A STUDY OF SPROUT RE-GROWTH.

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In any region where hardwood abounds it is evident that a prolific sprout growth results after a disease ravage, burning or cutting of any kind. In growing a crop of timber in such a region, it appears certain that the treatment of particularly weed species of sprout growth, with the object in view of obtaining the most promising combination for future timber production, constitutes a silvicultural problem of very great importance.

A sprout is defined as a tree which has grown from a stump over two inches in diameter at the ground line. The true basis of separation between sprouts and seedling sprouts is the root systems. Sprouts form a root system independent of that of the previous genereation. Portions of the old root system may be incorporated into the new plant but never the entire old system. The portions of the old root system not so utilized decays quickly and carrys decay back into the heart of the new tree. This accounts for the decay which is characteristically found in the butts of sprout trees. In most cases where stems are over two inches in diameter at the ground line the old stub fails to callus over completely before rot enters and the old root system is not entirely utilized by the new plant. Two inches is taken as a dividing size limit between seedlings sprouts and sprouts by Hawley and Leffelman, Yale Bulletin #15 (1) and Cline and Lockhard, Harvard Bulletin # 8 (2).

Sprout growth varies in rapidity depending on both inherent characteristices and environment. Each species and

variety has its own characteristic rate of growth. Other factors affecting sprout re-growth are (a) Soil (b) Moisture (c) Degree of competition for root and crown space. (d) Interference with normal development. All these factors certainly have their effect either individually or collectively or sprout re-growth. Our measurements indicate for certain age, size of stool and similiar site conditions many species of the better hardwoods have practically the same height regrowth. The wide range in numbers of sprouts per stool is due to difference in individual vigor as well as to specific habit.

Seasonal temperature has very little if any influence on the general sprout growth. First the temperature for any region varies from the normal for that period, so little that temperature may be disregarded in comparing height growth of sprouts in different years. A graph of mean monthly temperatures for the past four years shows the lack of variation by the closeness with which the curve for each year follows the normal curve bases on a long period of time.

Height growth is not influenced by the number of sprouts per stool. Considering site, species, and soil moisture the one big factor affecting growth of sprouts is diameter of the stool. Up to about a foot in diameter the number of sprouts varies directly with the size of the stool. Above the one foot limit, increased size and age result in a reduction of sprouting capacity until finally no sprouts are produced.

The measurements show conclusively that under normal conditions where sprout stems are cut back at occasional intervals, the process of regeneration from existing root systems can continue indefinitely without loss of vitality. If this cutting took place each year, so that the tree could not maintain its reserve food supply it would undoubtly die. After each cutting takes place a greater number of sprouts recur yet the data shows that they have the same ability for height growth as the former generation, if they are "free to grow". The only factor of control for vigorous sprouting species seems to be density or overtopping. Areas were studied where red maple, when cut back for the third time, gave forth only weak regrowths due to the fact that the canopy was practically closed. Similiar sprouts when "free to grow" seemed to posses the same vigor after the third cutting as after the first.

Interesting observations were made in stands where the stem was partially severed, and the part above the cut bent down to the ground. This results in a very much lessened growth of sprouts starting from below the cut due to the fact that the growth enery ordinarly used for regrowth of new sprouts is diverted into the lopped stems in an effort them alive. Where the cutting back of the sprouts had been done in the summer observation showed that the new shoots were killed back considerably during the following winter. It is reasonable to assume that these sprouts are by no means dead and that they still possess sprouting ability. This retarding effect is all very beneficial to the stand because the favorable elements still

have more opportunity to overtop the undesirable form of sprout growth.

Sprout growth varyins very greatly according to species as can be seen by the following figures, Dana(4) in his bulletin" Paper Birch in the Northeast" shows sprouts five years of age with a height of ten feet and a height of thrity six feet in twenty years. Sterett (5) says," White ash sprouts fr from stumps of healthy trees over three inches in diameter grow from three to seven feet the first year and from two to four feet a year for several succeeding years". Our own measurements show that red maple from stumps two to nine inches in diameter average as high as 4.8 feet during the first growing season. The second year after cutting back this growth rate decreases to an average of 2.1 feet per year. Enough measurments have not been made after the second cutting back to draw any very specific conclusions bu t the meager information shows that sprouts certainly possess as much sprouting capacity as they had after being cut back once. Black cherry, red oak, and black birch might be placed in the same class with red maple since all four species possess an unbelieveable sprouting ability. Grey birch on the other hand after the first cutting grows only an average of 2.7 feet the first year and 1.3 feet thesecond year.

REFERENCES.

1. Studies of Connecticut Hardwoods. The Treatment of Advance Growth Arising as a Result of Thinnings and Shelterwood Cuttings. L.J.Leffelman and R. C. Hawley. Yale Bull. # 15

2. Mixed White Pine and Hardwood.
A. C. Cline and C. R. Lockhard. Harvard Forest Bulletin # 8.

3. Paper Birch in the Northeast. S. T. Dana. U. S. D. A. Circular 163 Forest Service.

4. The Ashes,- Their Characteristics and Management. U.S.D.A. Bulletin 299 W. D. Sterrett Forest Service.

5. Factors Affecting the Reproduction of Hardwood Forests in Southern Connecticut. Jmaes L. Averill. Journal of Forestry January 1929.

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PLANTING CUT OVER CORDWOOD LAND.

This case deals with the conversion of cordwood stands to softwood sawtimber stands, as practiced on the Harvard Forest. Hundreds of thousands of acres of cut-over sawtimber land in New England are now covered with an inferior hardwood growth consisting chiefly of gray birch, red maple, cherry, and poplar together with a scattering of rank-growing sprouts of red oak and other hardwoods, which formed a part of the previous stand. The abundance of this this type, commonly known as "cordwood", and the difficulties encountered in converting it to sawtimber types combine to make the problem of handling cut-over land one of the most important in New England. No one case on the Harvard Forest exists in which all of the most desirable steps in the process of conversion have been progressively practiced. Consequently the case herein presented is a composite of parts of several opemations covering a period of several years. The five steps in the process are, (1) cutting the cordwood, (2) marketing the cordwood, (3) disposal of the slash, (4) establishing a new crop by planting, and (5) the care of the new crop.

DESCRIPTION OF THE CORDWOOD STAND.

The stand was well stocked, on medium soil, site II, and covered about fifteen acres. It originated largely from advance growth under the previous stand of old field pine, which was cut back at the time of logging, and partly from seedlings of such species as gray birch, pin cherry, and poplar which seeded in subsequent to cutting the previous stand. The density of the canopy was sufficient to keep out all buta light ground cover of club moss, wintergreen and grasses. The stand consisted of 50 percent. gray birch, 30 percent. red maple, and 20 percent. poplar, red oak, paper birch,

black cherry and overtopped white pine. Age 30 years; volume 15 cords per acre. The cordwood stand was in a thrifty condition, varying in height from 30 - 45 feet and the trees in diameter from 2 - 8 inches, breast high.

(PHOTOGRAPH)

Fig. 1. Showing typical cordwood stand on Harvard Forest, Prospect Hill Block, Compartment VII. Photograped by A.C. Cline.

CUTTING THE CORDWOOD.

During the fall and winter choppers cut and piled the wood in cord piles of 8 foot wood for $ 2.50 a cord, with the agreement that the brush be piled as long as the leaves were on and after that the brush would be scattered. (The choppers piled the wood three inches higher than the regular cord size, to allow for the shrinkage.) Every standing tree except pine was cut down regardless of size or kind. Unsaleable wood was handled as slash. The scattered white pines on the area were left standing to prevent damage to the plantation by the Pales Weevil. (Harvard Forest Bulletin # 3.) After the plantation has reached a height of five or six feet these pines will be cut.

MARKETING THE CORDWOOD.

While the sledding was good the cordwood was yarded a distance of about a half mile for a $ 1.25 per cord. From the yard, which was along a town dirt road, the wood was disposed of during the spring and summer. It was sold at the place of yarding as 8 foot wood for $ 5.00 per cord.

Table I.

Costs Per Acre of Removing the Cordwood.

Chopping - 15 cords at $ 2.50 per cord	$ 37.50
Yarding - 15 cords at $ 1.25 per cord	18.75
Supervision	3.75
Total Cost of 8 ft. Wood Yarded per Acre.	$ 60.00

Table II.

