AN EXPERIMENT ON THE EFFECT OF ROOT PRUNING ON PLANTED CONIFEROUS STOCK

by

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INTRODUCTION

This report is in the nature of a progress report on an experiment begun in the spring of 1937 by Mr. C. F. Coffman, Jr. The purpose of the experiment, which was established in part of Lot 8 of Block I of the University Stinchfield Woods, was to determine:-

1. The effect on survival and on the growth of both roots and tops of 2-0 Western yellow pine stock when planted after being root pruned to different lengths. Pruning was done by means of a large knife which was used to chop off the roots of a large handful of stock at one stroke;
2. The effect on survival and growth of 2-2 Austrian pine stock. Only one degree of pruning was done on this species;
3. The effect of slit planting compared to center hole planting on survival and growth.

Intermediate studies were made by Mr. William E. Towell during the spring of 1938, and by Mr. Robert L. Metzger during the spring of 1939. Some information will be taken from their reports, the originals of which may be found in the Forestry School Library.

The value of the experiment, of course, lies in the definite information obtainable in regard to the effect of root pruning for foresters to use as a guide in extensive planting programs; thereby possibly reducing establishment costs.

Although this experiment was made on a comparatively small area, there was a rather wide variation in site, which should be considered when comparing growth figures for the several plots. This variation increased the value of the experiment since it multiplied the number of

conditions to be observed.

The previous papers have covered reference material on this subject quite fully. Therefore, this paper is concerned largely with observation after five years of growth, with notes from some additional reference material.

It was found by Mr. Towell in the first examination that pruning stock to four inches is too severe (1). However, after five years it was found, much to the surprise of the writer, that there were 52 of the original 269 trees (less the number--probably 100--pulled in previous observations) still living. It should be noted that very favorable moisture conditions prevailed throughout this period. A comparison shows the most thrifty tree in this plot (No. 6) was not quite as tall as the poorest tree in Plot 7, in which the trees were unpruned and planted by the center hole method.

The second examination, two years after planting, showed better height growth for unpruned stock and still better growth for unpruned stock planted by the center hole method (2).

The third examination, by the author, in the spring of 1942 after five growing seasons indicated that stock root pruned to six inches had practically overcome the shock of pruning. However, those trees planted by the center hole method showed a distinct advantage in vigor and height growth over slit planted trees.

REVIEW OF LITERATURE

Inherent Development.

There is comparatively little published information on the development of root systems in relation to survival and growth of planted trees, particularly root pruned stock; but recent studies have furnished evidence to indicate that much more thought should be given to this phase of reforestation, especially in connection with site appraisal and more care in planting to insure better success in planting over a long period of time.

Although root development is inherent, it is typically plastic, which causes a tree to modify its root system to suit environmental conditions (3). For instance, if the development of a tap root on a tap rooted species is stopped for one reason or another, a thrifty tree will usually develop down-growing roots from the under side of lateral roots to take the place of the tap root. These are very strong growing roots, as can be seen from the picture of Tree No. 1, Plot No. 1.

Investigations carried out by Davis (4), Rogers (5), and Partridge (6) indicate that there may be an intermittent function of different parts of a root system. As long as the upper layers of soil contain available moisture, the superficial roots of a tree absorb most of the water used by it, but when this supply of moisture has been depleted, the tap roots become the active absorbing system.

This observation was corroborated in 1940-41 by H. J. MacAloney (7), who found tap roots and long descending vertical roots on jack pine, which is ordinarily considered to be a shallow rooted species.

MacAloney found ten-year-old jack pine in his investigation of 37 jack pine trees that had both tap roots and vertical roots that had

penetrated to a depth of nine feet. The soil was a very fine sandy loam of the Cass Lake, Minnesota fine sands, overlain with coarser sand, or fine gravel with an occasional clay stratum.

Adams and Chapman (8) found vertical roots developed from the lateral roots of 28-year-old jack pine in a plantation on sandy soil in Vermont.

MacAloney (7) also found a direct correllation between the size and extent of root systems and the size and vigor of trees, though it has also been observed that trees tend to develop comparatively small root systems where moisture and nutrients are plentiful or, where mychorriza are present in the soil (9).

There were numerous instances of angular roots, commonly thought to be caused by the root coming in contact with some impenetrable surface or compact soil (10). This was the case with one or two roots on the samples taken; but there were a number of others for which there was no apparent reason for the angular growth which H. P. Brown (11) ascribes to physiological conditions that cause the cambium to be active on one side of the root and dormant on the other side for as much as several years. This, without impairment of the viability in structureless sand.

E. G. Cheney (12) observed the roots of ten inch jack pine that had penetrated hard soil to a depth of five feet, though most of the tree roots were in the top six to twelve inches of soil. Some of the lateral roots were 34 feet long!

Soils in Relation to Root Development.

Contrary to common belief, the soils most difficult of penetration are those which maintain a loose character such as gravel soils or those which have been given such a character as the result of weathering (13).

