FOREST TREE NURSERYMEN'S MEETING

February 14, 1951

at the
U.S. Forest Service Regional Office
Post Office Building, Portland, Oregon

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Chairman Webster opened the meeting with roll call. Each member present responded with a brief description of the nursery or firm he represented.

Chairman Webster introduced Dr. L. C. Wheeting of Washington State College. Dr. Wheeting presented a paper on "Maintenance of Soil Fertility." He explained that fertilizer should be used as needed according to local conditions of the soil. Fit the fertilizer to the conditions of the soil and you will have a fairly good program for soil fertility.

MAINTENANCE OF SOIL FERTILITY IN NURSERY SOILS
by
Dr. L. C. Wheeting

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Most authorities agree that "at the present time fertilization of forest soils cannot be justified in America." This means fertilization of established stands of maturing trees. Authorities also agree that fertilization of forest tree nursery soils is generally a necessity. This is because of the high density of the stand, the complete removal of the whole plants, and the relatively high requirement for available nutrients by young trees. Young trees have a limited root system in comparison with old trees and, in dense plantings, each tree has but a small volume of soil from which to feed. In this respect, seedling trees resemble field crops, which, to thrive, require nutrients in a short time and in ample amounts. In mature stands, the time factor in supplying nutrients is not generally as important as other growth factors. Like the story of the Tennessee Mountaineer when asked - "But doesn't it take a long time to fatten your hogs by letting them hunt for acorns," replied - "Yes, but what is time to a hog?" Time is not important to an established tree, either. But it is important to a seedling.

Experimental results indicate a marked response to fertilization by seedlings. Data from the Wisconsin Forestry Station (Wilde) for Jack Pine grown three years in beds show a greater survival and a better height growth, averages being 78% survival and a 23-inch height when untreated and 88% survival and 29-inch height when fertilized. Jack Pine is said to have the lowest nutrient requirements of any of the conifers, and Douglas fir in this region may be expected to react even more definitely.

Nutrient Requirements

The requirements of trees for nutrients can be guessed at from the analyses of their ash. Calcium is generally the major constituent of ash and potassium is the next most abundant element. Appreciable quantities of phosphorus are also present. Magnesium, silica and iron are present in small amounts. Nitrogen in Scotch pine wood ranged from 0.12 to 0.16 percent, which is a little higher than the straw of cereals. In planning fertilization of nursery soils, it appears logical, then, to consider carefully the availability of nitrogen, phosphorus, potassium and calcium in the soil.

Cossett, Rindt and Gunning in the 1949 Yearbook - "Trees" - report that "It has been calculated that a crop of 2-year-old untransplanted white pine (at a density of 100 per square foot) removed 94.6 pounds of nitrogen, 31.8 pounds of phosphoric acid and 41.6 pounds of potash per acre." Normally the ratio of nitrogen to total organic matter in the soil is 1:20; thus the uptake by plants of roughly 95 pounds of nitrogen per acre would require the destruction of 1900 pounds of organic matter if all of the nitrogen released in decomposition is used by plants. Actually some will be lost by leaching during periods of heavy rainfall and it is likely then that well over one ton of soil organic matter disappeared per acre in the two years of the planting. The replacement of this organic material is one of the key points of soil management in nurseries. The simple replacement of one ton of undecomposed organic matter, like straw or litter, will not suffice since large amounts of carbon fraction is normally lost in humus formation. Cereal straw, for instance, which seldom contains more than 20 pounds of nitrogen per ton, when rotted to the humus form will shrink to about 400 pounds, because the ratio of nitrogen to total soil organic matter always ends up at 1:20. The legumes, such as alfalfa, with 50 pounds of nitrogen per ton, produce much more soil organic matter upon decomposition because the 50 pounds of nitrogen can make 1000 pounds of soil organic matter. Of course, the addition of nitrogen as an inorganic fertilizer to the cereal straws will also result in the formation of more soil organic matter. The key element which determines how much organic matter will be produced in the soil is nitrogen. The same element determines, to a large extent, what the yield of humus will be in composts. This nitrogen-carbon relationship is also worth considering in connection with the use of moss peats and sawdust as a source of organic matter because additions of nitrogen fertilizer are required to provide plants with enough available nitrogen until decomposition has proceeded far enough to release the nitrogen tied up by the decomposition process.

Wind River Nursery Studies

The Nursery and Experimental Forest is located in the Wind River Valley in the Cascade Mountains northwest of Carson, Washington, at an elevation of 1150 feet. Annual precipitation is extremely variable.