Profit Per Acre From the Sale of the Cordwood.

15 cords 8 ft. wood at $ 5.00 per cord	$ 75.00
Cost of same at place where sold	60.00
NET PROFIT PER ACRE	$ 15.00

DISPOSAL OF THE SLASH.

As soon as the snow had gone in the spring, not more than a month after the chopping was completed, the brush was burned. In that part of the area, where the wood had been cut while the leaves were on, the brush was burned for $ 2.00 an acre as the leaves had dried out sufficiently to cause the slash to burn readily. The remainder of the brush presented a different problem, since slash fires had to be started with any available dry material and kerosene, and the hardwood slash fed on. No attempt was made to make a clean burn. Often only the center of the pile was burned out, but this provided a place for a tree to be planted later on. The aim was to clear the cutting area sufficiently for easy planting with a fairly wide spacing. Hardwood slash decays so rapidly that after four years there is no longer any danger from the fire standpoint. Where the brush had to be piled and burned the cost was $ 10.00 an acre. Slash burning on the area now under consideration cost $ .47 per cord, including supervision, with an average figure per acre of $ 7.00.

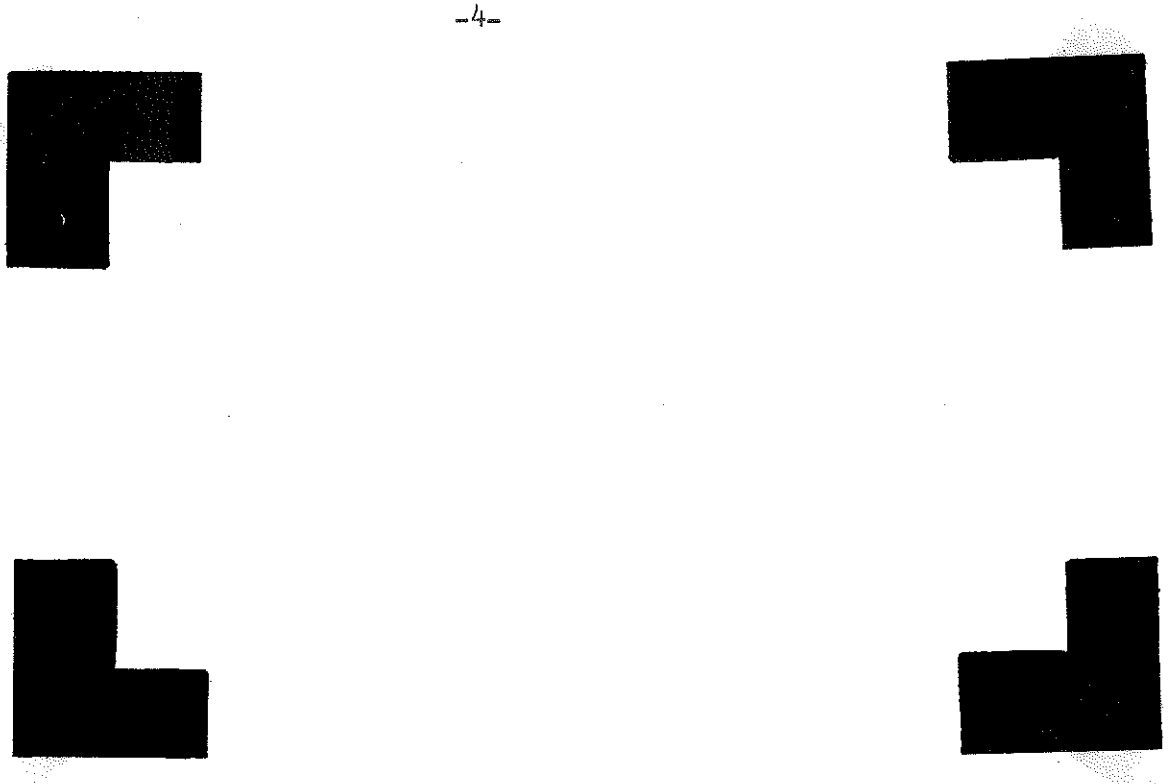


Fig 2. Slash burning on the Harvard Forest, showing the area ready for planting. Photographed by A. C. Cline.

ESTABLISHING A NEW CROP BY PLANTING.

As soon as the frost was out of the ground in April planting was begun. A mixture of white pine and white spruce in alternate rows with about an 8' by 8' (680 trees per acre) spacing was used. Large size, four year transplants were used in order to offset as far as possible the advantage gained by the hardwood sprouts on account of their rapid growth, and to reduce the costs of weeding. (Large, thrifty stock, if given timely help by weedings, can easily withstand the hardwood competition and make good growth from the start, whereas seedling (2 yr. old) stock is very difficult to bring along and the costs of the several weedings necessary to keep it "free to grow" are prohibitive.)

The Harvard Forest planting tool and planting basket were used. The white pine was planted first, in rows about sixteen feet apart, the trees being eight feet apart in the rows. Little importance was attached to having the spacing even and the rows straight. Rather the aim was to set the plants in the most favorable places away from hardwood stumps

and rocks. The spruce was then planted in rows between the white pines. A two man planting crew planted an average of eight hundred trees per day on the rocky, cut-over land.

Table III

Planting Costs per Acre.

Four year old (2-2) white pine and white spruce transplants. $ 10.00 per thousand. (680 to an acre.)	$ 6.80
Labor,-Two men at $ 4.00 per day. Two man crew planted at the rate of 800 trees per day.	$ 6.80
Supervision, transportation of men and stock, incidental expenses.	$ 1.50
Cost of Planting per Acre.	$ 15.10

THE CARE OF THE NEW CROP BY WEEDING.

Three years after planting the hardwood growth was several feet taller than the planted stock and a weeding was necessary in order to give the pine and spruce more light. In the spring, before the leaves were out, a machete was used to weed back all the hardwood growth. In this initial weeding one man covered an acre per day, with a total cost per acre, including supervision of $ 5.17.

Six years after planting a second weeding was necessary. By this time the plantation was about head high and much less time was required to weed it. As much hardwood as possible was left to help maintain a high density of stocking yet the pine and spruce were given sufficient room for unhampered growth during the next few years. An effort was made to so manage the hardwood in weeding that the young stand was kept dense, and at the same time the planted stock was "free to grow". On the second weeding, one man covered 1 1/2 acres per day with a total cost per acre of $ 2.83, supervision included.

Three years after the second weeding, the third was necessary because a few of the most vigorous hardwoods had to be topped back. This was a simple operation and cost only $ 75 an acre.

The total cost of the three weedings was $ 8.75 per acre with supervision included.

Table IV

Summary of Slash Burning, Planting and Weeding Costs per Acre.

Slash Burning	$ 7.00
Planting	15.10
Weeding	8.75
Total	$ 30.85

Subtracting the profits made on the sale of the cordwood thenet cost of establishing the plantation was $ 15.85. In this case the cost of establishing a plantation on cut-over land was the same as on an open field.

In the past it has been considered oftentimes financially impractical to establish plantations on cut-over land, it is being shown that with proper managementcordwood in many localities can be profitably converted to sawtimber stands, an such stands, owing to the presence of the hardwood will produce a better final crop than can be grown in plantations on open land. By the end of the rotation practically all hardwoods will have been eliminated and a stand of pure conifers will remain. The utilization of the hardwood element as "filler" has the following advantages,-