Vater (13) excavated a number of trees ranging from 22 to 120 years in age and found that the root systems developed in accordance with the variations in site, presumably according to the location of available food.

No roots were found that went down to ground water, though it was supposed that they would if there were oxygen available in the water.

The tap roots of pines and spruce were found to disappear after varying periods in years of growth.

In dry, slightly gravelly sands the depth of root penetration in a 66-year-old stand of pine was found to be not more than six and one half feet (13). However, the tap root of a 99-year-old pine growing on the heath sands of Dresden was excavated to a depth of 15 feet at which point it had a cross-sectional count of 50 annual rings.

It was also found in this study that the descending roots of some trees reached a depth almost two and one half times that reached by the tap root (13).

Soil Moisture in Relation to Root Development.

Stevens (14) and Lane (15) found in their studies of root development in relation to available moisture that root competition, rather than light, is the controlling factor in growth and survival.

Since root pruning decreases the root area considerably, there is a likelihood of high mortality where soil moisture is not plentiful, or where there is considerable root competition from other vegetation which has a tendency to reduce the soil moisture available to the trees.

Lane (15) in his studies at Iowa State College found that grass will reduce soil moisture low enough to cause death or wilting injury to trees under normal growing conditions.

Fungi in Relation to Root Pruning.

It seems unnecessary to consider rot as a result of pruning since the very rapid growth of the root tissues would tend to heal over the scar very quickly, and the seedlings are subject to rot even though they are not pruned (16).

Rot is sometimes carried into the field from the nursery, and is generally in the planting site anyway, so the prevention of rot is more a matter of proper planting, site selection, or site improvement designed specifically for the prevention of rot (16).

Pruning may be of value indirectly in planting, if it prevents the distortion of roots which results in slow growth and poor development of the root system and may ultimately cause the death of the tree (16, 17).

There are comparatively few observations on planted coniferous stock 25 years and older in this country, but the Appalachian Forest Experiment Station has been watching closely the development of 40- to 50-year-old plantations on the Biltmore Estate near Asheville, North Carolina.

The information from observations, as reported by Frothingham (17), (20) are to the effect that fungi gain entrance through dead roots in trees; and it was found that dead roots occurred in all of the poorly planted trees that were excavated.

Site selection and preparation to guard against root rot would result in providing drainage to facilitate aeration in wet soils or in dynamiting or deep-plowing heavy soils. Mixed hardwood-conifer plantations are desirable; as is the planting of hardwoods rather than conifers, particularly on worn out farm lands where an impervious layer of clay lies near the surface (16).

One form of fungus, the mychorriza, may be either detrimental or beneficial, according to the circumstances.

Seedlings that are grown in a nursery where mychorriza are plentiful should not be planted in a site that is not innoculated with mychorriza (9).

On the other hand, a heavy concentration of mychorriza in a soil lacking in nutrients may result in over-development of mychorriza and injury or death to the trees (18, 19).

DESIGN OF THE EXPERIMENT (1)

The experimental plot is located in Lot 8 of Stinchfield Woods, which constitutes one of the forest properties of the University of Michigan. It lies approximately 6 miles northwest of Dexter, Michigan in Sections 11, 12, and 14; R. 4 E., T. 1 S., M.P.M. The site for the experimental plot was plowed with a furrow spacing of 2 to 3 feet and was subdivided as shown in Figure 1. In both the location and design of the experiment, Coffman attempted to approach natural forest plantation conditions as nearly as possible. A two by two foot spacing was originally planned, but, because of the interference of stumps with plowing and the individual differences in the planting crew, spacing was quite irregular. Planting was done by three men to equalize differences in planting technique.

The pruning of the roots was done with a large knife. Many trees were grasped in one hand and all pruned to the desired length by one stroke of the instrument. The seedlings were then planted in the various subdivisions of the plot. Table I shows the make-up of each plot.

Samples of the stock used in each subdivision of the plot were allowed to become air-dry, that is, until all visible traces of water were gone. The roots and the tops were then weighed separately in order to determine top-root ratios, as given in Table I. These ratios are obtained by dividing the total weight of the tops by the weight of the roots. This is the commonly accepted method of expressing the ratio between tops and roots. As can be

PLANTING RECORD
1937

<table>
<tr>
<td>3.
Western yellow pine.
2-0 stock.
Roots unpruned.
Slit.
253 trees.
Planted May 1, 1937.</td>
<td colspan="2">4.
Western yellow pine.
2-0 stock.
Roots pruned to 6".
Slit.
237 trees.
May 1 & 8, 1937.</td>
</tr>
<tr>
<td>2.
Austrian pine.
2-2 stock.
Roots pruned to 6"
Slit.
199 trees.
May 1, 1937</td>
<td colspan="2">5.
Western yellow pine.
2-0 stock.
Roots pruned to 4".
Slit.
269 trees.
May 8, 1937.</td>
</tr>
<tr>
<td>1.
Austrian pine.
2-2 stock.
Roots unpruned.
Center hole.
184 trees.
May 1, 1937.</td>
<td>6.
Austrian.
2-2 stock.
Roots pruned to 6".
Center hole.
100 trees.
May 8,1937</td>
<td>7.
W. yellow.
2-0 stock.
Roots unpruned.
Center hole.
99 trees.
May 8, 1937.</td>
</tr>
</table>

Experimental Plots.
Scale: 1" = 40'.

