base.	Diameter at five feet.	Height.
4¾ inches.....	3½ inches.....	22 feet.
5½ " 	4½ " 	26 "
4 " 	3½ " 	20 "
5 " 	3 " 	25 "
6 " 	4¼ " 	27 "
6 " 	4½ " 	28 "
7½ " 	6 " 	22 "
8½ " 	6¾ " 	31½ "
6½ " 	5 " 	31 "
5½ " 	4½ " 	25 "

The trees have borne but few seeds, and these have germinated but poorly.

NORWAY MAPLE. (*Acer platanoides.*)

The species is readily recognized by the close, thick head and dark foliage. Trees of this species on the campus have made good growth, slower than the Soft maple, but more rapid than the Hard maple. Though but a few of this species have been planted, they have uniformly made good trees, and seem well adapted to this climate. Young trees of the dark-leaved variety, known as Schwedler's maple, seem equally as vigorous. Plate 3 shows a good specimen of Norway maple, planted 1886.

BOX ELDER. (*Acer negundo.*)

Trees of this species have made rapid growth, but are liable to form very low, bushy heads, unless planted thickly or regularly and carefully pruned. The wood makes fair fuel but is not durable as posts, and trees grown here have been too crooked and irregular for other uses. Trees seventeen years old, grown upon high ground of fair quality, average 30 feet in height and 7½ inches in diameter at four feet from the ground. These trees average about twenty cubic feet of wood each, although much of it is crooked and uneven.

One of the best Box elders on the campus, grown in a clump of trees, measured when forty-one years old:

Height.....	44 feet.
Diameter at base.....	12 inches.
" at 5 feet.....	9½ "
" at 10 feet.....	9 "
" at 20 feet.....	7 "

The Box elder is easily propagated from seed sown in the fall or stratified until spring. It transplants readily.

HONEY LOCUST. (*Gleditschia triacanthos.*)

Plats of Honey locusts have been planted at several different times upon the old College farm. A small planting made in 1891 extended from the bottom of a ravine to the top of a gravelly ridge. The trees were planted four feet apart each way and a part of them cultivated for three years. The growth and success have been directly according to the location and cultivation. The best trees, those near the ravine, measure 30 feet high, with a diameter of 4½ inches five feet from the ground.

Other plantings made at early dates in similar soil and at the same distances show the same conditions, and indicate that the Honey locust is not well adapted for close planting in poor soil. On good soil, the Honey locust has shown rather poor growth in close plantings.

When planted at greater distances the trees have made better growths. On the College campus the Honey locust has shown a tendency to form wide-spreading, rather low trees when planted alone.

The largest trees of this species were planted before the College owned the land, and, as nearly as can be ascertained, are forty years old. These trees are growing in upland soil of medium quality, and stand far enough apart to allow symmetrical development. They average slightly over 40 feet in height, with a spread of about forty feet. The diameter at four feet from the ground averages 22 inches. They branch low, but are very handsome and altogether desirable shade-trees.

The best growth noted upon the campus is that of a tree which is one of a row of seedlings grown in 1893. At this date, August, 1903, it measures:

Height	34 ft. 6 in.
Diameter at ground	10 inches.
“ at 5 feet.....	8 “
“ at 10 feet.....	5 “

The following record of a Honey locust planting in Lincoln county is a fair average of numerous observations made in various parts of the state. Trees one year old from seed were planted in 1886 on upland soil of fair quality. The distance was four feet apart; rows eight feet apart. Trees thinned in 1900 to eight feet each way. No cultivation since the fifth year. Dust from a well-traveled road has caused some injury in very dry seasons. Greatest height, 29½ feet; average height of sixty consecutive trees, 22 feet and 2 inches; greatest diameter of sixty consecutive trees, at four feet from the ground, 6 inches; average diameter at four feet from the ground, 4 inches. It would seem that this combination of the qualities of durability, resistance to drought and fair rate of growth make this one of the most desirable trees for planting in western Kansas.

The Honey locust is readily propagated from seed. Seed planted in the fall has usually given a fair stand, but the germination of seed in succeeding seasons is sometimes troublesome. Soaking in water heated to 150 deg. Fahrenheit has given good results.

Many Honey locust trees are thornless. This characteristic may usually be noticed in the nursery row or seedling bed, and it is well to select such trees for shade and street trees. Seed from the thornless trees has produced many trees with thorns, though the proportion of thornless trees is greater than from the seed from thorny trees.

BLACK LOCUST. (*Robinia pseudacacia.*)

The Black locust was planted quite extensively during the first part of the decade 1880-'90. Good growths resulted in all plantings, but the borers, *Cyllene robiniae*, have so seriously injured the trees as to prevent their growing large enough even for small posts. Were it not for this insect, the Black locust would probably be our best tree for post production, but is not to be recommended for localities infested by this insect.

It seems probable from observations made here that the best results from Black locusts are secured by cutting as frequently as the trees reach a suitable size for posts. The rapid-growing sprouts seem less liable to injury than slower-growing stocks. The trees may be relied upon to renew from sprouts. Trees ten years old measure 20 feet in height, and 4 inches in diameter at four feet from the ground. Trees twenty years old measure 30 feet in height, and 8 inches at five feet from the ground. The Black locust has been readily propagated from seed treated in the same way as those of the Honey locust.

COFFEE BEAN. (*Gymnocladus dioica.*)

The Coffee bean has not been widely planted, but has succeeded well wherever tried. The young trees make fairly rapid growth, reaching a height of 20 feet and a diameter of 4 inches at five feet from the ground in ten years. Older trees have maintained a fair rate of growth. The Coffee bean is a desirable shade-tree. When young the trees have a strong growth of leaves and shoots that produce a pleasing, almost tropical effect. The older trees are pleasing in leaf and blossom, but their winter form is less desirable, usually presenting a rather bare, grotesque form. Some of the trees, however, are entitled to be classed as picturesque in their winter form. The Coffee bean has been readily propagated by seed planted in the fall or treated with hot water, as described for the locust. They also grow readily from root cuttings or sprouts.

RUSSIAN MULBERRY. (*Morus alba.*)

This tree has not been largely planted by the College or Experiment Station, but to the extent of its planting has proven a useful and valuable tree. It is inclined to be shrubby in growth, and requires vigorous pruning to form a straight trunk. A promising method of pruning is to cut the trees back to the ground after the first or the second year's growth and restrict the coppice growth to one strong, straight shoot. It is not uncommon for the new shoots to

make a growth of eight feet in height and an inch in diameter in one season.

Ordinarily the mulberry has made sufficient growth to make fair posts in ten or twelve years, and in low, rich soil somewhat sooner. They have endured close planting in rich soil, but on poor soil have made but slow growth in thick plantings. Its thick, shrubby growth makes it a desirable tree for windbreaks. When grown at greater distances it has required severe pruning in order to form trees of even appearance. Trees grown in this way have frequently made a diameter of ten inches at four feet from the ground in fifteen years.

A twenty-two-year-old tree growing in Harper county on rich, moist soil furnishes the best measurements taken. The tree forked near the ground, but four feet from the fork the three branches measured 15, 10 and 8 inches, respectively, and would probably cut twenty good posts.

The mulberry has withstood the drought without apparent injury, but has been killed back somewhat in very severe winters. In most cases the injury has affected only the previous year's wood, and the trees have in nearly every instance made a good recovery. The posts are durable, and the wood makes good fuel. It is to be recommended for general planting.

The mulberry has been readily propagated by seeds. Good results have been secured by planting the seeds as soon as ripe, either by planting the entire fruit, or by washing the seeds from the pulp and planting immediately. The seeds soon germinate, and in good seasons have made a growth of from one to two feet during the summer and fall. Washing and drying the seeds and planting the following spring has also been practiced with fair success.

COTTONWOOD. (*Populus monolifera.*)

The cottonwood has been the most-rapid-growing species under observation. As should be expected, the wood of such rapid growth is of comparatively low value for fuel and timber, and has but little durability when used as posts. For barrels, packing cases, boxes and crates the lumber is considerably used. With an increasing demand and decreasing supply of other woods for such purposes, it seems probable that plantations of cottonwood might be made profitable. On sandy land and land along rivers liable to wash, cottonwood groves would prove desirable.

On uplands the cottonwood gives evidence of being short-lived, while on lower bottom lands trees thirty years old are making vigorous growths. It is the only species of which any number have made growth of sufficient size to make sawed lumber.

A good average tree, growing in fairly rich soil, at twenty-four years gave the following measurements:

Height.....	71 feet.
Diameter at base.....	28 inches.
“ at 5 feet.....	24 “
“ at 10 feet.....	21½ “
“ at 20 feet.....	19 “
“ at 30 feet.....	12½ “

making one good and one fair log for sawing, and the tops and branches containing slightly over one-half cord of wood.

Measurements made of a small grove in Rice county, growing in sandy land of fair quality, averaged at nineteen years: Diameter at five feet from the ground, 16 inches; at ten feet, 13½ inches; at fifteen, 10½ inches.

As a shade or street tree, the desirability of the cottonwood is questionable. The cottony substance which floats the seeds is objectionable when the seeds are ripening, but this may be avoided by planting trees propagated from cuttings of staminate-flowered trees. Cottonwoods are propagated from seed, which should be sown as soon as ripe, covering it lightly. The young seedlings are easily obtained from sand-bars in the principal rivers, and frequently from fields near seed-bearing trees. Cuttings of ripe wood are easily grown.

WHITE OR SILVER POPLAR. (*Populus alba.*)

White or Silver poplar is much the same in characters of growth as the cottonwood, the timber being more valuable. It has been much shorter-lived and not so resistant in regard to drought and cold, much more liable to sprout badly, and much less certain to form straight trunks than the cottonwood. It is readily propagated from cuttings and suckers.

LOMBARDY POPLAR. (*Populus nigra italica.*)

This species has proved to be short-lived in all situations. For the first few years a rapid growth was made, but later growths have been uneven and irregular, with many dead branches. It has little to recommend it.