Climatic Conditions at Wind River, Washington

Year	Rainfall Total Annual Inches	Rainfall Departure from Normal	Month	Rainfall Average Distribution Inches	Mean Temps. °F	
1930	56.98	- 30.60	Jan.	14.37	Jan.	32.3
1931	96.06	+ 12.31	Feb.	10.98	Feb.	35.9
1932	96.83	+ 13.08	Mar.	10.20	Mar.	41.2
1933	135.92	+ 52.17	Apr.	6.24	Apr.	47.0
1934	99.19	+ 15.44	May	3.84	May	53.0
1935	62.91	- 20.84	June	2.08	June	59.4
1936	78.74	- 11.54	July	0.48	July	64.2
1937	112.53	+ 22.25	Aug.	1.02	Aug.	64.0
1938	74.75	- 15.53	Sept.	3.72	Sept.	57.2
1939	75.00	- 15.28	Oct.	7.28	Oct.	49.4
1940	88.14	- 2.14	Nov.	15.67	Nov.	40.6
1941	88.25	- 2.03	Dec.	14.40	Dec.	34.2
1942	97.11	+ 6.83	Year	90.28	Year	48.2
Average	90.28					

Mean annual temperature is 48.2 °F.

The soil is mapped as Martha loam and is well drained, brown in color and shotty. Pumice fragments are also present. Forest conditions prior to clearing of the nursery area have been described by Isaac in the 1949 Yearbook - "Trees."

In 1930, soil samples were taken on the nursery and sent to our laboratories for analysis and recommendations. Each succeeding year, including 1942, similar samples were examined. The organic matter content as determined by loss on ignition, the soil reaction (pH), and the fifth normal nitric acid soluble nutrients were determined. Nitrate nitrogen was determined during the last five years only. Following the first examinations, a program of green manuring combined with commercial fertilizer applications was started and modifications made in accordance with the analytical results. No data are available regarding the quality of the trees produced, but it may be assumed that satisfactory stock was produced or the nursery manager would have demanded changes.

Organic Matter

The accompanying chart I shows the average value for organic matter as related to the soil building and planting program. Since the entire area was not under the same cropping scheme in any one year, the chart has been set up to show land use on the horizontal and percentage organic matter on the vertical scale. Although the range in organic content is rather large, probably more than can be accounted for by the green manuring practices, there is a tendency for the organic matter to decrease during the time the transplants are in the ground. This leads to the conclusion that soil organic matter is rapidly broken down under nursery management conditions and regular replacements will be needed to maintain it at a satisfactory level and in an active form. Evidently this was accomplished at Wind River because the level at the end of twelve years was still high. The system

used was to plant spring oats immediately after the removal of the transplants. This crop was plowed down in the early autumn, and a mixture of winter oats and common vetch seeded. The following spring this too was plowed in and the land fallowed until time for setting transplants. In this way, two green manure crops could be added to the soil in one year. The system worked well, but there is a suggestion that decomposition was delayed through lack of moisture in dry years.

Fertilizers

The basic treatment consisted of 200 pounds of calcium nitrate, 400 pounds of superphosphate and 100 pounds of sulphate of potash per acre. This treatment was made when the spring oat crop was planted and again just prior to the plowing down of the winter oats and vetch crop. The fertilizers applied carried 32 pounds of nitrogen, 80 pounds of phosphoric acid and 50 pounds of potash in each basic treatment. Sometimes this was not enough and based on the analysis, larger amounts were recommended. When 600 pounds of superphosphate was added at one time, an immediate improvement was noted in the phosphate supply which lasted for about two years. Potash supplies were generally adequate, but twice during the period, 200 pounds were applied to raise the quantity to a higher level. The effect of nitrogen applications on available nitrogen for a limited period, as well as other changes in nutrient levels, are shown in Chart II.

Soil Reaction

The pH values ranged between 5.5 and 6.2 throughout the course of the study and appeared to be related in no way with the soil treatments. The nursery manager reported the use of aluminum sulphate and sulfuric acid on seedlings to control damping off, but the effect of these treatments was not noticeable in the regular pH determinations. Evidently the soil is well buffered and resists reaction changes. According to most authorities the pH range found at Wind River is wholly desirable for conifer seedlings.