Figure I.

Table I

Make-up of an experimental plot planted at Stinchfield Woods on May 1 and 8, 1937.

Subdivision No.	Species	Age	Condition of Roots	Method of planting	Top-root ratio	No. of plants
1	Austrian pine	2-2	Unpruned	Center hole	3.8	184
2	Austrian pine	2-2	Pruned to 6"	Slit	5.1	199
3	W. yellow pine	2-0	Unpruned	Slit	2.9	253
4	W. yellow pine	2-0	Pruned to 6"	Slit	2.85	237
5	W. yellow pine	2-0	Pruned to 4"	Slit	4.16	269
6	Austrian pine	2-2	Pruned to 6"	Center hole	5.1	100
7	W. yellow pine	2-0	Unpruned	Center hole	2.9	99
				Total no. of plants:		1341

seen in Table I, the pruning definitely upset these ratios in most cases. The lower the ratio the greater is the percentage of roots, and during dry conditions, the greater is the possibility of survival.

DATA COLLECTED

First Data Collected.

The first data collected on the experiment were survival counts and growth measurements in the spring of 1938 by Mr. William E. Towell.

Weather conditions during the first growing season were very favorable to survival, which may or may not account for the high percentage of survival for all trees. However, there was a slightly larger mortality observed for the pruned stock, particularly that which was planted with the dibble (Table II), and for that stock which was pruned to four inches.

There was one unrelated observation made in regard to the planting that indicates a direct benefit of pruning. In the unpruned plots, the root systems of most of the dead seedlings were bent upwards "so that the fine fibrous roots were very close to the surface of the ground; while in the pruned plots there were no dead seedlings with upturned roots."

It was quite evident, even after a most favorable season, that pruning to four inches is too severe and should not be practiced. Some mortality was experienced as a result of plant competition for both light and root space.

Competition is likely to be most severe on the pruned stock since those trees are incapable of developing a crown as rapidly as the unpruned stock. It was found at this time, through a careful measurement of top-root ratios (weight of the top above the root collar), that practically all trees had developed root systems comparable to the original top-root ratios.

Table II

Survival percentages and causes of mortality for various plots--1938.

Plot No.	Species	Method of planting	Condition of roots	No. trees planted	No. trees dead	Mortality due to pruning	Mortality due to planting	Mortality from other causes	Survival
7	W.y.p.	Hole	U.P.	99	6	0.0%	2.0%	4.0%	94.0%
3	W.y.p.	Slit	U.P.	257	18	0.0%	2.3%	4.7%	93.0%
4	W.y.p.	Slit	Pruned-6"	237	3	0.0%	0.4%	0.8%	98.8%
5	W.y.p.	Slit	Pruned-4"	269	22	5.2%	1.5%	1.4%	91.9%
1	Austr.	Hole	U.P.	184	6	0.0%	1.1%	2.1%	96.8%
6	Austr.	Hole	Pruned-6"	100	1	0.0%	0.0%	1.0%	99.0%
2	Austr.	Slit	Pruned-6"	199	5	1.0%	1.5%	0.0%	97.5%

Second Examination.

The second examination was made by Mr. Robert L. Metzger in June, 1939. At this time it was quite noticeable that the average height of the unpruned seedlings was greater than that of the pruned stock of either degree of pruning; and it was further apparent that the stock planted by the center hole method had much better growth and survival.

Unfortunately, there were no survival counts taken at this time, though subsequent girdling by rodents would have nullified the value of any further comparisons.

Third Examination.

The third examination was begun by the author in the spring of 1942 after five growing seasons. Survival counts and height growth measurements were made in the latter part of May. The sample trees were not all excavated at that time--some of them were taken as late as the first part of September--but it is thought that this would not effect the value of the experiment except to accentuate the differences attributable to pruning.

During the summer there were a number of trees that died as a result of previous girdling by rodents. These trees and all other dead ones were removed and a light release from overtopping vegetation was made for the remaining trees.

At this time it was quite apparent that differences in site were accountable for some of the variance in growth on the experiment, and perhaps some of the mortality. These differences in site, however, did not obviate the comparison between the development of pruned and unpruned root systems.

A comparison of survival by numbers should not be made, since there was an extensive area, in comparison to the size of the experiment, where trees were killed as a result of girdling by rodents, both mice and rabbits.

Photographs of Samples, with Discussion.

Plot No. 1 - Tree No. 1

51" 2-2 Unpruned Austrian pine center hole planted.
Top-root ratio 7.4-1.

Roots partly doubled in planting, but not turned upward.

Fairly well developed root system.

Plot No. 1 - Tree No. 1

Second view showing one-sided growth, though adequate for good top development.

Plot No. 1 - Tree No. 2

65.5" 2-2 Unpruned Austrian pine center hole planted. Top-root ratio 6.8-1.