QUAKING ASP. (*Populus tremuloides.*)

The only planting of this species was made in a block set by the United States Division of Forestry in 1897. The trees have made a rapid growth, but are less vigorous and probably less hardy, and, as far as noted, inferior to the Cottonwood.

THE WHITE ELM. (*Ulmus americana.*)

The White elm has been planted for shade and ornament only, and for these purposes is highly recommended. It has succeeded in all sorts of soils and locations, the rate of growth decreasing in poor soil and dry situations. In poor soil and exposed places it is liable to form low, spreading tops, but a large majority of the trees planted are well formed, fine appearing, strong, tough, and less liable to injury from wind than more-rapid-growing species. They stand transplanting and pruning well, have not been seriously injured by drought, and are in every way desirable for planting when the living tree, and not the product, is the end in view. The wood is tough, usually hard to split, and for fuel rated quite low.

The rate of growth is moderate, seedlings reaching the height of 2 or 3 feet the first season, and frequently making an annual growth of 2 to 3 feet in height during the first four years of its growth. In close planting the trees have made straight growths, but are much less vigorous than where given sufficient room, thinning being required before the trees are of sufficient size to pay for the work.

An average of a number of trees twenty-three years old gives growths as follows:

- Height..... 40 feet.
- Diameter at base..... 12 inches.
- Diameter at five feet..... 10 inches.
- Cord-wood, 16 cubic feet.

The rate of growth is somewhat slower in older trees, but, judging from trees in various localities and situations, the White elm is one of the most durable trees grown in our climate. The White elm has been readily propagated from seed sown as soon as ripe and covered lightly.

RED ELM. (*Ulmus fulva.*)

The Red elm compares very favorably with the White elm in rate of growth and desirability. The growth, as noted here, is likely to be more upright and not so graceful in appearance. The wood is more valuable for fuel, and when well-seasoned makes fair posts. The poles are useful for a variety of purposes. Trees of as great age and size as the White elm are seldom found, but those now growing seem equally hardy and vigorous. The Red elm has been readily propagated by seeds sown in the fall or kept until spring, stratified in sand.

CORK OR ROCK ELM. (*Ulmus racemosa*.)

The Cork elm is much slower in growth than either the Red or the White elms. Trees ten years old have not made a growth of one foot each year. It is very hardy and of good appearance. The wood is tough and strong. Seeds should be sown as soon as ripe.

HACKBERRY. (*Celtis occidentalis*.)

The hackberry has been planted in various soils and locations and invariably proved to be a good tree. The rate of growth is about equal to elm, in rich soil rather more rapid than elm. The wood makes very fair fuel, but is of low value for posts. The trees are readily propagated from seed, sown in fall or stratified in moist sand or soil over winter and planted the following spring.

PLANE TREE (SYCAMORE). (*Platanus occidentalis*.)

This species has been planted at this Station only as an ornamental, and has been uniformly hardy, but of rather slow growth. It usually forms an open, spreading head, making poor shade. Much the best growth has been made in low, rich soil, but even on high ground they have made satisfactory trees.

Trees twenty-two years old give the following measurements:

Height	33 ft. 6 in.
Diameter at base	9½ inches.
“ at 5 feet	7 “
“ at 10 feet	6 “
“ at 15 feet	4½ “

The sycamore has been propagated from seed sown in the spring and covered. As a rule, but a small per cent. of the seed has germinated.

THE OAKS.

Probably no group of trees is so universally admired, and justly so. The oak is a tree that "lives in song and story," is handsome, useful in many ways, long-lived, proverbially strong, and in every way admirable. Like many other things most desirable, possession of them is to be obtained at considerable expense of time or money, or both.

In order to be able to transplant a tree of any size, it must have been lifted or transplanted while a small tree, usually several times, before it reaches a size considered desirable by tree-growers, generally from five to eight feet. The grower is certain to sustain some loss, the transplanting is more or less expensive, and the trees are consequently comparatively high-priced.

If the acorns are planted where the tree is desired it is a long time before the tree is of sufficient size to insure it respectful treatment. If the acorn be planted in the fall it is sought by mice, squirrels, and skunks, and other nut-loving animals. Stratifying in moist sand over winter and planting early in the spring is necessary if the small animals are numerous. Ten to fifteen inches is a very good growth for the first season, consequently careful cultivation is essential to its success. But in a few years the bright fall coloring and the generally attractive appearance gives the oak an honored place. Oaks succeed well in partial shade and are especially well adapted for planting among short-lived species.

PIN OAK. (*Quercus palustris*.)

This is one of the best oaks tested by the College or Experiment Station. It is one of the most-rapid-growing of the genus, and a particularly handsome tree, of symmetrical form, fine glossy foliage, which assumes a brilliant coloring in the fall and is retained well through the winter, a desirable character for a windbreak tree. It is one of the most easily transplanted of the oaks, and is reported as succeeding well in cities, a fact in its favor, as dust and smoke are believed to be injurious to most of the oaks.

Plate 5 shows a good specimen of Pin oak set in 1888, then a tree about 3 feet high.

SHINGLE OAK. (*Quercus inbricaria.*)

The Shingle oak is equally desirable with the Pin oak. Its foliage is a fine glossy green, well colored in the fall and retained through the winter. It has transplanted readily and made good growth.

RED OAK. (*Quercus rubra.*)

The Red oak has been used in replanting land where a quicker-growing species of tree is standing. It transplants readily and has been easily grown from the acorns. It is a fine, handsome tree, the fall coloring being excelled by none.

BLACK OAK. (*Quercus tinctoria.*)

The Black oak has been grown upon the campus and compares closely with the Red oak except in fall coloring.

BUR OAK. (*Quercus macrocarpa.*)

The Bur oak has been grown successfully in various locations upon the College campus and in forest plantings among larger trees. It is rather more difficult to transplant than the species previously named, but it is easily grown from acorns. The trees are frequently rough and somewhat irregular in appearance even while young, but are always strong and vigorous in appearance.

YELLOW CHESTNUT OAK. (*Quercus muhlenbergii.*)

The Yellow Chestnut oak, like the Bur oak, is rather difficult to transplant, but, like it also, is easily grown from acorns. It has been of slower growth than most other species, but has succeeded well in a variety of soils.

CHESTNUT OAK. (*Quercus prinus.*)

The Chestnut oak has made a good growth in a variety of soils. The young trees are handsome, very slender in growth, and succeeding well among other species. This oak has been transplanted quite easily, and although but few acorns have been planted, they have germinated well.

SWAMP WHITE OAK AND WILLOW OAK.
 (*Quercus bicolor.*) (*Quercus phellos.*)

The Swamp White oak and the Willow oak are represented by but few trees—these growing in the lowest ground on the campus. They are hardy and have made good growths.

ENGLISH OAK. (*Quercus robur.*)

The English oak has been seriously injured in severe winters, nearly all trees being killed to the ground in February 1899.

Table I shows rate of growth of various oaks growing on the College grounds.

TABLE I. OAKS ON COLLEGE CAMPUS.

Planted 1885. Measured November, 1903.					Set 1888.				
Series.	Height.	Diam. at ground.	Diam. at 2 ft.	Diam. at 6 ft.	Series.	Height.	Diam. at ground.	Diam. at 2 ft.	Diam. at 6 ft.
PIN OAK.					RED OAK.				
No.	<i>Ft.-In.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	No.	<i>Ft.-In.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
1.....	37-3	12.75	10.25	8.5	1.....	16-6	3.75	3	2
2.....	33-1.5	12.5	9.75	7.375	2.....	17	4	3.75	3
3.....	34-6	12.25	9.75	7.5	3.....	16	4.25	4	3.5
SWAMP WHITE OAK.					BLACK OAK.				
1.....	21-1.5	10.5	8.5	6	1.....	18	4	3.5	2.25
2.....	29	12.25	10.5	7.25	2.....	17-6	3.75	3	2
SHINGLE OAK.					WHITE OAK.				
1.....	33-4	11.25	9.125	7.75	1.....	19-4	4.5	4	3.35
2.....	30-2	11.75	9.5	7	2.....	18-6	4	3.75	3.25
3.....	30-2	10.25	7.75	6.25	3.....	19	4.25	4	3.5
4.....	33	15	8.5	6.125	BUR OAK.				
5.....	36-4	12.25	11	8.5	1.....	20	5.5	5	4
6.....	34-8	11.25	9.25	7	2.....	16	4.5	3.75	3
7.....	29-10	10.25	8.25	6.25	3.....	22	5	4.5	3.75
					4.....	21	5.25	4.5	4
					CHESTNUT OAK.				
					1.....	15	3.5	3	1.75
					2.....	17	4	3.25	2.5
					3.....	19	3.5	3	2.75
					4.....	22	3.75	3.25	2.75
					5.....	24	4	3.5	2.5

CONIFERS.

AUSTRIAN AND SCOTCH PINES.

The opinions expressed in the Kansas Experiment Station Bulletin No. 10, published by the Department of Horticulture and Entomology in 1890, have been confirmed by observations made and notes taken during the past thirteen years.

There is no question as to the desirability of evergreen trees. Whether studied from the standpoint of the landscape artist, of the promoter who wishes to improve property for the increase of value, or from the standpoint of the stock-feeder who realizes that wind-breaks save corn, and corn is money, the evergreens are to be considered as among the most beautiful and useful trees. The success of plantings made by the Kansas Agricultural College in various soils and situations is most encouraging for tree-planters.

While some notes upon the rate of growth may be of interest, the full description and discussion of the species given in Bulletin 10 need not be repeated here. The suggestions given for transplanting and cultivating may be indorsed and emphasized. Best success has continued to be secured from settings made just before growth begins, and clean, thorough cultivation has sufficed for good growth with well-established trees. In some seasons, when extremely trying weather has closely followed the time of planting, watering has been very beneficial. In all cases when watering is done, it should be done thoroughly, and the ground thoroughly soaked, and the surface cultivated as soon as the ground is sufficiently dry for working.