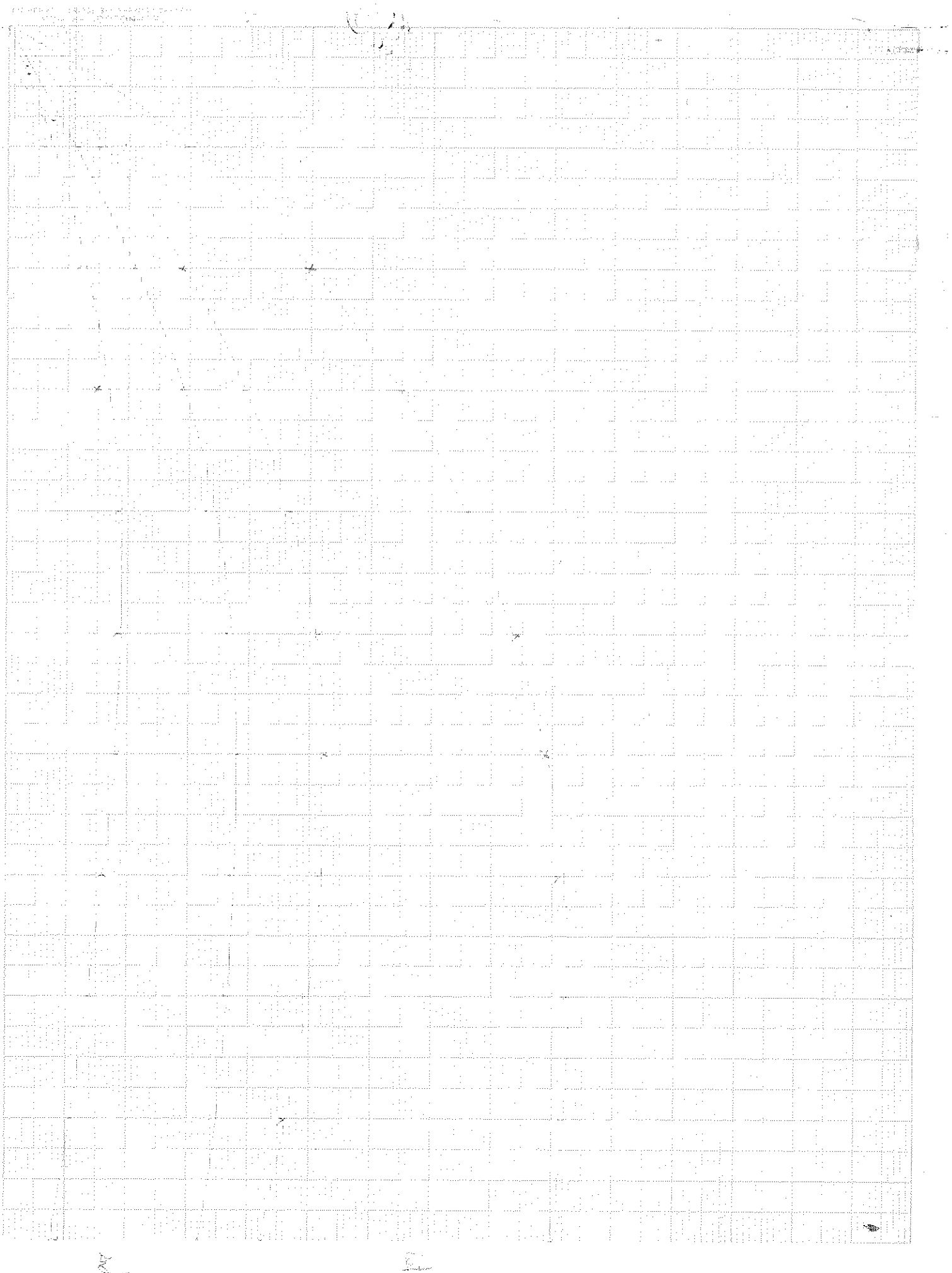
(1) Makes possible lower planting costs due to wide spacing.

(2) Gives greater protection from white pine weevil.

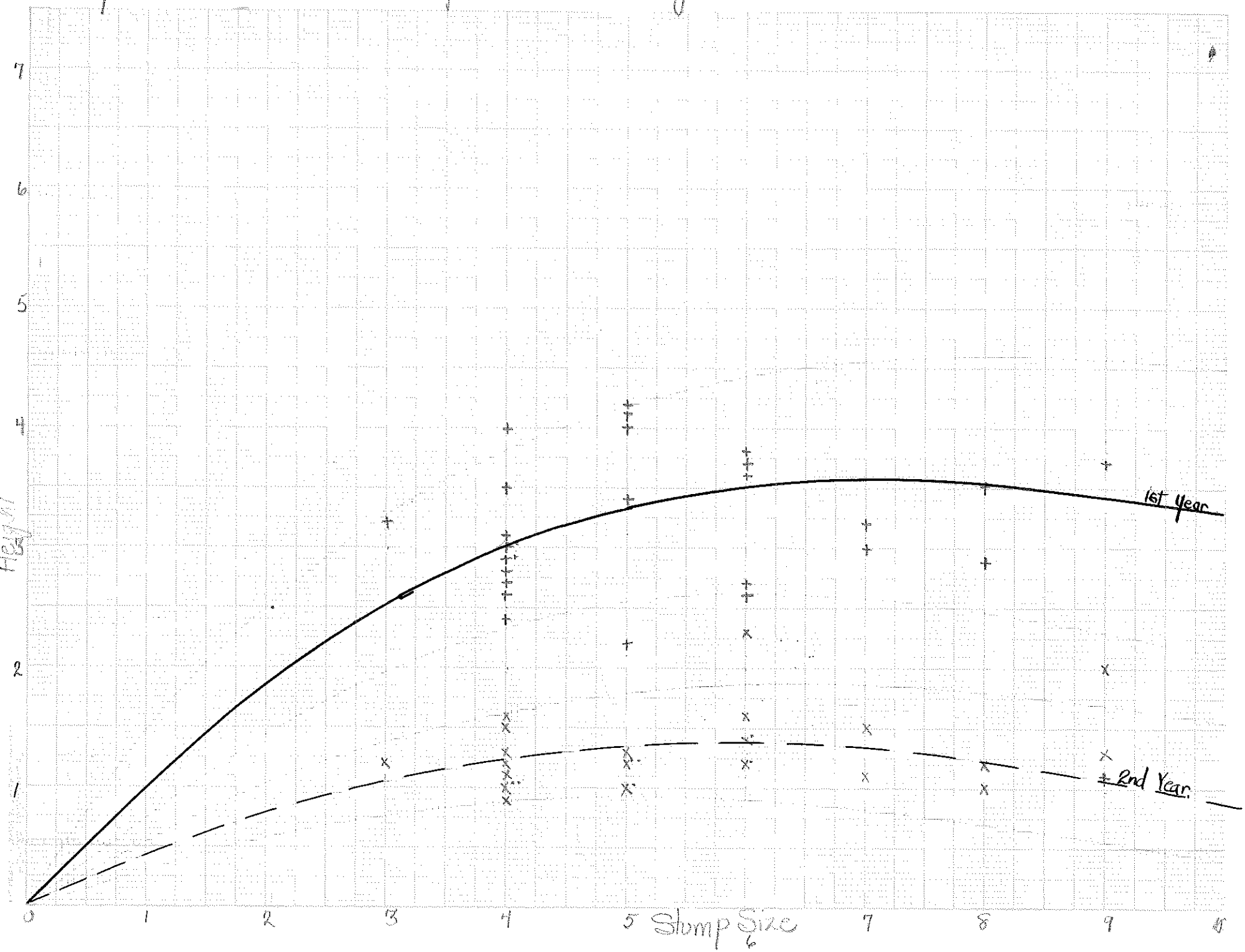
(3) Causes early natural pruning of the conifers.

(4) Maintains the soil fertility.