Root system largely lateral. Many roots went down to hardpan, then grew upward again to within 4 - 6 inches of the surface where they continued to spread.

Good moisture conditions in soil (drainage) in this location.

Plot No. 1 - Tree No. 2

Second view showing well distributed root system.

Plot No. 1 - Tree No. 2

Enlarged "root-section," showing the extraordinary development of lateral roots.

Note comparatively minor tap root development and upward growing laterals.

Plot No. 1 - Tree No. 3

29" 2-2 Unpruned Austrian pine center hole planted. Top-root ratio 8.9-1.

Well developed root system.

Stem girdled one-half way around.

Plot No. 1 - Tree No. 4

59" 2-2 Unpruned Austrian pine center hole planted. Top-root ratio 9.35-1.

Well developed root system, strong tap root.

Tree had been planted over edge of large rock. Root grew along edge.

Partly girdled.

Plot No. 2 - Tree No. 1

40" 2-2 Austrian pine pruned to 6 inches and slit planted. Top-root ratio 5.02-1.

Root development largely in one plane except for laterals on one side.

Carpenter ants tunneling in shortest tap root.

Slightly drier site than Lot No. 1. Deep sandy soil with some large rock fragments.

Compare with tree No. 4, Plot No. 6.

Plot No. 2 - Tree No. 1

Second view showing laterals on one side of what otherwise would be a root system in one plane.

Plot No. 2 - Tree No. 2

36" 2-2 Austrian pine pruned to 6 inches and slit planted. Top-root ratio 8.58-1.

Roots developed largely in one plane, though they have gone deep. Deep sandy soil.

Plot No. 2 - Tree No. 2

Second view at 90° showing minor degree of root growth from the one plane.

Plot No. 2 - Tree No. 3

42" 2-2 Austrian pine pruned to 6 inches and slit planted. Top-root ratio 5.12-1.

Well distributed root system though no tap root. No doubt caused by the presence of hardpan.

Note the angular growth of one root which grew toward the surface twice.

Plot No. 2 - Tree No. 4

45" 2-2 Austrian pine pruned to 6 inches and slit planted. Top-root ratio 4.92-1. The low ratio is a result of the extraordinary tap root and one lateral root development. The bunch of fibrous roots near the surface is also extraordinary.

Very thrifty tree with rapid growth during the last two seasons.

Plot No. 2 - Tree No. 5

52" 2-2 Austrian pine pruned to 6 inches and slit planted. Top-root ratio 6.44-1.

The root system has a strongly developed tap root, with a small bunch of lateral roots near the surface.

Very thrifty, fast growing tree.

Plot No. 3 - Tree No. 1

24" Unpruned Western yellow pine; slit planted.
Top-root ratio 4.7-1.

Hardpan under this tree, but a well distributed lateral root system is sufficient to make this a thrifty tree--steadily increased growth during the past three seasons.

Plot No. 3 - Tree No. 1

Second view of root system showing the extraordinary development of the lateral roots.

Plot No. 3 - Tree No. 2

25" Unpruned Western yellow pine; slit planted. Top-root ratio 5.14-1. This high percentage of top weight is due, in part, to the thick butt of the tree.

Well developed and well distributed root system. Deep sandy soil.

Plot No. 3 - Tree No. 3

34" Unpruned Western yellow pine; slit planted.
Top-root ratio 4.33-1.

The low ratio of top to roots is probably due to the extraordinary development of lateral roots, though they are still largely in one plane as shown in the second photograph taken at 90° to the first one. This tree had the largest total weight of any of the four specimens by 1.6-1.

Plot No. 3 - Tree No. 3

Second view showing root development largely in one plane.

Plot No. 3 - Tree No. 4

37" Unpruned 2-0 Western yellow pine; slit planted. Top-root ratio 4.9-1.

This is the highest and driest plot in the group.

The roots were doubled in planting, but the tree developed multiple long tap and lateral roots. In this case not confined to one plane. Deep sandy soil.

Plot No. 3 - Tree No. 4

Close-up of root system.