Discussion

Some of the interpretations and reasons for the soil management system employed at Wind River will be worth considering in a general way. It was regarded as important that frequent additions of organic matter be made and since peat, sawdust, forest litter and the like were not available it appeared to be a better plan to resort to green manure crops. This was especially feasible because of the mild winters. The basic fertilizer treatment containing nitrogen supplied the amounts of this element that would be needed to effectively decompose the spring oat straw, and the vetch which had been inoculated with nitrifying bacteria, supplied the nitrogen for the decomposition of the winter oat-vetch green manure mixture. At the same time, leaching losses of the nutrients by the heavy winter rains were reduced to a minimum.

Soils containing shot pellets have the property of fixing large amounts of phosphorus in an insoluble form. This probably accounts for the need of such large amounts at Wind River. The young plants would be expected to remove not over 40 pounds of phosphoric acid per acre, which is about one-half that applied in the 400 pounds of superphosphate. Of course, some was tied up in the soil

organic matter in organic combination. By using calcium nitrate as the nitrogen carrier and ordinary superphosphate as the phosphorus carrier, relatively large amounts of available calcium were furnished. Since wood ash is so rich in calcium, this was regarded as a wise selection of fertilizers. Soils with reaction values of pH 5 to 6 are generally low in available calcium. By using sulphate of potash, both potash and sulphur was supplied. Judging by the results obtained, the program of soil management employed at Wind River was successful.

The question of the choice of commercial fertilizers for nursery soils is often raised and managers should consider individual fertilizers as well as price in making selections for use. Among the nitrogen carriers, for instance, nitrate of soda leaves an alkaline residue, sulphate of ammonia an acid residue. Choice between the two depends upon which way the grower wishes to change the soil reaction. Calcium cyanamid has an alkaline effect and during the first 12 days after application, is also a weed killer. Ammonium nitrate, either solid or liquid, is one of the best nitrogen carriers without effect on the soil reaction. Costs vary but should be compared if no special objective is involved. Present price for ammonium nitrate is $88.00 per ton, equal to $4.40 per 100. The material contains 33 percent nitrogen. Dividing $4.40 by 33 gives a price of 13.3 cents per pound of nitrogen. Sulphate of Ammonia is now selling for $73.00 per ton and contains 21 percent nitrogen. Dividing the cost of a 100-pound sack (3.65) by 21 gives a price for nitrogen in this material of 17.4 cents per pound. Unless one needs sulphur, as is often the case, the ammonium nitrate is the better buy.

With the phosphate carriers, similar conditions prevail. Treble superphosphate contains no gypsum and carries 43-45 percent phosphoric acid. Presently it costs $80.00 per ton or $4.00 per 100. Cost per pound of phosphoric acid is 9.3 cents. Ordinary superphosphate contains 50 percent gypsum and for legumes this material is often recommended as a sulphur carrier. But superphosphate contains only 18-20 percent phosphoric acid and costs $41.00 per ton. Dividing 20 into $2.05 (cost of 100 pounds of super), gives a value of a little over 10 cents per pound for phosphoric acid in this material. Even though the cost is more per pound, it would be cheaper to use superphosphate on legume stands than to buy both treble superphosphate and gypsum to do the job. When both nitrogen and phosphoric acid are needed, the ammonium phosphate fertilizers are usually preferable. Two forms are available, the 11-48 and the 16-20 combinations. There is not much choice between the sulphate and muriate of potash as to use or price, although the latter is generally in better supply and a little cheaper.