The oldest pines growing on the College and Experiment Station grounds are of mixed plantings of Scotch and Austrian, made in 1872 and 1873. Some of the trees were two and some three years old when set. The trees were set in a nursery, the rows four feet apart and the trees two feet apart in the row. Thinnings were made by transplanting trees to other parts of the College grounds; the trees now stand at irregular distances from four to twelve feet apart. Some of the trees transplanted from the College farm to other situations and better soil have made better growth than those left in the row, but the largest pine trees on the grounds are those remaining where planted in the nursery rows in rich alluvial soil.

The mixed pine planting in 1872 was measured in the summer of 1896. The trees were those remaining where planted in the nursery

rows in 1872. The rows extended north and south, with rows of ash, elm, walnut, maple and ailanthus crowding close on each side. The soil is upland prairie, a shallow loam with stiff clay subsoil. The trunks are straight and slender, with small side branches. This is probably the result of crowding. The average of sixty-five Austrian pines was:

Height.....	27.3 feet.
Diameter at ground	8.2 inches.
" at 6 feet.....	5.5 "

The best ten Austrian pines averaged:

Height.....	34.2 feet.
Diameter at ground	10.25 inches.
" at 6 feet.....	7 "

In January, 1903, the same ten trees averaged:

Height.....	40 feet.
Diameter at ground	12 inches.
" at 6 feet.....	8 "

The average of the best ten Scotch pines in 1896 was:

Height.....	32.7 feet.
Diameter at ground	9 inches.
" at 6 feet.....	6 "

In January, 1903, the same trees averaged:

Height.....	40 feet.
Diameter at ground	11½ inches.
" at 6 feet.....	7 "

In another block of trees, planted a year later, 1873, in the same kind of soil, but without shelter rows, sixty-three Austrian pines averaged, in 1896:

Height.....	32 feet.
Diameter at ground	10 inches.
" at 6 feet.....	6.66 "

In January, 1903, the same block averaged:

Height.....	39 feet.
Diameter at ground	12 inches.
" at 6 feet.....	8.2 "

In 1891, blocks of Scotch and Austrian pines were set in rows four feet apart and about four feet in the row. They were at that time from 6 to 12 inches in height. They were given good cultivation, and during the first season were well watered during a drought.

In February 1896, 319 Scotch pines averaged 7 feet and 6 inches in height and 2¼ inches in diameter at one foot from the ground.

At the same date, February 1896, 334 Austrian pines averaged 5

feet 5 inches in height and 1 ⁸⁹/₁₀₀ inches in diameter at one foot from the ground. Where left unthinned, the stronger trees have practically overgrown the weaker ones, and at this writing, November 1903, at least one-third of the trees are crowded out.

In November 1903, 100 Scotch pines averaged 18 feet 4 inches in height and 3 ⁷/₈ inches in diameter at four feet from the ground. The tallest trees are 24 feet in height; the greatest diameter at four feet from the ground is 5 ³/₄ inches.

One hundred Austrian pines measured November 1903, averaged 16 feet 4 inches in height and 4 ¹/₈ inches at four feet from the ground. The tallest trees are 21 feet in height; the greatest diameter at four feet from the ground is 5 ³/₄ inches.

These two pines, the Scotch and the Austrian, seem nearly equal in hardiness and rate of growth. The choice for setting would depend upon other considerations. The Austrian seem more nearly certain to form straight, regular trunks when planted singly or in small groups, but in larger plantings the Scotch pine is little inferior. The Austrian is rather darker and heavier in appearance; perhaps too much so for best artistic results in small plantings. The Scotch pine is more variable, usually of a lighter color and more graceful and less stately appearance.

Tables II and III give a comparison of the rate of growth of the Austrian and Scotch pines planted on the College campus:

TABLE II. AUSTRIAN PINES ON COLLEGE CAMPUS.
Transplanted from nursery stock set in 1872-'73.

Series No.	June, 1897.				January, 1903.			
	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2½ ft., inches.	Diam. at 6 ft., inches.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2½ ft., inches.	Diam. at 6 ft., inches.
47.....	23-6	10	8.25	6.75	28	12	9.5	9
48.....	24	9	7.5	6.25	30-6	12.5	8.75	7.5
49.....	30-6	12.75	10.37	9.25	38-4	15.75	13	11.5
50.....	30	11.75	10.62	9.25	37-9	15	13.5	11.25
52.....	20	11	9	7.25	26	13.5	11.5	9.75
53.....	26	12	10.5	8.5	31-6	15	12.5	11
54.....	20	10	8.75	6.5	25-4	10.5	9.5	7.25
55.....	25	12.5	10.5	9.25	32	16	14	13.5
7.....	23-3	13	12.5	9.5	28-8	16.75	15	12.75
8.....	23-9	14	11.75	10	27-3	18.5	15	12.5
9.....	27	14	11.5	10.25	33-8	20.5	16	14
10.....	32	17	14	11.5	37-3	19.75	16	15.25
11.....	30-6	9.5	7.5	6.25	38	11.5	8.5	7.25
12.....	35	14	12.5	9.5	39-6	15.75	13	11
13.....	27-6	13	10.5	8.75	36	14	12	10.5
14.....	28-10	13	11	9	35-6	15	12	11.5
15.....	29	13	10.25	9.25	35	15	12.5	12.25
16.....	24-6	11	9.5	8	27-3	13.5	10.25	8.5

TABLE III. SCOTCH PINES ON COLLEGE CAMPUS.

Series No.	1897.				1902.			
	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 6 ft., inches.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 6 ft., inches.
1.....	19	12	11	7.5	21	14	11	8
2.....	32	15.5	14	10.75	37-6	17.75	15	13.25
3.....	35	17	15	11.5	40	19.5	17	14.25
4.....	30	12.75	11.5	9.75	36	15.25	12.25	11.5
5.....	32	15.5	12.75	12	36-6	16.5	16.25	13.5
6.....	32	12.5	10	9.5	37-6	13.25	11.75	10.5
7.....	30	12.5	11	9	35-6	14.75	11.5	10.25
8.....	29-6	} 22 * {	11	10	35-6	} 25 * {	13	10.75
9.....	29		11	8	35-3		11	9
10.....	29		14	11	35		15	12.

*One trunk; divides into three trees one and one-half feet from ground.

WHITE PINE. (*Pinus strobus.*)

It is pleasant to record the fact that the hope expressed in Bulletin No. 10, "that continued trial may prove our present judgment of the hardiness of this tree mistaken," seems likely to be realized. The trees which were well established at that writing have made uniformly good growths during the past thirteen years, and are now fine, handsome trees. It has been more difficult to handle than the Austrian and the Scotch, and a much greater loss has followed each setting and transplanting, and it is in all probability inferior to those species for general planting. See table IV.

PITCH PINE. (*Pinus rigida.*)

The Pitch pine seems to have little to recommend it except perfect hardiness. The trees noted in 1890 as "the least attractive of the pines," and as having an "unkempt appearance," have not improved with age. See table V.

TABLE MOUNTAIN PINE. (*Pinus pungens.*)

The Table Mountain pine continues to rank as perfectly hardy, and, as they age, confirm the judgment expressed in Bulletin 10, that they "are much less available in planting than the Scotch and Austrian on account of rather too picturesque irregularity in form, and are scarcely desirable in limited grounds." For plantings upon poor, stony soil this species may be worthy a trial. The growth in recent years compares well with other species. See table VI.

RED CEDAR. (*Juniperus virginiana.*)

The Red cedar continues to deserve the good opinion in which it has always been held. Although at some seasons the foliage is rather too faded and brown to merit the name "evergreen," and although

some of the trees as they age incline to an open and scraggy growth, yet in general its appearance is such as to make it a welcome addition to any Kansas landscape. Its extreme hardiness when once it is well rooted, its great beauty as a young tree and its value when grown entitle it to a place in the list of desirable trees. See table IX.

TABLE IV. WHITE PINES ON COLLEGE CAMPUS.

Group No.	1897.				1902.			
	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 6 ft., inches.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 6 ft., inches.
4.....	18-6	5.125	4.25	3.125	25	12	9	7.75
7.....	15-6	5.5	4.75	3.125	26	10	8.25	7.5
8.....	17	6.125	4.62	3.125	26	11.25	8.25	7.75
12.....	17	4.75	4.25	2.75	25.6	9.75	7.75	6.75
15.....	18	5.25	4.125	3.25	25.8	9.5	7.5	6.5
16.....	14-6	4.125	3.25	2.25	25.6	6.75	6.5	5.75
17.....	21	7	6	5	32.6	11.25	9	8
18.....	12	4.125	2.875	1.5	30.8	11	8.75	7.5
19.....	18	7	5.875	3.75	31.4	12.75	8.5	7
21.....	20	6.75	5.125	3.625	32.4	11.25	8.5	7.5
22.....	12	3.625	2.625	1.25	23.8	7.5	5.75	5
23.....	22-1.5	8	6.5	4.5	31.6	11.75	9.5	8
24.....	11-6	4.5	3.125	1.625	26	8.75	7.5	6.25
25.....	16	5.375	3.75	2.625	28.6	8.75	7.5	6.25
26.....	22	6.5	5.75	4.375	33.6	11.5	9.5	7.75
27.....	16	5.875	4.375	2.625	30.6	10.5	8.25	6.5

TABLE V. PITCH PINES ON COLLEGE CAMPUS.

Transplanted from College nursery stock set in 1872-'73.

Group No.	1897.				1902.			
	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 6 ft., inches.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 6 ft., inches.
1.....	26-3	11	9.5	8.75	31-8	12.75	11	9.5
2.....	24	8	7	5.5	26	9	7	5.75
3.....	28	8.5	7.5	6.25	31	10.75	8.75	7.75
6.....	25-6	10.75	8.5	7.5	29-6	12.25	10.75	9.5

TABLE VI. TABLE MOUNTAIN PINES ON COLLEGE CAMPUS.