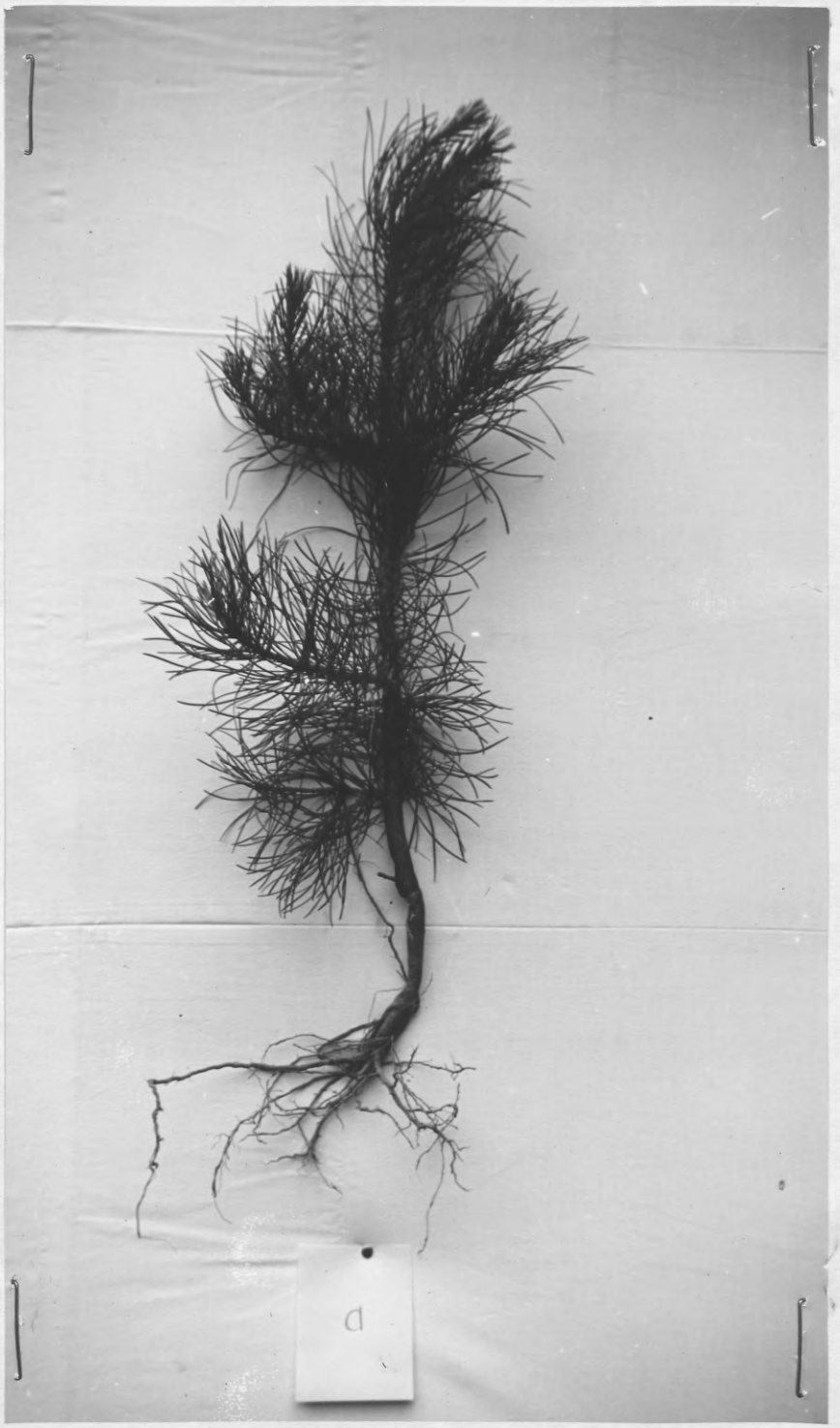
Plot No. 4 - Tree No. 1

26" Western yellow pine pruned to six inches and slit planted. Top-root ratio 3.24-1.

The soil in this plot has slightly better moisture conditions than Lot No. 3.

The development of this tree was retarded through partial girdling by rodents.

The root system, though slit planted, was not confined to one plane as were many of the samples. The tree apparently recovered from the injury and was quite thrifty in appearance.



Plot No. 4 - Tree No. 1

Second view taken at 90° to show the distribution of roots.

Note the angular development of the lateral root, (11).

Plot No. 4 - Tree No. 2

33" Western yellow pine pruned to 6 inches and slit planted. Top-root ratio 6.7-1.