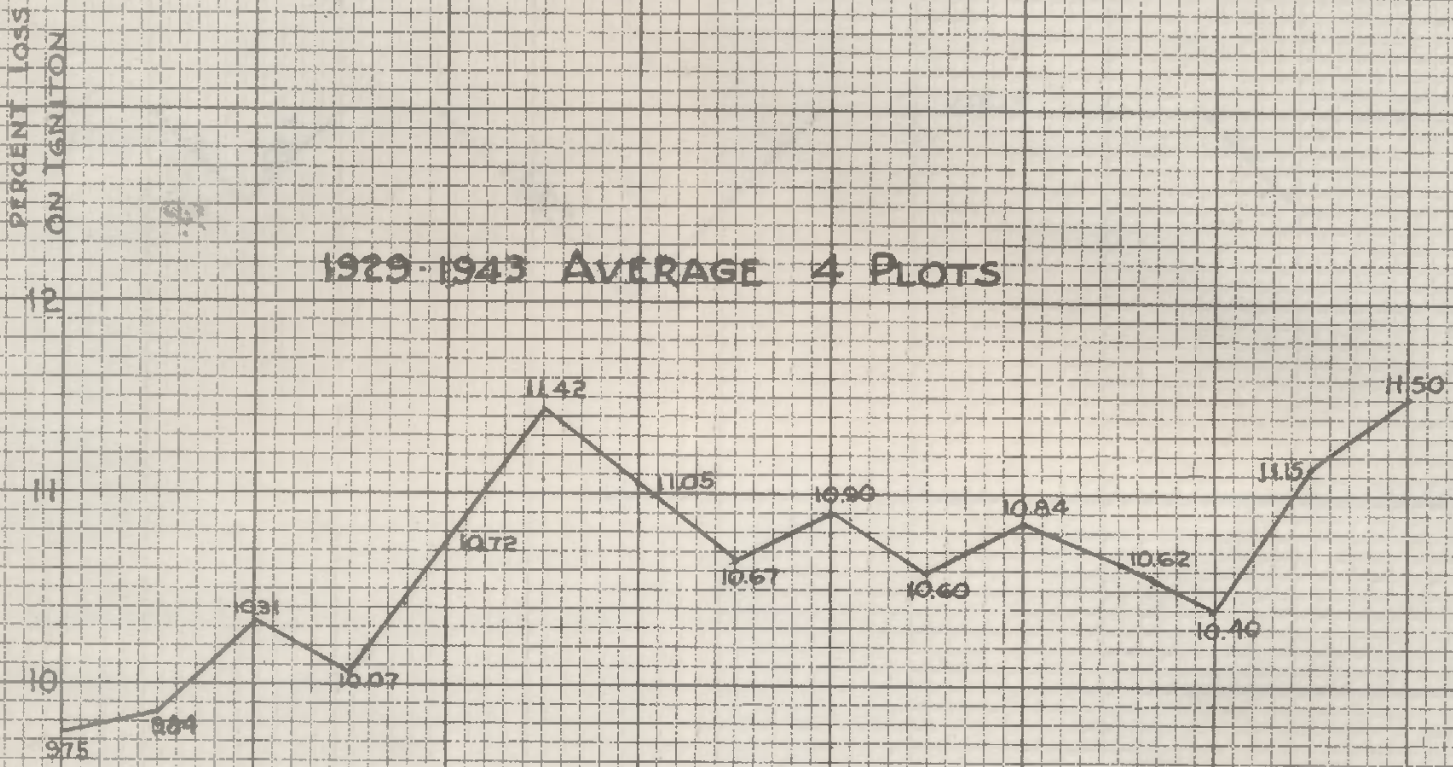
To summarize, nursery soils need fresh organic matter at frequent intervals and a program of fertilization to insure satisfactory growth. This can be accomplished by the usual methods, through wise selection and use of materials, and a consideration of local climatic and soil conditions.

Mr. Isaac: Dr. Wheeting emphasized the importance of calcium in tree growth. We have just received an analysis of western species. We find that Western red cedar or alder are particularly heavy in calcium. That may be important in planting progress where your soil is deficient in calcium. In deficient soils the growth stops in mid-summer which is the period that puts in the food for the next year's growth.

Mr. Augenstein: Does it make any difference whether the fertilizer is applied in liquid?