Series No.	Measurements July, 1896.				Measurements November, 1903.			
	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 6 ft., inches.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 6 ft., inches.
28.....	19-6	9.75	8.5	7	24-8	13	11.15	10
30.....	18-6	10.75	8	6.75	27	13.5	12	10
36.....	18-8	10.5	9	9	25-9	13.5	12	10
37.....	15-7.5	10.25	8.25	7.5	22-2	13.5	11.75	9.5
38.....	17	10	8.5	7	22-8	16.5	13	10
39.....	14-6	10.25	7.5	5.75	18-6	13	11.5	8
39.....	17	9.5	8.5	5.5	21	14	9	8
34.....	17	8	6.5	6	19-10	14.5	10.25	9

TABLE VII. CEDARS ON COLLEGE CAMPUS.

Set 1887.

Group No.	1897.				1903.			
	Height, ft.-in.	Diam. at ground, inches.	Diam. at 1 ft., inches.	Diam. at 2 ft., inches.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 1 ft., inches.	Diam. at 2 ft., inches.
6.....	10-6	3.625	2.5	1.375	18-6	7.5	5.5	4.75
9.....	10-6	4.25	2.75	2.5	18-6	6.25	5	4.5
11.....	10-6	3.75	3.25	2.625	19-6	6.75	5.5	4.5
12.....	11 6	4.5	3.5	2.875	19	5.25	4	3.5
14.....	10	3.5	2.625	2	19	5.25	4.25	3.75
16.....	9	2.5	1.875	1.75	18-6	5.25	4	3.5
27.....	10-6	3.5	2.75	2	18-6	6.75	5.25	4.75
37.....	11-6	3.25	2.875	2.25	20-6	8	5.5	5
39.....	11	4.375	3.125	2.25	18	7	5.5	5
41.....	10-6	3.125	2.625	2.375	20-3	6.75	5.5	4.5
7.....	9-6	2.75	2	1.625	17	4.37	4	3.5
15.....	7	2.5	2.125	2	15-3	4	3	2
18.....	9	3	2.5	2.25	18-6	5	4.25	4
19.....	8	3	2	1.625	18-9	6	4	3.75
35.....	12	4.25	3.75	2.25	22-6	6.5	5.75	5.25
36.....	8	3	2.5	1.625	17-9	4.5	4.25	3.75

TABLE VIII. CEDARS ON COLLEGE CAMPUS.

Set 1884.

Series No.	1897.				1903.			
	Height, ft.-in.	Diam. at ground, inches.	Diam. at 1 ft., inches.	Diam. at 6 ft., inches.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 1 ft., inches.	Diam. at 6 ft., inches.
1.....	20	8.5	8.25	3.365	27	13	12	8.5
2.....	20-6	9	8.125	4.5	28	12	11	7.5
3.....	19	8.875	7.365	4.365	28-6	11.5	10.75	7.5
4.....	19-6	8.5	6.625	3.75	23-6	11	10	7
5.....	16-6	7.125	6.625	3.5	29	13	11	6.25
22.....	21-6	9.5	7.25	4.25	30	12.5	11.25	7
23.....	17	9	7	3.5	25	13.75	10.5	6.25
24.....	19-6	9.625	8.25	5.875	28	13.5	12.5	8.75
26.....	16	7	7	3	23-6	10	9.5	4
27.....	20-6	6.75	5.5	3	25-6	8.5	7	6
28.....	21	7.875	6.5	3.75	27-6	11	9.75	6.25
29.....	20	7	6.125	4	27	12	10.5	7

TABLE IX. RED CEDARS. (*Juniperus virginiana*.)

Standing where planted in nursery rows in 1873.

Series No.	June, 1896.				November, 1902.			
	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 6 ft., inches.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 6 ft., inches.
1.....	30-6	11	9.5	8	34	11.5	10	8.5
2.....	32	13	11	9	38-8	16	13	10.75
3.....	31-6	14	11.25	10.25	39	15.25	13	12.5
4.....	32 6	14.5	12.5	10.5	30	16.5	13.75	12
5.....	32	13.5	11	9	39	16.5	13	10.75
6.....	30	12.5	10	8	38	15	12	9.75
7.....	32-3	13.5	10	8	36-6	15	11.5	9.5
8.....	31-0	13	12	9.5	38-3	15.5	13.5	10.75

SPRUCES.

With regard to the spruces, the opinions expressed in Bulletin No. 10 are especially applicable. The White spruce, *Picea alba*, and the Colorado Blue spruce, *Picea pungens*, were the only ones not seriously affected by the severe drought of 1901. A number of Douglas spruce, *Pseudotsuga douglasii*, died during the season, and others were noticeably injured, the leading shoot of several dying before fall. The Norway spruce, *Picea excelsa*, was likewise injured. Fewer trees were entirely killed, but many were seriously injured.

TABLE X. COLORADO BLUE SPRUCE ON COLLEGE CAMPUS.

Series No.	1897.				1902.			
	Height, ft.-in.	Diam. at ground, inches.	Diam. at 1 ft., inches.	Diam. at 2 ft., inches.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 1 ft., inches.	Diam. at 2 ft., inches.
22.....	4-6	2.25	1.75	1.25	8-4	5	3.5	3
23.....	4	2.5	2	1.25	6-8	4.25	3.75	2.75
24.....	6	2.5	2.25	1.75	10-8	6.25	5.25	4.25
25.....	7-6	3.75	3.125	3	11-8	7.25	5.5	5
26.....	5	2.37	1.62	1.5	7	5.5	4.75	4.25

TABLE XI. DOUGLAS SPRUCE ON COLLEGE CAMPUS.

Series No.	Measurements July, 1897.				Measurements November, 1903.				
	Height, ft.-in.	Diam. at ground, inches.	Diam. at 1 ft., inches.	Diam. at 2 ft., inches.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 1 ft., inches.	Diam. at 2 ft., inches.	Diam. at 6 ft., inches.
16.....	11	4.125	3.125	2.875	21	7.5	6.5	6	5.25
17.....	11	4.25	3.75	3.5	22	7.5	7	5.75	4.5
18.....	5-6	2.5	2.25	1.75	18	6.5	5.75	5	4
19.....	7-6	3	2.5	2	14-3	6	5.25	4	2.75
20.....	6	3	2.25	1.5	15-6	7	6.5	5.5	3.5
21.....	6-6	3	2.25	2	14-6	6.5	6	7	3.25
27.....	5	2.5	1.5	1.5	16-3	6.25	5.5	4	2.5
28.....	3-6	2	1.5	1.75	8-10	3.5	3	2.5	1
29.....	5-6	2.75	1.75	1.25	11	4.75	3.75	3	2
30.....	2	1.75	1	.....	10	3.75	3	2.5	1.75
31.....	3-6	2	1.25	.75	12	5.5	4.5	3.75	2.5
32.....	8-6	2.5	2	1.75	11	4.5	3.5	2.75	1.5

HARDINESS.

A Test of the Hardiness of Tree Seedlings.

In the fall of 1896 the Division of Forestry, United States Department of Agriculture, invited this department to cooperate in a test of forest-tree seed from various localities. Some extracts from a letter from Assistant Chief Charles A. Keffer will serve to explain the purpose:

“As you are no doubt aware, there is prevalent a general idea that a species may grow successfully over a wide area when propagated from seeds taken within restricted limits, but that if seed grown in one part of its range be planted in a distant part the seedlings are less hardy than those of native origin.

“It is desirable to know to what extent the leading economic species are thus affected by locality, and it is hoped that from such a beginning other studies of equal practical bearing may be instituted.

“It is proposed to gather, at each station interested, a quantity of seed of each of the species named below. Each station will keep a portion of each variety gathered, and send an equal quantity to all cooperating stations.

“The first year the species chosen and the quantities planted at each station are as follows:

- Acer negundo* (Box elder)..... ½ pint.
- Juglans nigra* (Black walnut)..... 2 quarts.
- Quercus macrocarpa* (Bur oak)..... 1 quart.
- Fraxinus americana* (White ash)..... ½ pint.
- Fraxinus viridis* (Green ash)..... ½ “
- Celtis occidentalis* (hackberry)..... ¼ “
- Gleditschia triacanthos* (Honey locust)..... ¼ “

The seeds were planted according to common nursery practice, and notes taken as to the germination of the seeds and the growth of the seedlings. There has been no appreciable difference in the vigor and hardiness of the trees. During the severe cold of the winter of 1898–’99 the tips of the young shoots of many trees were killed, but not to a greater extent than the trees of the same species in the native timber along the creeks. In no one case was the injury permanent or even serious, the trees making good recovery and strong growth the succeeding season.

A number of trees were transplanted from the nursery rows to a permanent location in a testing grove. Observations have been made

frequently as to the growth and characters, but in no case has there been noted any difference that could be regarded as more than individual, as great differences occurring in a species from a single as in the same species from the different states.

Until 1902 the trees were given sufficient cultivation to keep down weeds and secure good soil conditions. The last two years the trees have furnished sufficient shade to keep down large growing weeds.

The experiment was to some extent duplicated in 1897, the seeds being planted that fall and the following spring as the particular species required.

The winter of 1898-'99 was very severe and many seedlings were killed back, but, as in the lots planted the preceding year, no differences were noted that could be referred to the locality of seed collection. Many stems were killed to the ground, but seedlings from Alabama, Kentucky and Ontario were affected alike. The rate of growth has not shown any special variation from the other lot.

Some trees have been transplanted from the rows, but many are yet growing in the rows where the seed was planted and warrant the conclusion that planting seed where the trees are desired is an excellent way to secure groves and wood lots.

The young seedlings require good care the first season, but after that are no more difficult to cultivate than larger trees. In localities where tree-growing is somewhat difficult, planting the seed is to be recommended. **See table XII on pages 113 and 114.**

In addition to species listed in the table, seed of Hardy catalpa and Osage orange were included in the same planting. Good growths have been made, the catalpa now averaging 14 feet high and 3 inches in diameter at two feet from the ground. The Osage orange averages 9 feet high and 1½ inches at two feet from the ground.

Acorns of Bur oak, *Quercus macrocarpa*, from Vermont, Illinois and Kansas were planted in the fall of 1897 and germinated very well and have been uniformly hardy and vigorous. No difference is apparent in lots from the various states. At this date, November 1903, the Bur oaks vary in height from 3 feet 9 inches to 11 feet 9 inches, averaging 7 feet 8 inches. At two feet from the ground the maximum diameter is 2¼ inches and the average at two feet is 1½ inches.