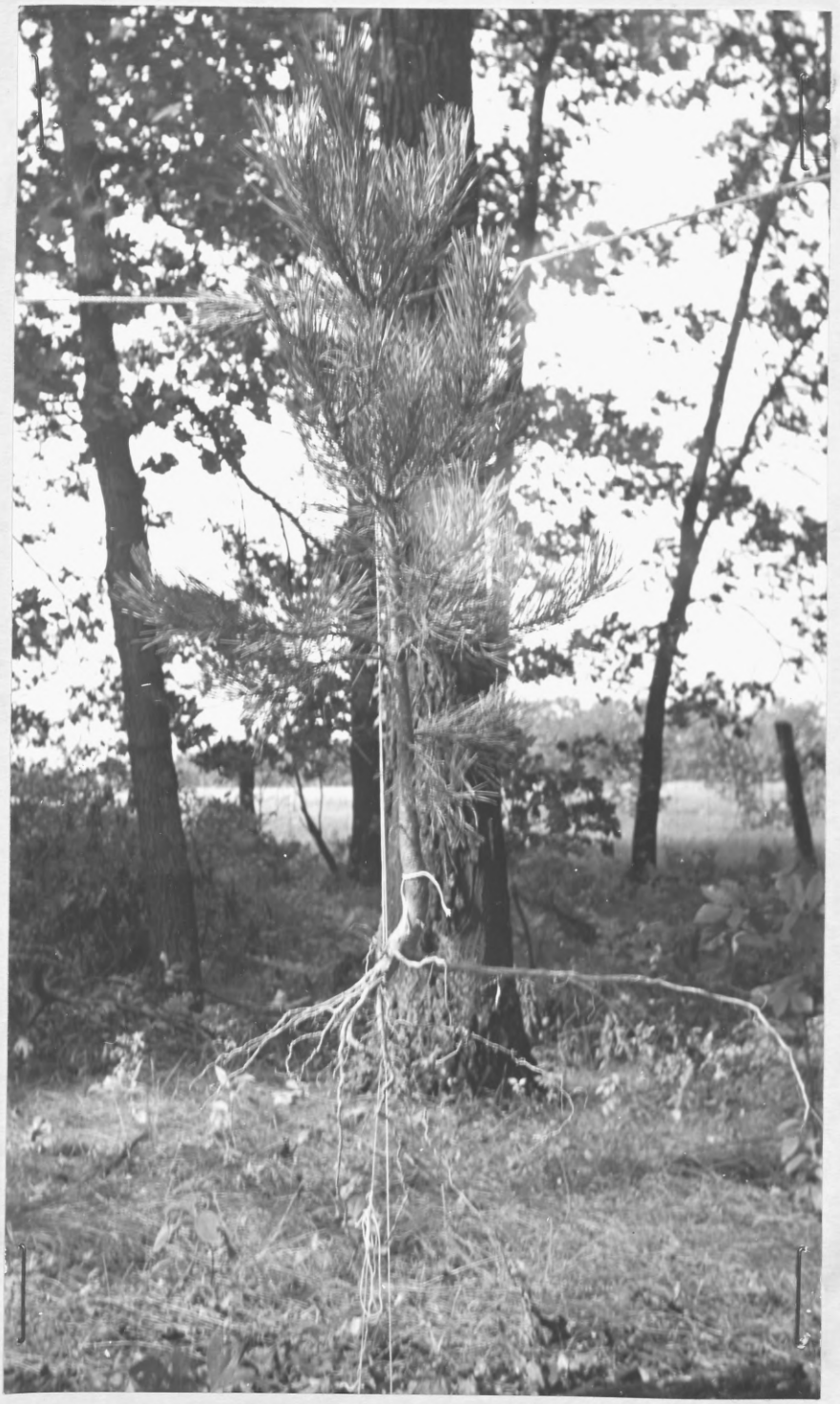
Tree partly girdled but well developed root system and vigorously growing top.

Plot No. 4 - Tree No. 2

Second view taken at 90° to first.

Note the spread of roots from the "one plane" as compared to other samples.

This tree was in comparatively coarse, sandy soil with good moisture content, which may account for the better distribution of roots.



Plot No. 4 - Tree No. 3

37" Western yellow pine pruned to 6 inches and slit planted. Top-root ratio 5.8-1.

Small tap root development but extraordinarily long lateral root. Very coarse sandy soil.

Plot No. 4 - Tree No. 4

39" Western yellow pine pruned to 6 inches and slit planted. Top-root ratio 6.3-1.

Very well developed root system with long tap root. Vigorous and thrifty tree.

Very coarse, sandy soil. Good moisture conditions.

Plot No. 5 - Tree No. 1

24½" Western yellow pine pruned to 4 inches and slit planted. Top-root ratio 10.2-1.

No tap root development but several fairly long laterals.

Very sparse growth, though soil conditions more favorable than in Plots 3 and 4.

Roots in one plane.

Total weight when compared to an unpruned tree of the same height is only 1 to 4.

Plot No. 5 - Tree No. 2

25" Western yellow pine pruned to 4 inches and slit planted. Top-root ratio 7.9-1.

Comparatively thrifty tree. Strong tap root development. When compared to an unpruned tree of similar proportions it has a total weight ratio of only 1 to 2.4.

Plot No. 5 - Tree No. 2

25" Western yellow pine pruned to 4 inches and slit planted.

Second view of root system showing the meager root development, though good tap root development.

Plot No. 5 - Tree No. 3

30" Western yellow pine pruned to 4 inches and slit planted. Top-root ratio 5.34-1.

This tree has been partly girdled but, in spite of this and the severe pruning, it has developed into a fairly thrifty tree with a well developed root system. It was in the open, however, and had very little competition.

Plot No. 5 - Tree No. 4

31" Western yellow pine pruned to 4 inches and slit planted. Top-root ratio 4.6-1.

This was the largest and best developed tree in the plot. It had a fairly long, double tap root and numerous lateral roots that grew in one plane, however.

Coarse sandy soil; good moisture conditions.

This tree--the best in Plot 5--is only slightly better than the poorest tree in adjacent Lot 7 which was unpruned and planted by the center hole method.

Plot No. 6 - Tree No. 1

56" 2-2 Austrian pine pruned to 6 inches; center hole planted. Top-root ratio 6.88-1.

Good distribution of roots--extraordinarily long tap root. Coarse sandy soil.

Plot No. 6 - Tree No. 1

Second view (at 90° angle to first view) to show even distribution of root development.