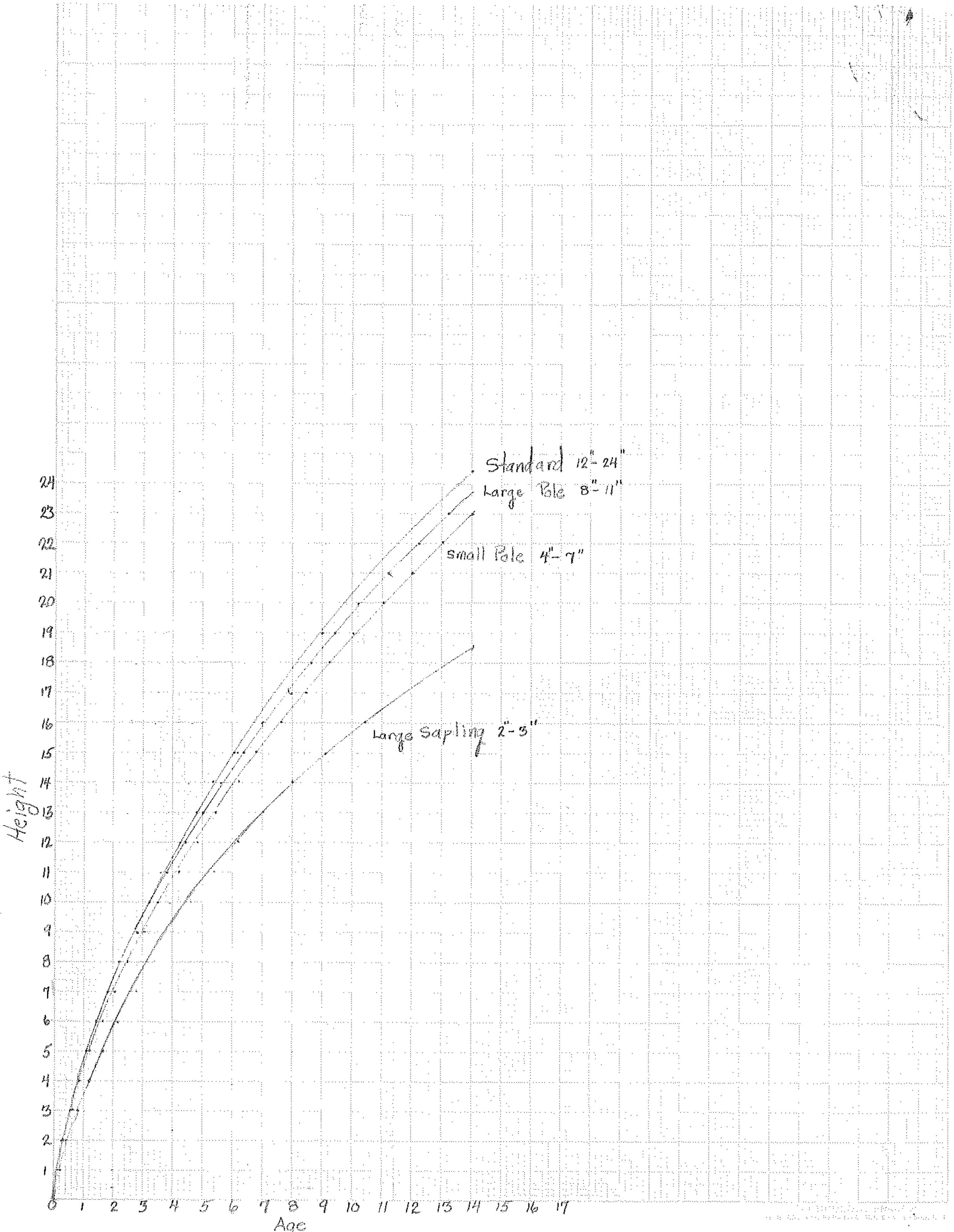
(5) Stimulates rapid growth of the conifers.



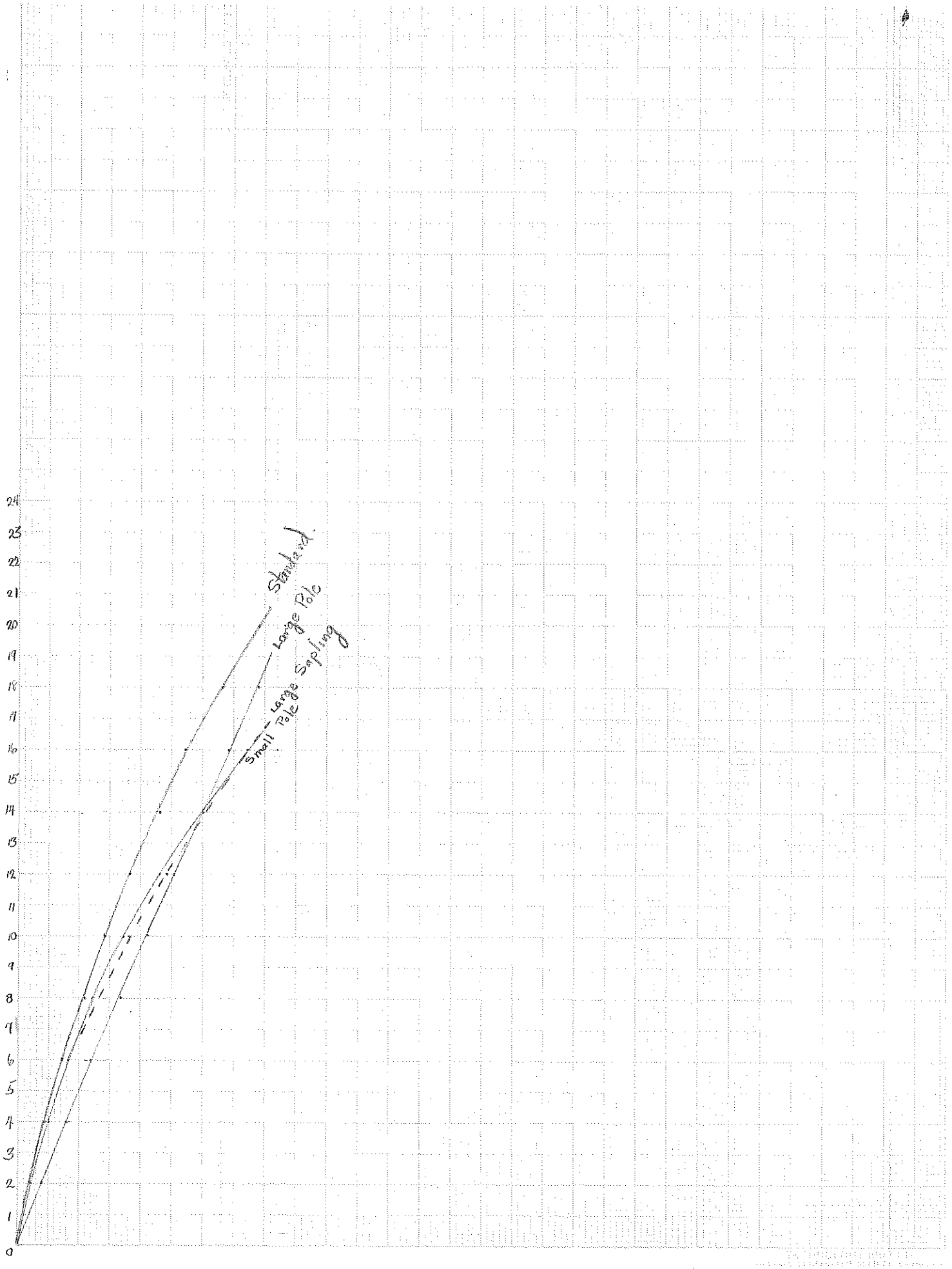
Gray Birch - Re-Growth after 1st cutting



Red Maple - Growth following cutting of the original stem.