Acorns of the Red oak, *Quercus rubra*, from Kansas, were planted in the fall of 1897, have germinated well, and have made fine growth for this species. In height they vary from 6 feet to 10 feet 3 inches, averaging 9 feet. The average diameter is 1 ⅛ inches.

Plate 12 (p. 131) shows the planting of 1896 in August 1903.

TABLE XII. COOPERATIVE FOREST-TREE SEED TEST.

SPECIES.	Source.	Percent of seed germinated.	1897.	Average growths.		Total, 1901.		Maximum growth.		Av. measurement, 1903.		1903.	
			First season's growth, inches.	1898-'99,	1900-'01,	Height, ft.-in.	Diam., inches.	Height, ft.-in.	Diam., inches.	Height, ft.-in.	Diam., inches.	Max. height, ft.-in.	Max. diam., inches.
				ft.-in.	ft.-in.								
BOX ELDER. (<i>Acer negundo.</i>)	Alabama.....	5											
	Iowa.....	5	29	4-10	6-2	11	2.25	11	2.25	14-6	2.75	14-6	2.75
	Illinois.....	20	21	3	6-4	9-4	2	11	2.25	10-3	1.45	11	2.75
	Nebraska.....	20	19	3-4	6-2	9-6	2.25	11	2.5	12-11.4	1.68	15	3.25
	Ohio.....	5	12	2-2.4	6	8-2.4	2	10	2.25	10-4.8	2.06	13	2.5
	Ontario.....	10	11	1-4.8	7	8-4.8	1.5	9-6	2	10-1.2	1.9	11	2.25
So. Dakota.....	5	12	1-4	5-3.2	6-7.2	1.6	9	1.75	8-6	1.5	8-6	2.25	
HACKBERRY. (<i>Celtis occidentalis.</i>)	Connecticut.....	10	12	0-8	9-10.2	10-7.2	1.6	12	2	11-8.4	1.9	13-6	2.5
	Iowa.....	5		4-10	3-11	8-7.2	1.5	10-6	2	11-9.6	2	13-6	2.25
	Kentucky.....	5	10	0-10.5	8-8.6	9-8	1.38	10-6	1.5	13-8	2.1	14	2.25
	Nebraska.....	5	16	1-8.4	9-3.6	11	2.5	12-6	3	16-3.6	2.9	17-6	3.25
	Ohio.....	20	18	1-4	7-2.4	8-9.6	1.5	10-6	2	10-10.8	1.9	13	2.75
	Oklahoma.....	20	16	1-5	7-7.8	9-1.7	1.9	12-6	2.5	13-9	2.4	15	3
Pennsylvania.....	20	9	5-1.2	3-9.6	8-11	1.5	10	0.75	11-3.6	1.7	12	2	
GREEN ASH. (<i>Fraxinus lanceolata.</i>)	Colorado.....	20	11	1	6-6	7-6	1.5	9	2	9-7.2	1.47	12-6	2.25
	No. Dakota.....	80	15	1-9	5-3	7	1.25	8-6	1.25	9-4.6	1.55	11	2
	Ohio.....	10		1-8	5-1	6-9	1.75	7-6	1.5	9-6	1.5	12	2
HONEY LOCUST. (<i>Gleditsia triacanthos.</i>)	Alabama.....	60	14	1-1.2	6-4.8	7-6	1.3	10	1.5	8-4.8	1.7	12	2
	Indiana.....	20		2-6	7-9	10-3	1.5	13-3	2	14	1.87	17-6	2.5
	Illinois.....	10	13	3-2.4	8-3.6	11-6	2.75	15	3	14-7.2	2.47	17	3.25
	Kansas.....	20	12	2-9	8-3	11	2.4	14-6	2.5	15-3.6	2.65	18-6	3
	Kentucky.....	5	12	3-9	7-0.75	10-8.6	1.8	13	3	16-6.75	2.25	17-6	3.5
	Nebraska.....	5	16	2-10	9-10	12	2.12	15	2.25	17	2.5	18-6	3.25
	Ohio.....	5	5	1-6	5	6-5	1	6-6	1	11	1.75	11	1.75
	Ontario.....	80	9	1-6	5-8	7-2	1.25	10	1.5	10-9	1.58	15-6	2.5
	Pennsylvania.....	20	9	2-4	7-11	10-3	1.5	13	2				
Tennessee.....	80	14			4-9	1	6	1.5	6-10.2	1	9	1.75	

January 1904.]

Tests of Forest Trees.

TABLE XII. COOPERATIVE FOREST-TREE SEED TEST—*Concluded.*

SPECIES.	Source.	Per cent. of seed germi- nation.....	1897. First season's growth, inches.	Average growths.		Total, 1901.		Maximum growth.		Av. measurement, 1903.		1903.	
				1898-'99, ft.-in.	1900-'01, ft.-in.	Height, ft.-in.	Diam., inches.	Height, ft.-in.	Diam., inches.	Height, ft.-in.	Diam., inches.	Max. height, ft.-in.	Max. diam., inches.
BLACK WALNUT. (<i>Juglans nigra.</i>)	Alabama.....	60	17	0-4.8	0-10.8	1-4.5	0.5	2-3	0.625	2-6	0.5	4	0.75
	California.....	60	12	1-4	1-5	2-4.5	0.87	4	1.25	3-9.6	0.42	5	1.75
	Colorado.....	20	16	0-4	3-10	4-2	1.5	6	1.25	5-2	0.75	6	1.5
	Georgia.....	20	18	0-4	3-4	3-6	0.87	4	1	3-6	5	6	1.5
	Iowa.....	20	13	0-7.2	5-4.8	6	1.25	6	1.5	8-1.2	1.35	8-6	1.75
	Illinois.....	20	19	1-6	2-10.8	4-4.8	1	6	1.25	6-1.2	0.95	8	1.75
	Kentucky.....	5	13	1-4	1-8	3	1	6	1	4-6	6	4-8	1.5
	Missouri.....	20	14	1-8	3-10	5-6	1.5	6	1.5	8-1.5	1.5	10	2
	Nebraska.....	5	5	3-4	1-4.8	5	1	7	1.25	6-9.6	1.2	8-6	2
	No. Carolina.....	40	14	.....	.....	8	1.5	8	1.5	11	2	11-10	2
	Ohio.....	10	13	1-3	3-9	5	1.75	6	2	6-10.5	1.25	9	2.25
	Oklahoma.....	80	20	.....	.....	4-9	1.75	6	2	8-9	1.75	10	2.25
	Ontario.....	80	12	0-11	3-1	4-3	1	4-6	1.25	5-9.3	0.9	7-6	1.75
	Pennsylvania.....	20	14	1-8	3-6	5-6	1.3	6	1.5	.....	.....	.....	.....
So. Dakota.....	5	8	-8	3	3-3	1	5	1.25	.....	1.16	8	1.5	

COOPERATIVE PLANTING.

Tree Planting in Cooperation with U. S. Department of Agriculture.

During the years 1896 and 1897 this department, in cooperation with the Division of Forestry, United States Department of Agriculture, made a number of plantings of various species of forest-trees to test the adaptability of the species and the value of the various species to be used as nurse crops for slow-growing trees.

TABLE XIII. COOPERATIVE TREE PLANTING, 1896.

SPECIES.	Plat.	Planted 1896.	No. alive Oct., 1897.	No. alive July, 1898.	No. alive Aug., 1900.
Artemisia	A	3,630	2,417	2,388	2,316
Oak	A	75	55	14	11
White elm	A	328	246	227	180
Scotch pine	A	403	163	134	7
White spruce	A	404	16	16	.....
American aspen	B	3,630	2,367	2,117	1,973
Oak	B	50	24	19	16
American larch	B	5,555	5	.....	.....
Bull pine	B	202	.....	52	.....
Red cedar	B	202	.....	107	52
Douglas spruce	B	201	.....	13	.....
Yellow birch	C	1,815	710	206	69
American aspen	C	1,815	1,268	1,160	1,134
Oak	C	50	40	36	61
Green ash	C	252	237	237	237
Austrian pine	C	303	.....	18	13
Catalpa	C	302	247	245	245
Douglas spruce	C	303	.....	28	.....
American aspen	D	605	395	347	300
Yellow birch	D	2,117	830	155	52
Artemisia	D	605	346	343	312
White elm	D	151	82	99	38
Catalpa	D	157	122	121	115
Red cedar	D	303	.....	151	126
Bull pine	D	302	.....	.....	.....
American larch	D	302	8	4	.....
White fir	D	303	.....	54	.....
Jack pine	1.12	2,494	1,418	1,142	1,142
Bull pine	1.12	584	7	24	24
Scotch pine	1.12	416	820	640	535
Norway spruce	1.12	382	293	200	145
Douglas spruce	1.12	508	50	28	28
Bur oak	1.12	96	2	1	11
Ironwood	1.12	67	.....	.....	.....
Cherry	1.12	57	1	.....	.....
.....	.....	302	.....	.....	.....
Bur oak	1.32	.....	.....	.....	.....
Norway spruce	1.32	251	.....	.....	.....
Douglas spruce	1.32	733	.....	.....	.....
Scotch pine	1.32	27	.....	.....	.....
Douglas spruce	3.11	1,196	.....	.....	.....
Norway spruce	3.11	1,068	.....	.....	.....
Bull pine	3.11	525	.....	225	110
Scotch pine	3.11	371	262	91	.....
Bur oak	3.11	253	.....	.....	.....
Scotch pine .....	.45	731	273	478	475
Bull pine .....	.45	285	26	22	12

The plans and trees were furnished by the Division of Forestry, and the expense of setting was divided. The plats were located upon the old College farm, on ground adjoining the first tree experiments undertaken by the College. The soil is much the same, very poor and gravelly, sloping to the south and east.

Table XIII shows the species planted and the grouping in plats. Some seeming contradictions in the table are accounted for by the record that in 1898 there were used in replanting 1107 Bull pines, 1696 Scotch pines, and 3004 Austrian pines.