Plot No. 6 - Tree No. 2

55" 2-2 Austrian pine pruned to 6 inches; center hole planted. Top-root ratio 8.85-1.

Well developed root system, though not many laterals.

Coarse sandy soil.

Note 90° angle on root. There was no obstruction or other apparent reason for this growth. (11), due to temporary dormancy on one side--continued growth on the other.

Plot No. 6 - Tree No. 3

31" 2-2 Austrian pine pruned to 6 inches; center hole planted. Top-root ratio 5.7-1.

This tree was partially suppressed and has had the leader broken out.

Tree now quite thrifty with spreading root system.

No strongly developed tap root as yet, but one developing.

Plot No. 6 - Tree No. 3

Second view.

Plot No. 6 - Tree No. 4

40" 2-2 Austrian pine pruned to 6 inches and center hole planted. Top-root ratio 9.4-1.

Roots partially doubled in planting. Rather sparsely developed root system, but a well formed, thrifty tree--past summer's growth 15 inches.

Another example of angular root development.

This tree has quite a long tap root--26 inches below surface of ground. Coarse sandy soil. Laterals growing toward surface.

Plot No. 6 - Tree No. 4

Second view.

Plot No. 7 - Tree No. 1

31" 2-0 Western yellow pine, unpruned; center hole planted. Top-root ratio 4.92-1. Sandy soil with little hardpan.

Well developed and well distributed root system.

The low top-root ratio probably due to oppression.

Plot No. 7 - Tree No. 2

35" 2-0 Unpruned Western yellow pine; center hole planted. Top-root ratio 10.4-1.

Well developed tap root and laterals.

Plot No. 7 - Tree No. 3

39½" 2-0 Unpruned Western yellow pine; center hole planted. Top-root ratio 9.85-1.

Long double tap root with comparatively few laterals. Note the double right angle turn on one tap root.

Loose sandy soil. Good moisture content.

Plot No. 7 - Tree No. 4

42" Unpruned Western yellow pine; center hole planted. Top-root ratio 7.23-1.

Long tap root with numerous laterals. The one-sided growth was probably due to soil conditions. However, it is possible that the original planting favored such growth.

SUMMARY

After five years of growth it was obvious that root pruning gives a shock to trees that they may not overcome unless they have favorable conditions for growing. This is particularly true of trees that are over-pruned. Pruning of both 2-0 Western yellow pine and Austrian pine to six inches is considered to be quite practical.

There is a seeming contradiction to this statement in the figures on the average height of the stock that was pruned to four inches--Plot 5.

The explanation for this is that the death of many plants in this plot during the first season provided more light and root space for the remaining trees in the plot; and the soils and moisture conditions were considerably better than in Plots 3 and 4, which show less growth.

When it is necessary to prune roots to insure that they will not be doubled in planting, it is best to prune. Particularly in the light of the findings of D. V. Baxter (16) and Hepting (20) on the occurrence of rot in older plantations as a result of poor planting.

The findings of Baxter and Hepting indicate, as does this experiment, that center hole planting is highly desirable.