White Ash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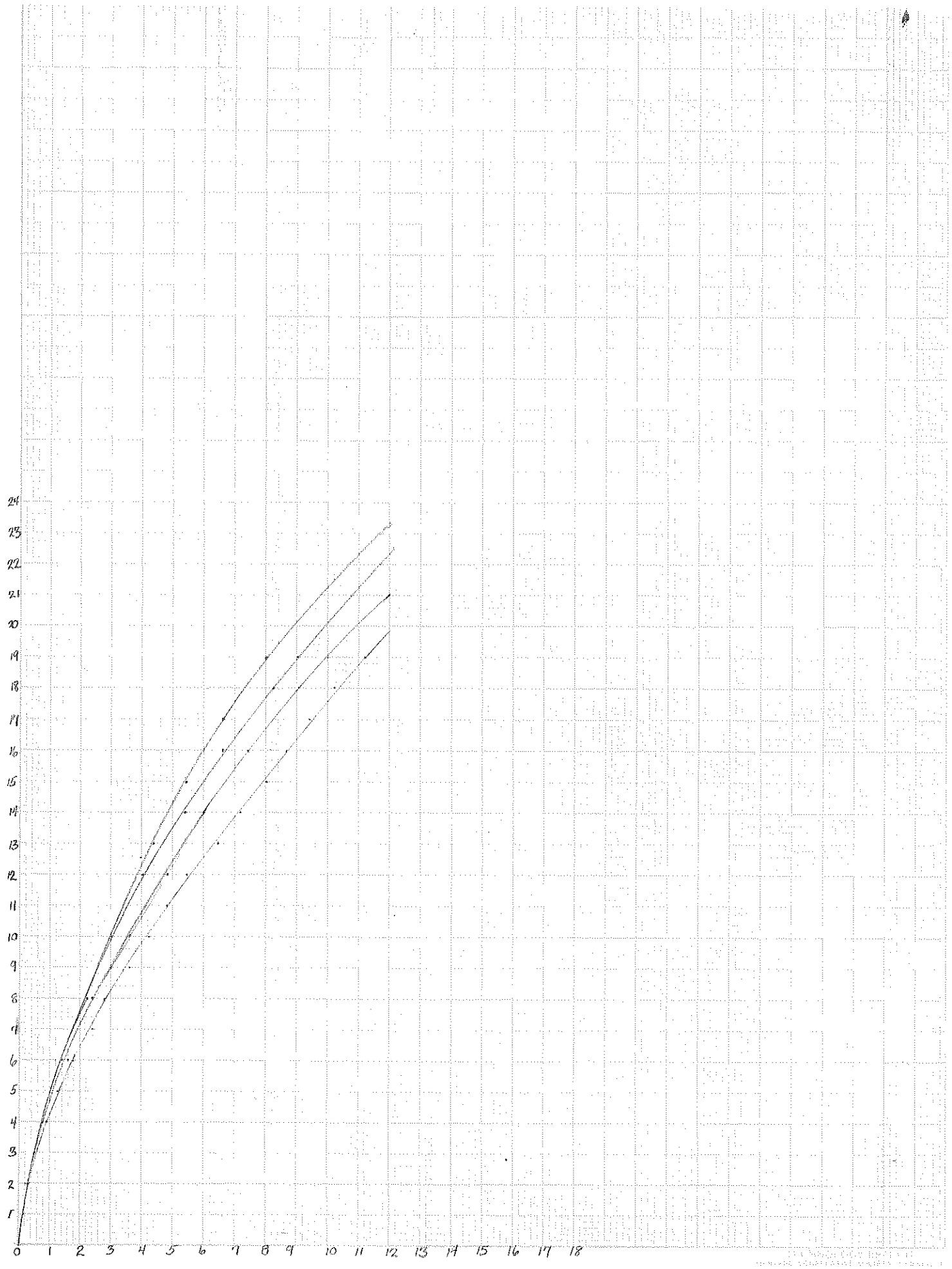
Small - Large Pole
Sapling

Red Oak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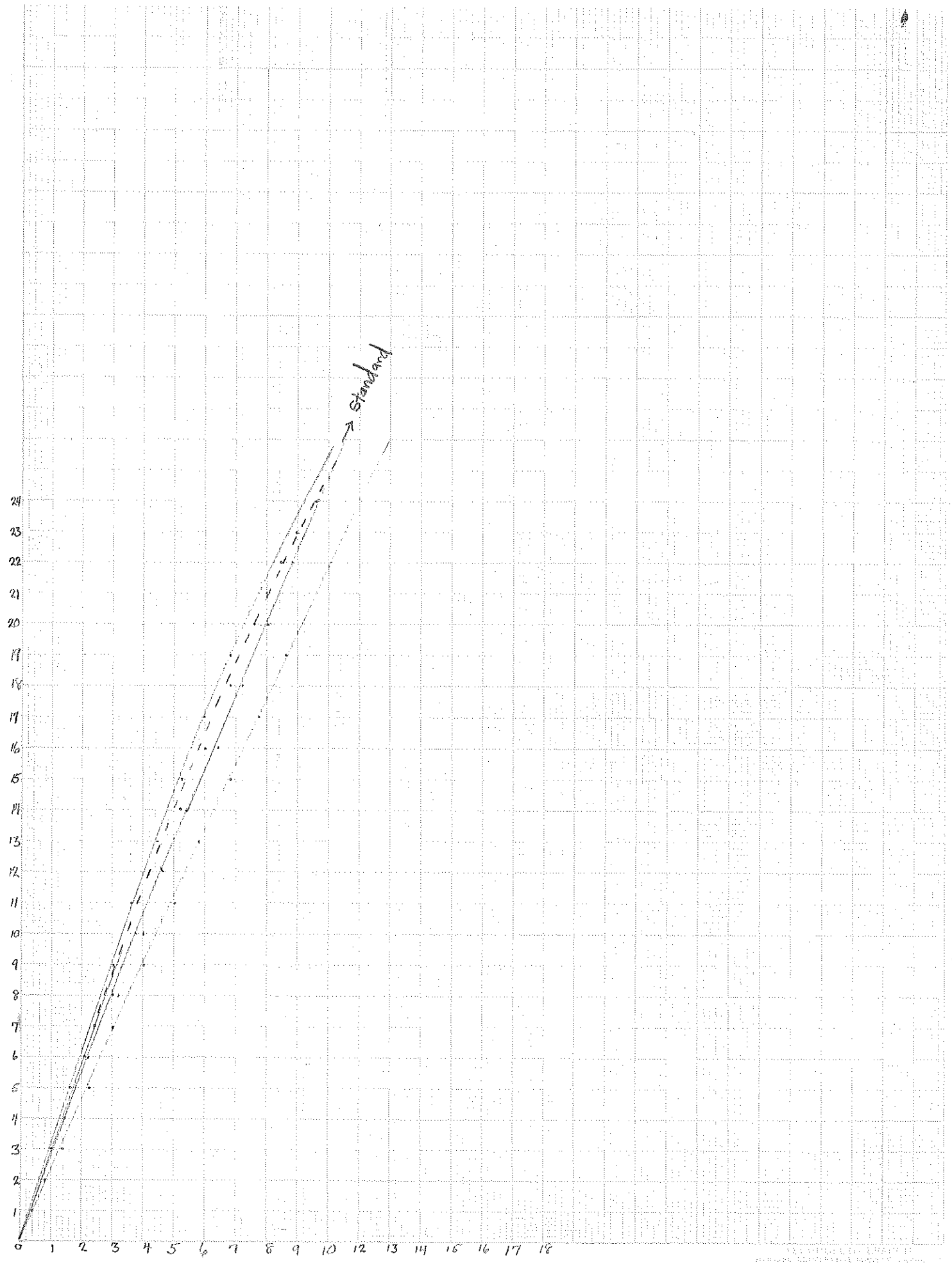
Paper Birch