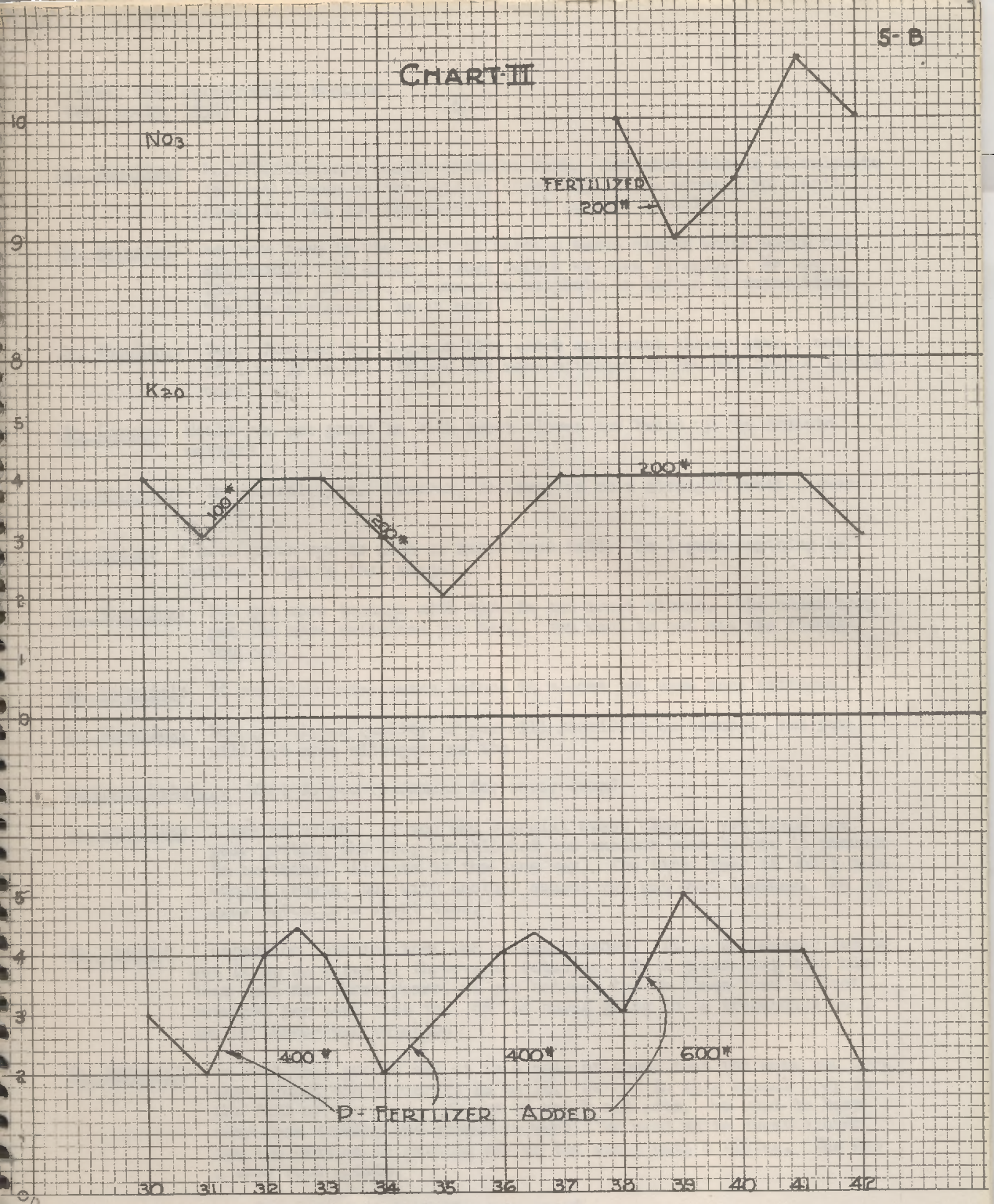
CHART I

1929-1943 AVERAGE 4 PLOTS



S - SEEDLINGS PLANTED AFTER PLOWING IN (O&Y)
T_1 - FIRST YEAR TRANSPLANTED
T_2 - SECOND YEAR TRANSPLANTED
T_0 - TRANSPLANTS HARVESTED: OATS SEEDED

CHART-III


NO3
FERTILIZER
200# →
K20
200#
400#
600#
400#
400#
600#
P - FERTILIZER ADDED
30
31
32
33
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Dr. Wheeting: Most fertilizers really dissolve fast. Ammonium nitrate of sulphate is just strewn on the soil at night and in the morning you can't find it. The dew dissolves it. It is very soluble.

Mr. McDaniel: We have been in the habit of raising sweet clover which works out splendidly. We knock it down before we plow it under. We use 150 pounds per acre of ammonium sulphate to hasten decomposition. That is advisable, is it not?

Dr. Wheeting: Yes. Most of the legumes like vetch and sweet clover have a ratio of 1 to 35 or 40. If you put more nitrogen in you may hold a little more.

Mr. Lemmon: Would you put grass in with sweet clover and build up the organic matter?

Dr. Wheeting: In general, yes. However, we never do on a straight sweet clover crop.

Mr. Wells: I have grown rye as much as seven feet tall. Do I gain anything by letting it go to that stage?

Dr. Wheeting: You get more tonnage with alfalfa and sweet clover. The older they get the more cellulose you have. You want to get all the tonnage you can.

Mr. McDaniel: If you plow under vetch before it blooms you have more nitrogen.

Dr. Wheeting: You get higher quality if you will sacrifice on tonnage, but you will get more nitrogen per ton.

Chairman Webster: What do you recommend for cover crop?

Dr. Wheeting: I prefer vetch. If you use biennial sweet clover, you spend one year getting the crop established and another year before it amounts to anything. Alfalfa is the same way. The first year it won't make enough growth, but with another season you get more tonnage. We can grow vetch in a short time.