It will be noted from the table that in 1900 the surviving trees were largely of the species which have been in some degree successful in previous plantings. At present (November 1903,) the count is much the same as in 1900. A few feeble individuals failed to survive the trying summer of 1901, but for the most part the appearance of the trees during and after the prolonged drought was very gratifying.

Notes dated March 1898, and February 1899, state that the elms, oaks and catalpa were seriously injured by rabbits. A considerable number of these have made new growth from the roots and are now fairly thrifty trees.

In the severe winter of 1898-'99 nearly all the catalpas were killed to the ground. Since then many of the trees have by flower and fruit been identified as the common catalpa, *Catalpa catalpa*, formerly *C. bignonioides*, and not the Hardy catalpa, *C. speciosa*.

The artemisia, probably *A. abrotanum*, has been removed from the plats, where it was used as a nurse crop; in most cases where the trees made good growths it was overgrown and died.

Where the aspens have seemed to be crowding the permanent trees they have been removed. Table XIV shows the growth of an average block of twenty-five trees. As a tree it is probably of little value.

TABLE XIV. AMERICAN ASPEN.
In plat B. Planted 1896. Measured in November 1903.

No.	Height, ft.-in.	Diam. at 2 ft., inches.	Diam. at 6 ft., inches.	No.	Height, ft.-in.	Diam. at 2 ft., inches.	Diam. at 6 ft., inches.
1.....	15	1.875	1.75	15.....	20	2.25	1.875
2.....	17	2.25	1.625	16.....	17-6	2	1.5
3.....	14	1.625	1.25	17.....	13	1.25	1
4.....	14	1.125	1	18.....	17	1.875	1.125
5.....	17-3	2	1.5	19.....	15	1.5	1.125
6.....	16-6	1.625	1.5	20.....	18	2.25	1.625
7.....	15	1.25	1.125	21.....	17	1.25	1
8.....	15	1.375	1	22.....	20	2.75	2.25
9.....	17-3	1.5	1.125	23.....	17-6	2	1.75
10.....	17-6	1.625	1.25	24.....	14-3	2	1.75
11.....	18	2.25	1.5	25.....	17	2	1.625
12.....	19	2.5	2				
13.....	19-6	2.25	1.875	Averages,	16-8.5	1.86	1.4
14.....	17-6	2	1.625				

The Red cedars have made growth nearly equal to stock set at the same time in the nursery rows in very much better soil. The trees in plat D have not been shaded as closely as those in plat B, and show somewhat better growths. They are fine, vigorous trees.

TABLE XV. RED CEDARS.
Planted 1896. Measured November 1903.

In plat B. Among aspens.					In plat D. Among aspens and catalpas.			
No.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 4 ft., inches.	No.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.
1.....	5	1.375	.625	.25	1.....	6-9	2.25	.875
2.....	5-3	1.5	.625	.25	2.....	6	2	.875
3.....	5-6	1.625	.75	.5	3.....	7	2.25	2
4.....	4-9	1	.375	.125	4.....	7-6	2.375	2.125
5.....	5	1.625	1	.5	5.....	7-6	2.5	1.5
6.....	6-9	1.75	1.125	.75	6.....	5-9	2	1
7.....	5	1.25	.5	.375	7.....	6	2.25	1
8.....	5-3	1.125	.5	.25	8.....	7	2.25	1.25
9.....	5-9	1.25	.75	.375	9.....	6-9	1.75	1
10.....	5	1.5	.75	.375	10.....	7	2.75	1.5
11.....	7	1.5	1.875	.5	11.....	6	2	1
12.....	5	1.25	.75	.25	12.....	7	2.5	1.25
13.....	4-6	1.25	.625	.375	13.....	6	2.375	1.125
14.....	5	1.75	.625	.375	14.....	5-9	1.75	.75
15.....	5-8	1.625	.75	.375	15.....	7-3	3.125	1.5
16.....	6	1.75	.875	.375	16.....	6	2.5	1.625
17.....	6	1.625	.75	.5	17.....	7	2	1
18.....	6-6	1.5	.625	.375	18.....	6	1.75	.75
19.....	8	1.75	.875	.625	19.....	6-6	2	1
20.....	5-9	1.5	.75	.375	20.....	4-6	1.625	.5
21.....	6-8	1.75	.75	.5	21.....	6-8	2	.75
22.....	7-2	2	1	.375	22.....	5-6	1.5	.75
23.....	6	1.75	.625	.25	23.....	6-9	2.125	1.125
24.....	5-9	1.625	.5	.25	24.....	5-6	1.875	.75
25.....	6	1.375	.625	.375	25.....	5-6	2	1
Averages.	5-9	1.5	.76	.385	Averages.	6-4	2.15	1

The Jack pine, *Pinus divaricata*, invoiced at the time of planting as *Pinus banksiana*, had not been previously planted here. While not to be compared with the Scotch or Austrian pines as an ornamental tree, its present vigorous condition and its rate of growth make it worthy of notice and mark it as of probable value for forest plantings and windbreaks. Plate 12 (p. 131) shows this plantation.

Table XVI gives a comparison of twenty five successive trees of each species growing in plat 1.12.

Plat .45 was planted upon a gravelly southern slope, growing a heavy crop of grass, mainly bluestem. The holes were dug and the trees were set in the sod. No cultivation has been given, but the Scotch pines have made a surprisingly good growth for the conditions. Considerable care has been required to maintain fire-guards, as the grass has grown tall and rank. The Bull pine, *P. ponderosa*, has not been so vigorous.

Tables XVII and XVIII make the comparison.

TABLE XVI. JACK PINES AND SCOTCH PINES.

In plat 1.12. Planted 1896. Measured November 1903.

Jack pines.					Scotch pines.				
No.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 4 ft., inches.	No.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 4 ft., inches.
1.....	10-7	3	2.5	2.25	2.....	12	3.25	2.5	2
2.....	12	3.25	2.5	2	3.....	9	2	1.5	1
3.....	12-6	3	2.25	2	4.....	10-6	3.25	2.5	2
4.....	13-6	4.5	2.75	2.5	5.....	9-6	2.625	1.75	1.25
5.....	9-6	2	1.25	1	6.....	13-6	3	2.5	2.25
6.....	10-6	2.75	2.25	2	7.....	13-9	4.5	3.625	2.75
7.....	9	2.5	1.875	1.25	8.....	8-6	2.5	1.625	1.25
8.....	13	3.875	2.625	2.25	9.....	12	4.25	2.875	2.25
9.....	9-9	2.375	2	1.5	10.....	9-9	2.25	1.875	1.25
10.....	11	3	2.25	1.75	11.....	9-9	3.25	1.75	1.5
11.....	10-3	2.75	2.25	1.75	12.....	13	4	3.5	2.5
12.....	14-6	3.75	2.875	2.625	13.....	10-3	2.75	2.25	1.625
13.....	10	2.75	1.75	1.5	14.....	9-9	2.75	2	1.625
14.....	9-6	2.5	1.75	1.5	15.....	10	2.25	1.75	1.625
15.....	10-6	2.25	1.75	1.625	16.....	12-9	3	2.625	2
16.....	12-9	3.75	2.375	2.125	17.....	8	2.75	1.75	1.5
17.....	11-3	3.375	2.5	2.125	18.....	9-6	2.5	1.75	1.5
18.....	11	2.625	2	1.75	19.....	12-3	3.25	2.625	2.375
19.....	13-3	3.375	2.25	2.125	20.....	10	2.875	2.25	1.75
20.....	10-6	2.625	2	1.75	21.....	9-9	2.375	2.25	1.75
21.....	11-9	2.625	2	1.875	22.....	10	2.75	2	1.75
22.....	11-3	2.5	2	1.75	23.....	9-6	2	1.625	1.25
23.....	9-9	2	1.5	1.25	24.....	8-3	2.5	1.75	1.625
24.....	12-6	3.625	2.75	2.5	25.....	11	3.25	2.625	2.625
25.....	8-6	3	2	1.5					
Averages,	11-2	2.625	1.75	1.8	Averages,	10-6	3	2.2	1.79

TABLE XVII. SCOTCH PINE IN SOD PLAT.

Plat No. 45. Planted 1896. Measured November 1903.

No.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 4 ft., inches.	No.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 4 ft., inches.
1.....	9-6	3	2.375	1.875	15.....	9	3	2	1.625
2.....	10	3	2.375	1.75	16.....	7-3	2.5	1.75	1
3.....	9	3	2.125	1.625	17.....	6-6	2.25	1.5	1
4.....	10	3.125	2.5	1.75	18.....	7	2.5	1.875	1.25
5.....	10	4.125	2.75	2.25	19.....	8	2.75	2.25	1.25
6.....	9-6	3.75	2.75	2	20.....	8-3	3.5	2.5	2
7.....	9	4	3.75	1.75	21.....	10-6	3.625	2.625	2.25
8.....	8	3.25	2.375	1.25	22.....	7-9	2.75	2	1.625
9.....	9-6	3.25	2.75	1.75	23.....	9-6	3.25	2.5	2
10.....	10	3.625	2.75	2.25	24.....	14	4.25	3.5	2.5
11.....	9-6	3	2.5	1.75	25.....	7	2.25	1.75	1.25
12.....	8-6	3	2.375	1.5					
13.....	8-6	3.375	2.125	1.75	Ave..	8-11	3.17	2.48	1.7
14.....	7	3	2.25	1.625					

TABLE XVIII. BULL PINES IN SOD PLAT.
 Plat No. 45. Planted 1896. Measured November 1903.

No.	Height, ft.-in.	Diam. at ground, inches.	Diam. at 2 ft., inches.	Diam. at 4 ft., inches.
1.....	5	1.125	.75	.375
2.....	3-9	.625	.375	.....
3.....	4-3	.75	.5	.25
4.....	4-9	1	.75	.5
5.....	3-3	.625	.25	.....
6.....	4-3	2.5	.75	.5
7.....	2-6	.5	.25	.....
8.....	2-6	.625	.25	.....
9.....	4	1	.5	.25
10.....	2	.625	.....	.....
11.....	4-3	1.25	1	.375
Averages..	3-8	.97	.54	.375



Plate 1. Black Walnut grove, standing where seeds were planted in 1869.