Standard
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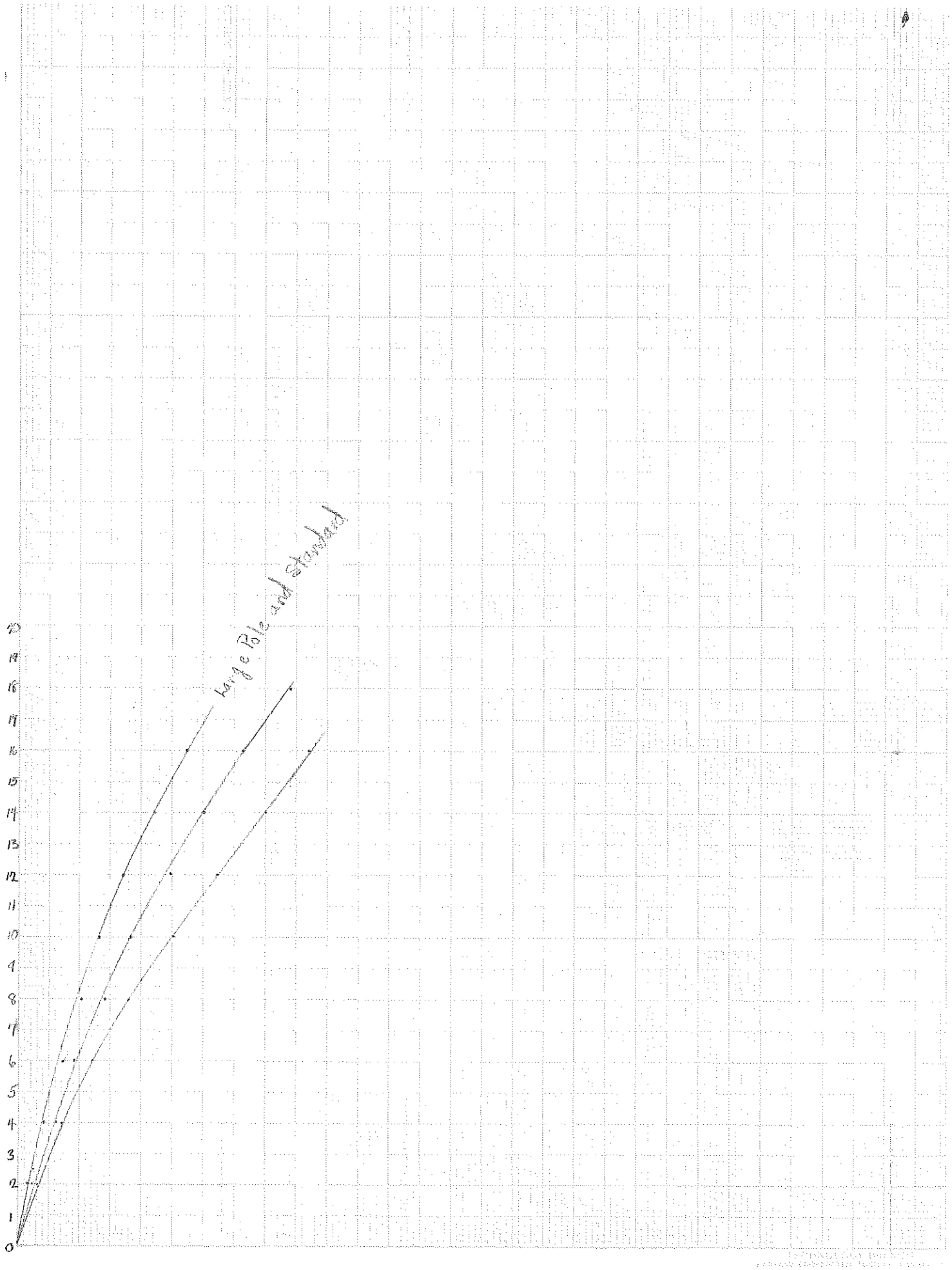
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Hard Maple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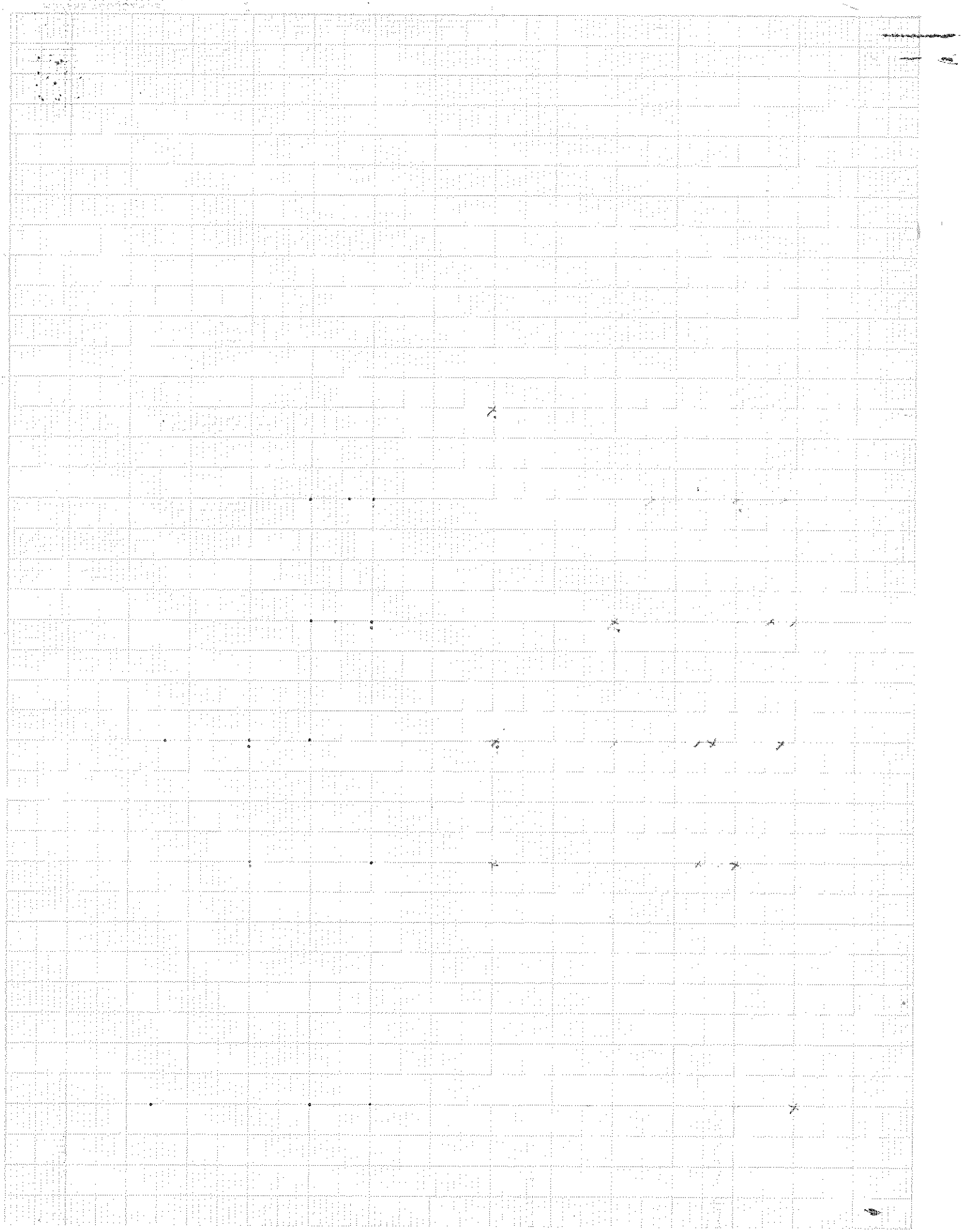