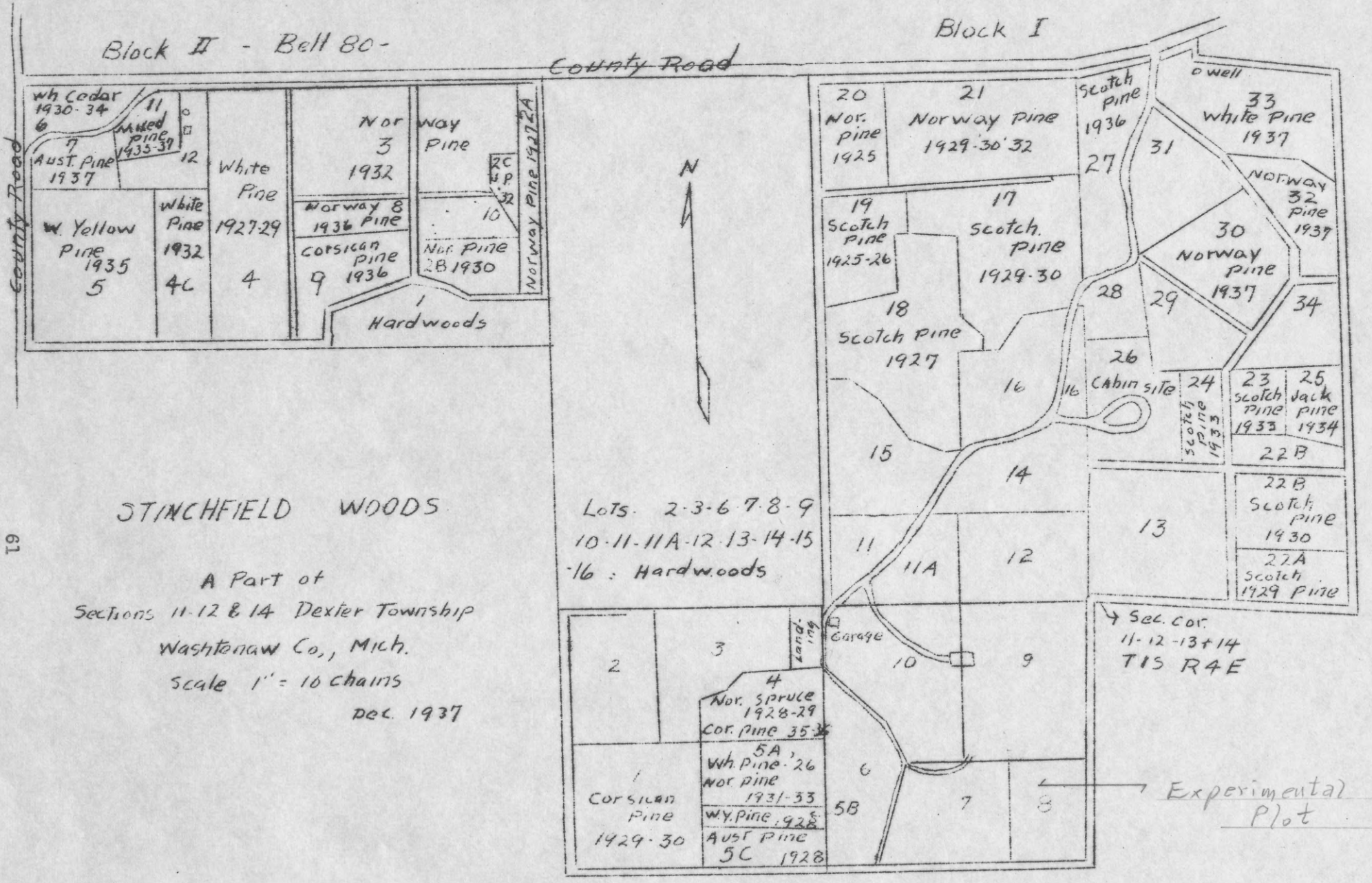
New developments in planting machines which plant in the manner of "oblique planting" as developed by Munch (21) will tend to eliminate slit planting and, therefore, make pruning unnecessary.

APPENDIX

Map of Stinchfield Woods, University of Michigan.

Map of Experimental Plot.

Fifth Year Survival Counts.



STINCHFIELD WOODS

A Part of
Sections 11-12 & 14 Dexter Township
Washtenaw Co., Mich.
Scale 1" = 10 chains
Dec. 1937

Lots 2-3-6-7-8-9
10-11-11A-12-13-14-15
-16 : Hardwoods

EXPERIMENTAL PLOT
In
Lot Eight of Block I

<table>
<tr><td>Plot No. 3

2-0 Western yellow pine
Un-pruned
Slit planted</td><td colspan="2">Plot No. 4

2-0 Western yellow pine
Pruned to 6"
Slit planted</td></tr>
<tr><td>Plot No. 2

2-2 Austrian pine
Pruned to 6"
Slit planted</td><td colspan="2">Plot No. 5

2-0 Western yellow pine
Pruned to 4"
Slit planted</td></tr>
<tr><td>Plot No. 1
(33'x 40')

2-2
Austrian pine
Un-pruned
Center-hole planted</td><td>No. 6

2-2
Austr. p.
Pruned - 6"
C-hole planted</td><td>No. 7

2-0
W.y.p.
Un-pruned
C-hole planted</td></tr>
</table>

LEGEND:
1942

- - Area of girdling

- - Area partly suppressed

- - Break in slope

SURVIVAL

June 1, 1942

PLOT NO.	1	6	2	7	3	4	5
SPECIES	Austr. pine	Austr. pine	Austr. pine	W.y.p.	W.y.p.	W.y.p.	W.y.p.
Stock Age	2-2	2-2	2-2	2-0	2-0	2-0	2-0
Method of Planting	Center hole	Center hole	Slit	Center hole	Slit	Slit	Slit
Pruned or Unpruned	U.P.	6"	6"	U.P.	U.P.	6"	4"
Number trees left in 1942	25	37	58	23	95	81	52
Average Height	51.3"	48.0"	41.6"	29.82"	22.19"	23.44"	26.75"
Average Height Sample Trees	46.9"	45.5"	43.2"	39.40"	30.00"	33.75"	27.60"
Average Height Remaining Stand	54.7"	48.35"	41.4"	32.02"	21.85"	22.91"	26.40"
Number Dead	30*	---	16*	---	1	4**	---
Partly Girdled--Alive	1	---	1	1	---	2	1
Broken Top	---	1	---	1	---	1	---
Ants Feeding	---	---	1	---	---	---	---
Oppressed	---	1	---	3	---	---	2
Dead--Not Girdled or Suppressed	---	---	---	2	---	---	---

NOTE: All dead trees, including some that died during the summer of 1942 as a result of girdling during past seasons, were cut, and a light release from overtopping vegetation was made for all the trees that were left in the stand.

* Girdled trees.

** Suppressed.

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