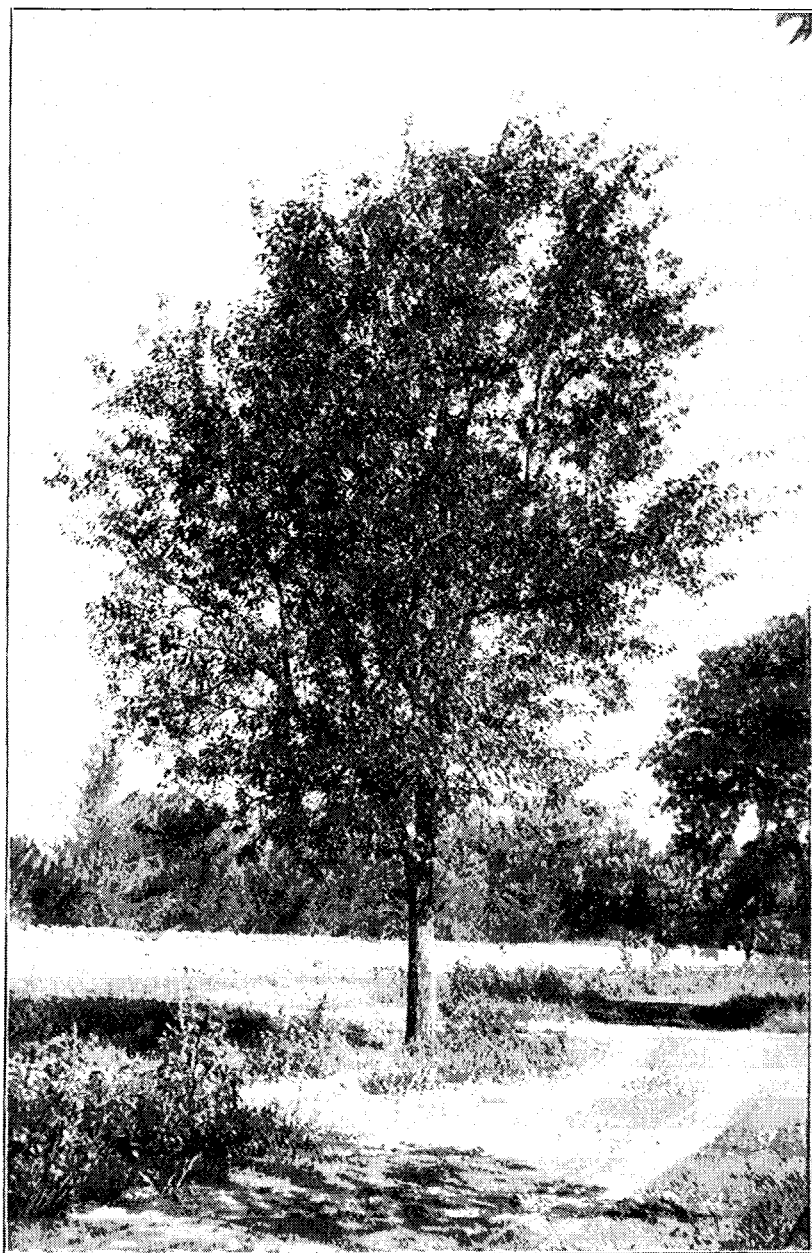


Plate 2. Osage Orange.

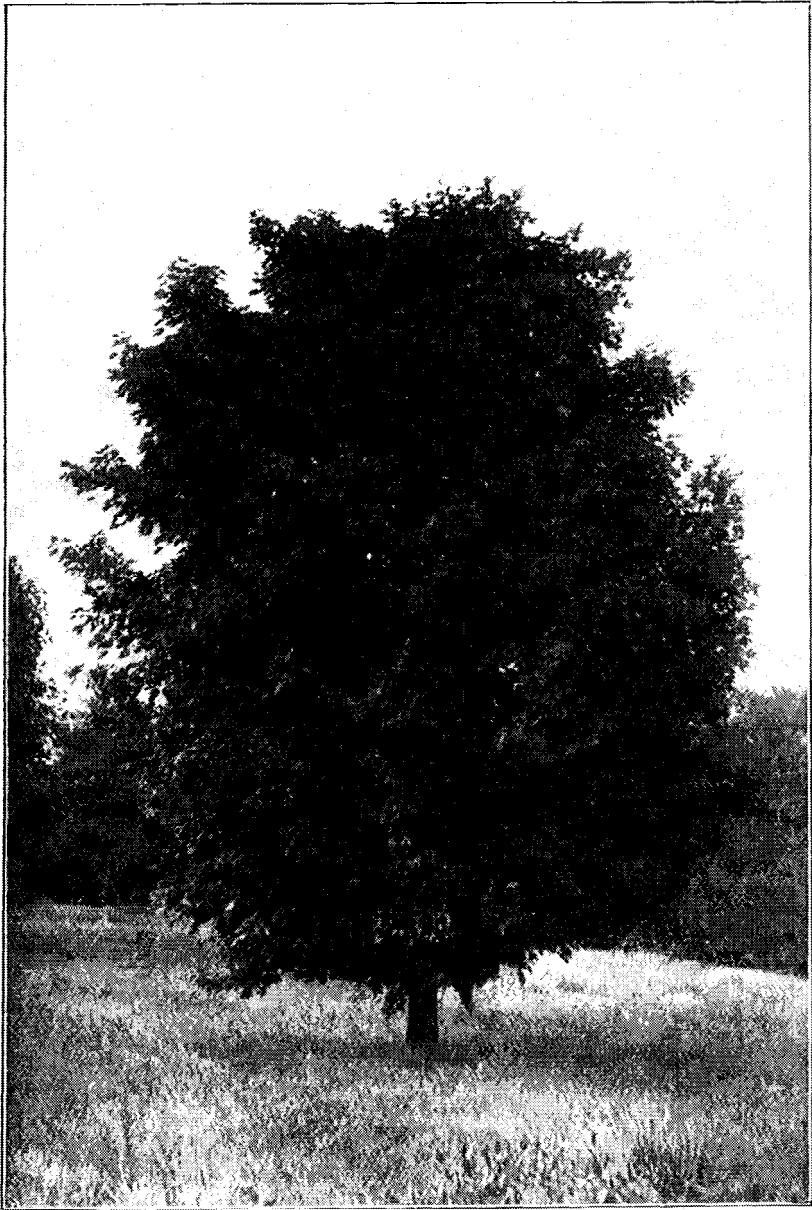


Plate 3. Norway Maple.



Plate 4. Cottonwood on College campus.

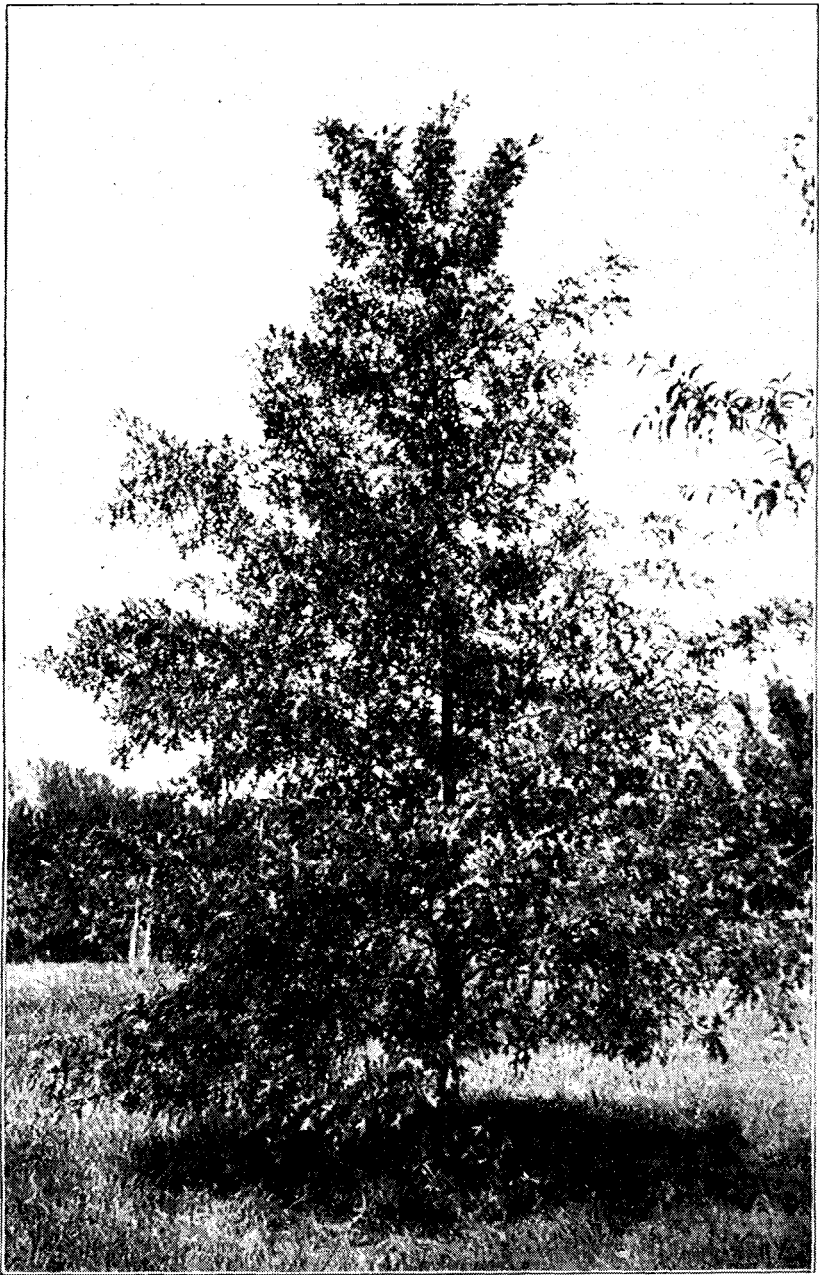


Plate 5. Pin Oak, set 1888.