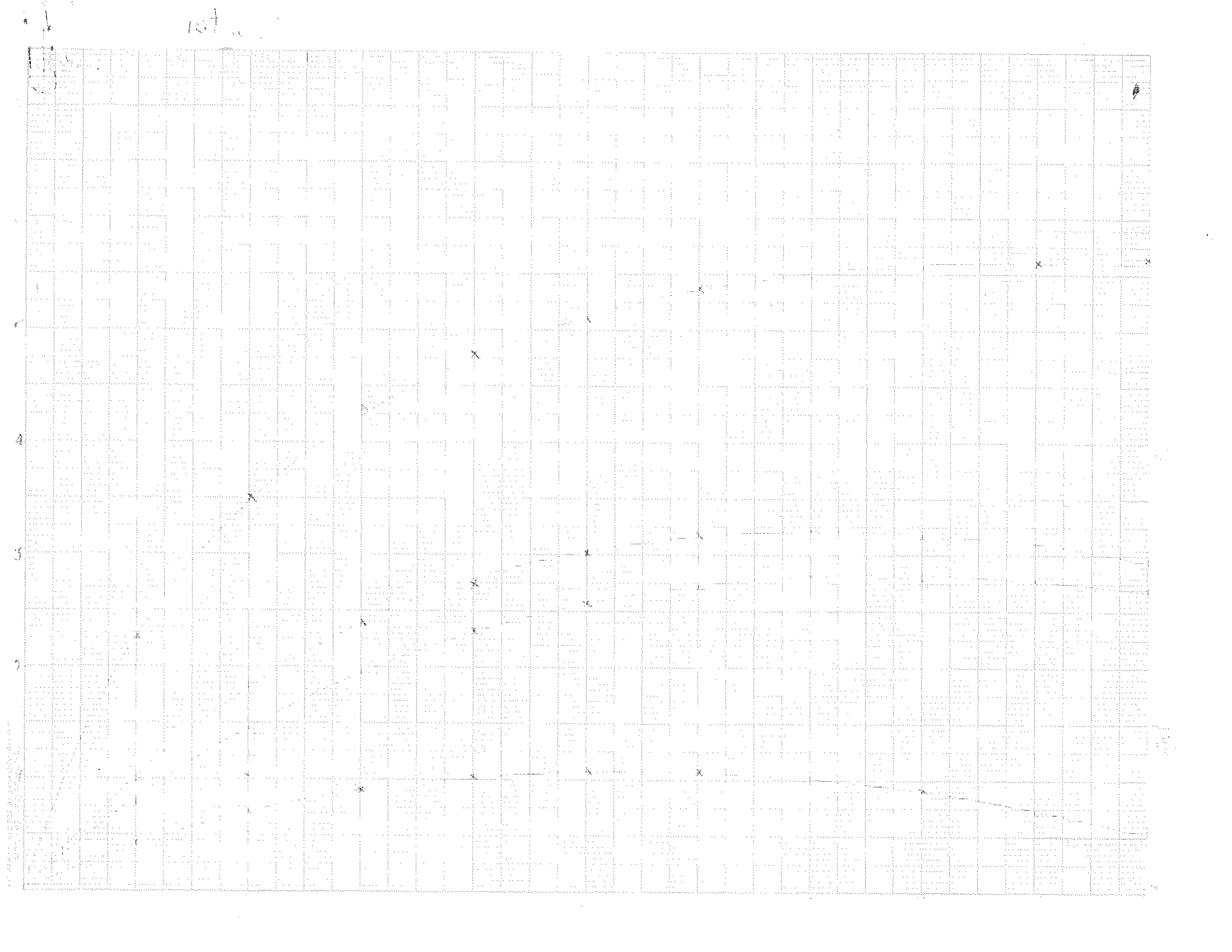

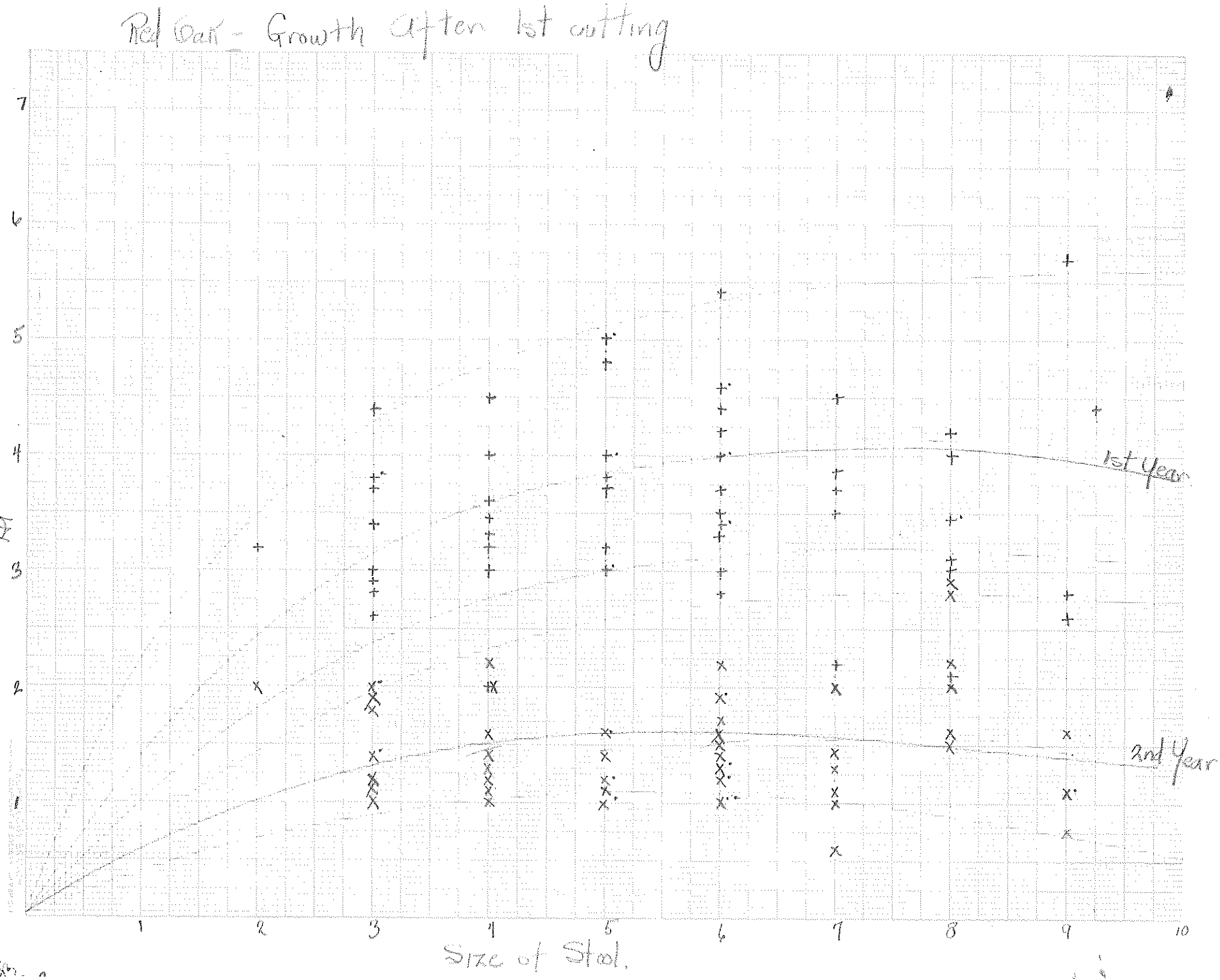
Red Oak - Growth after 1st cutting
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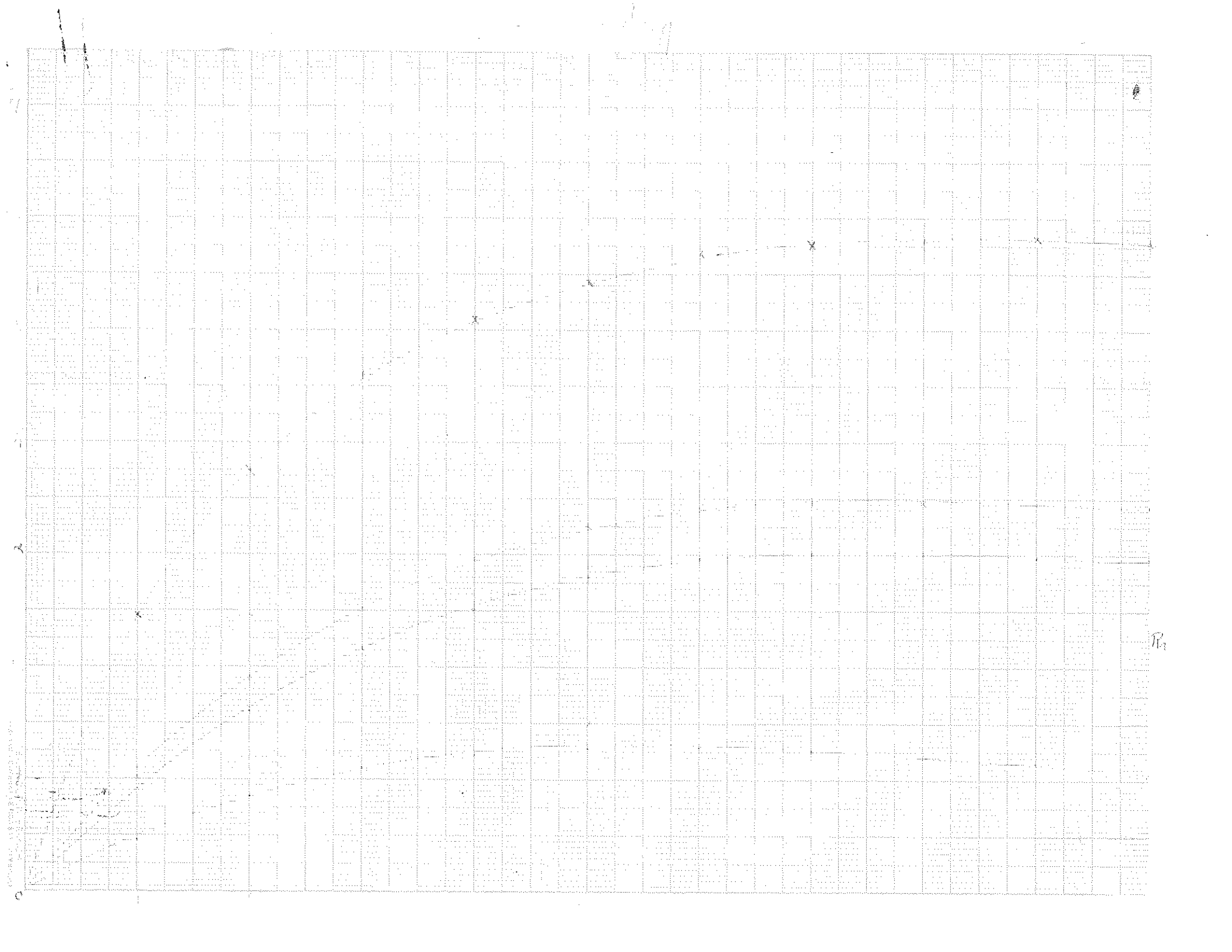
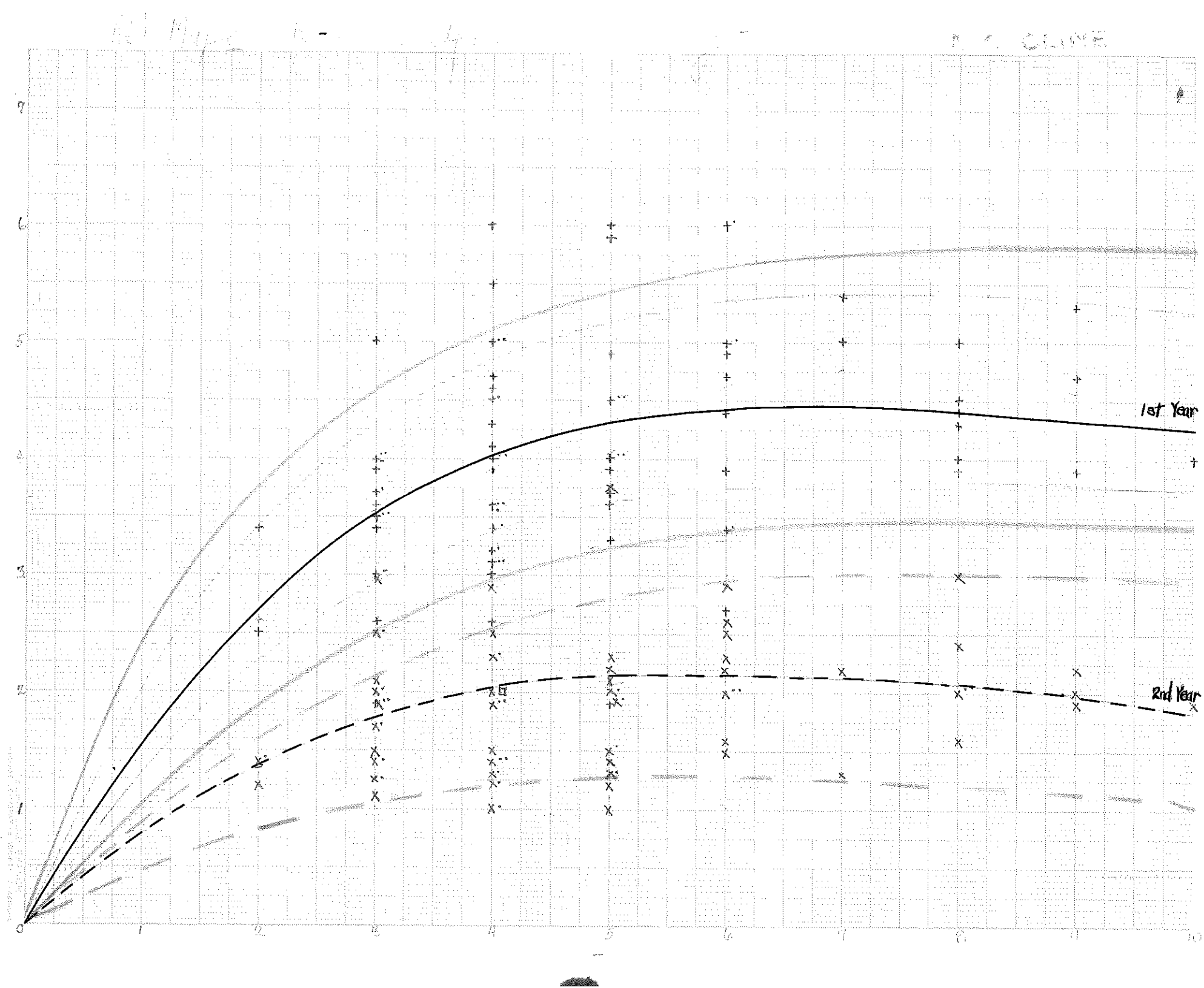