Plate 6. Scotch Pines, set 1873.

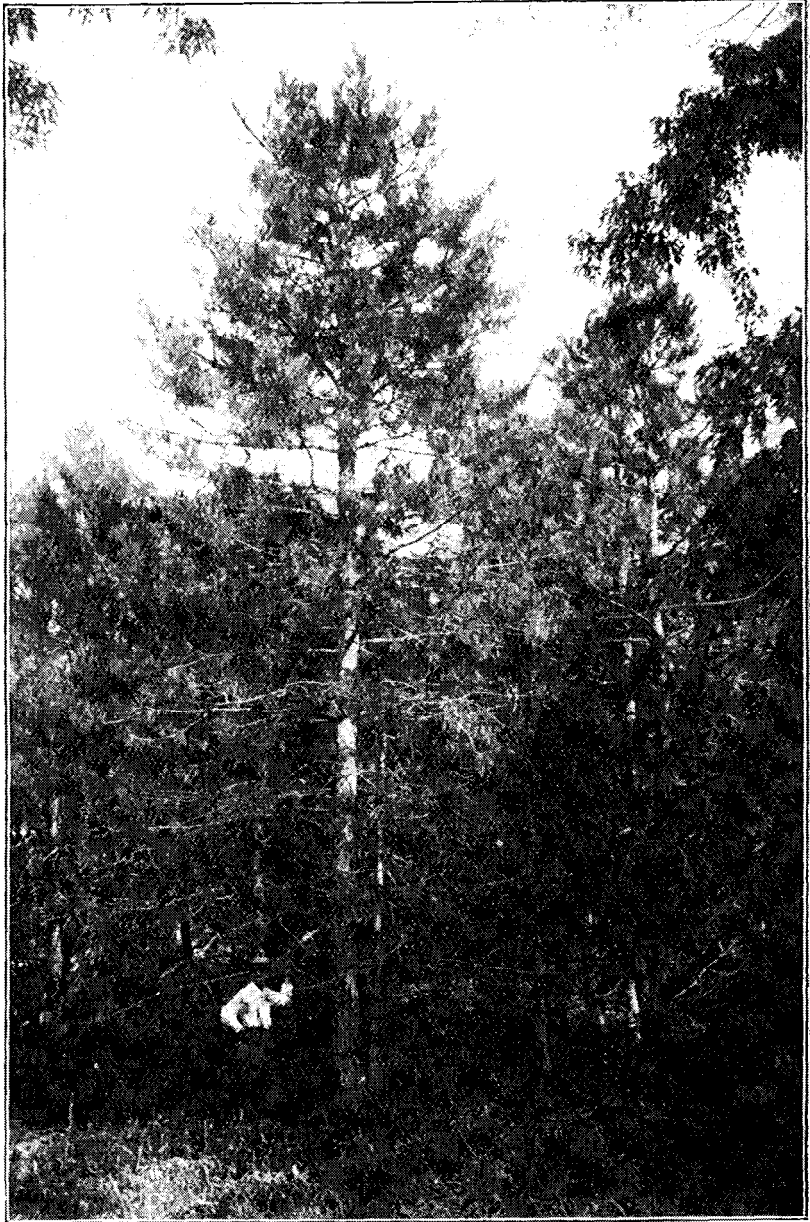


Plate 7. Austrian Pines, set 1873.



Plate 8. Red Cedar. Probably forty years old.

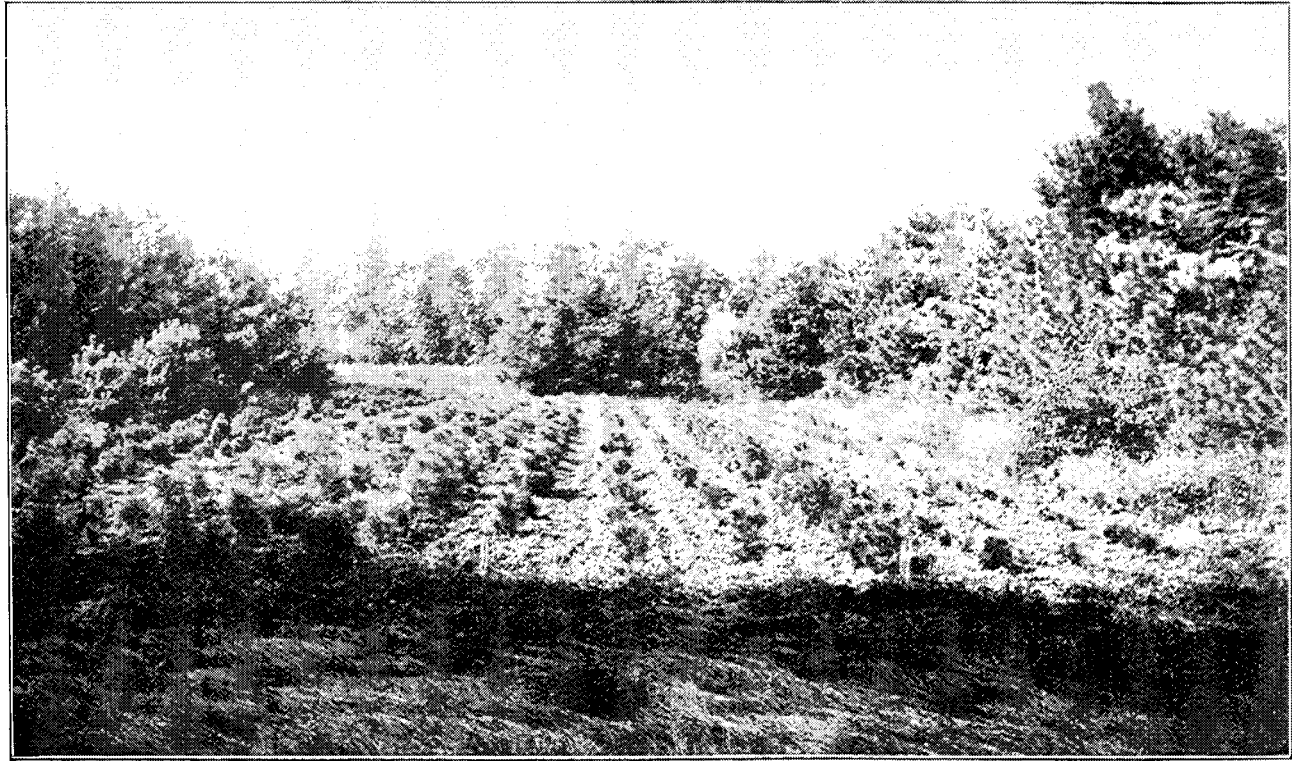


Plate 9. Young pines in Experiment Station nursery.

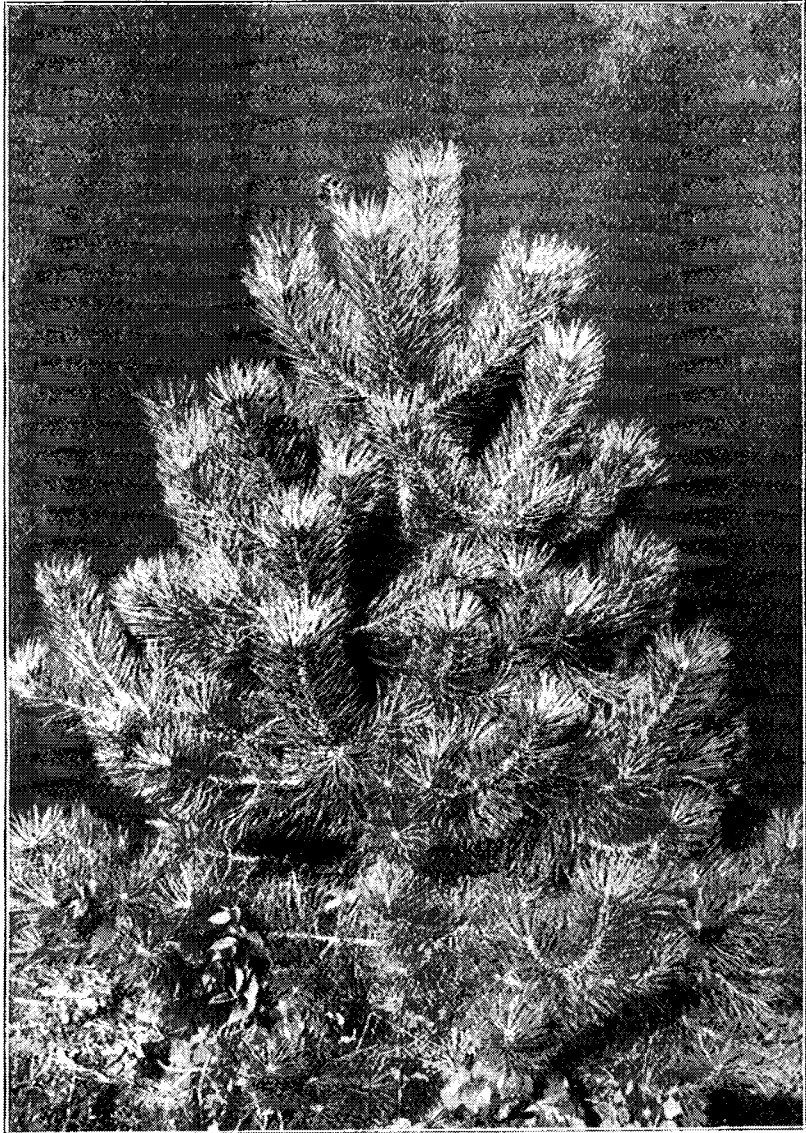


Plate 10. Pine three years from nursery row.

Historical Document
Kansas Agricultural Experiment Station



Plate II. Trees in seedling rows. Planted spring 1898.

Historical Document
Kansas Agricultural Experiment Station



Plate 12. Cooperative planting, 1896. Scotch Pine in foreground; Jack Pine in background.