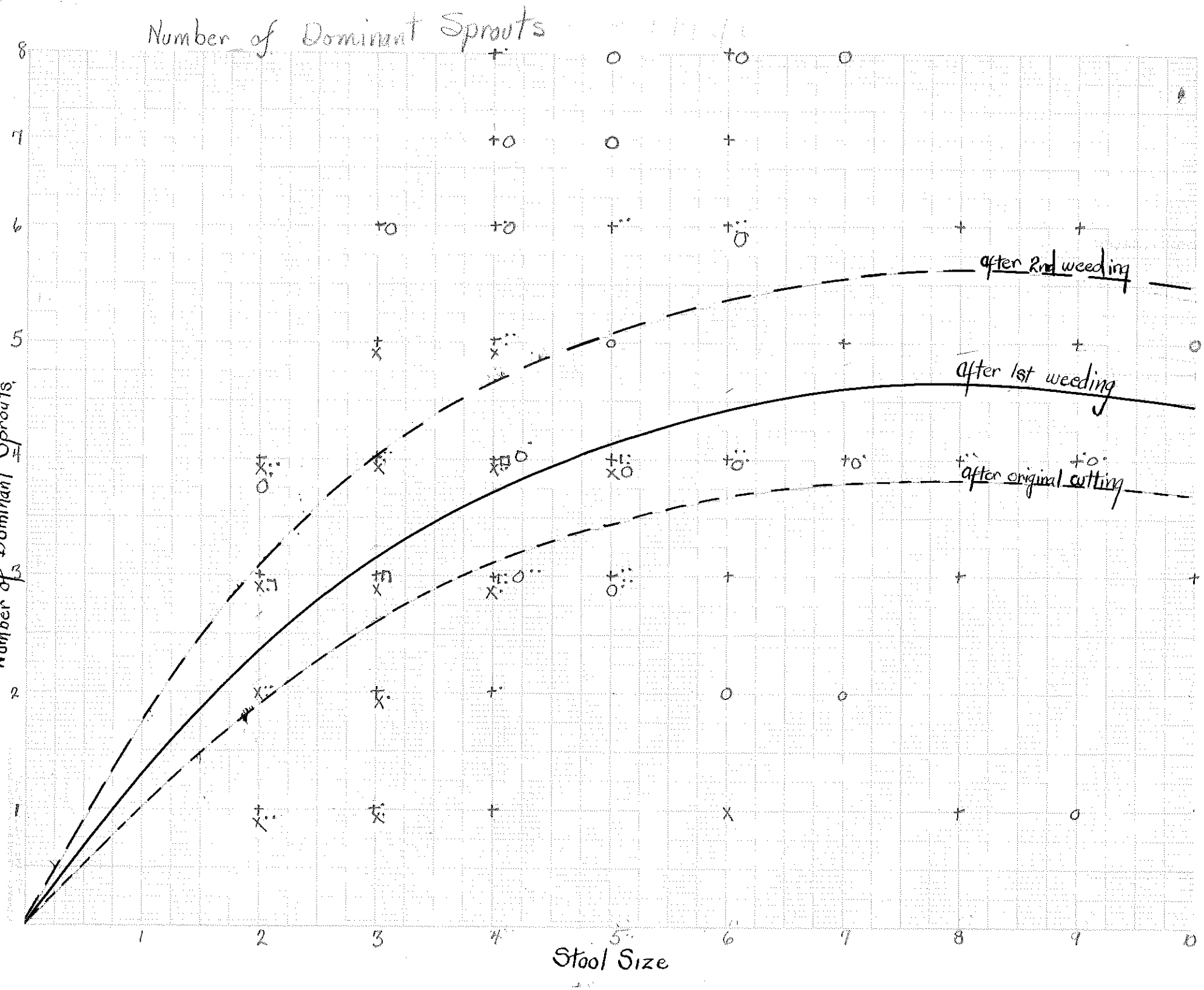



1st Year
2nd Year


Number of Dominant Sprouts
Number of Dominant Sprouts
Stool Size
after 2nd weeding
after 1st weeding
after original cutting
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