Mr. Chapin: I depend on rotation that can be established. It is a one-year job to set it up on a two or three-year rotation. On a grass crop that has been left for three years, we put between two or three tons of root material per acre back in. So the humus going in is tremendous on a two or three-year rotation.

Mr. McDaniel: We work that ground and it is a rule of thumb that the more you work that ground the harder it is on it. We put in this annual crop in the fall of the year. We put in vetch and oats. We want to keep away from working the ground so much. We used white sweet clover. Now the problem is getting rid of the roots with a tiller. You get a stem root growth.

Chairman Webster: Do you put it back the same year?

Mr. McDaniel: The year after. We can crop to hold the soil on the hill.

Dr. Wright: Dr. Wheeting, the boys may have had in mind the timing on damping-off. When you have a high nitrate nitrogen, you get a heavy damping-off. If you have a green crop, you could turn it under and have a fairly ideal condition.

Dr. Wheeting: You could probably do that if it is a grassy crop. The buds are made of proteins. They are taking the nitrogen. They will slowly start dying off.

Chairman Webster: What are the grasses that you recommend putting in with your soil crop?

Mr. Chapin: We raise considerable grass seed. Alta fesque mixed with legume. We do not use vetch. We cannot raise sweet clover in Bellingham, but can use white clover. Our grass is left down about three years.

Dr. Wheeting: Yuban is a continuous crop. It is easy to plow. I like it, but I find no one else will recommend it. Seed is very difficult to get.

Mr. Augenstein: Does it produce a lot of nodules?

Dr. Wheeting: Yes. Yuban will be in bloom in three months. Ten weeks to three months, it would be up and beginning to bloom. It is good to handle and easy to get into the ground.

Mr. Deffenbacher: At Wind River our problems have changed. Our production has been stepped up and we do not have ground enough. We have not had good luck with spring cover crop. What do you recommend?

Dr. Wheeting: We had better talk that over privately.

Mr. Deffenbacher: We put in a cover crop the 20th of April. Our cover crop has been a failure. We can produce fall-sown vetch and oats of good quality, but we can't do it because of lack of space.

Chairman Webster: I want to ask about Rapidgro. It is advertised that one pound of Rapidgro is equal to 100 pounds of other fertilizer. Is this correct?

Dr. Wheeting: I did not know it could be that rich. Rapidgro is made up of pure salts. Most fertilizers are impure salts. I understand Rapidgro is a mixture of these pure salts and they get an absolute complete mixture of all the essential elements.

Chairman Webster: We are going to experiment with it.

Dr. Wheeting: It would dissolve right away. Whether it leaves or not will depend on the soil.

Chairman Webster: Is it necessary that we add organic matter to get by with the Rapidgro?

Dr. Wheeting: It is not absolutely necessary, but it is advisable for best results over the long pull to keep the soil in good fertile condition. If we start to take stuff out of the soil, we are going to have to keep organic matter in. I do not believe we will ever see the day when we do not need fresh organic matter in the soil.

Mr. Lemmon: You have to try to make up for the requirements of nature.

Mr. Stubbs: It is essential to try to maintain soil structure.

Dr. Wheeting: Organic matter is one of the good points.

Mr. Stubbs: You talk about tonnage of humus. Soil that is high in humus will be productive.

Dr. Wheeting: Yes, if it has water.

Mr. McDaniel: You can have all the cover crops you want, but if I can have access to barnyard manure, I prefer to use that.

Mr. Landquist: We have been keeping land productive in California. We have not had a chance to put in cover crops. We have been raising trees all the time. Would you say we should put in cover crops at the end of four years?

Dr. Wheeting: Yes. The chart shows that method does a pretty good job. However, we do not have to grow cover crops. Other methods for adding humus can be used. One of the common occurrences here is losing the first crop of alfalfa in the rain. Alfalfa hay that is old and spoiled, also straw, can be used. Peat may be used. Some is better than others. The moss peats take too much nitrogen to break them down. Sawdust again takes nitrogen.

Chairman Webster: You can get this very cheaply.

Dr. Wheeting: But you have to put some nitrogen with it.

Chairman Webster: Are we as well off to use sawdust?

Dr. Wheeting: If sawdust is used three to four inches thick on the ground, it requires 30 pounds of nitrogen per acre to keep the plants from turning yellow.

Mr. Gessel: At Pack Forest we do have to fertilize to get good results. We have several types of fertilizers. Then soil on top of that.

Mr. Landquist: Ithink it depends on soil conditions at your nursery whether to use sawdust or not. If you get a heavy soil, it may be good.

Mr. Augenstein: If sawdust is four years old or so, it may be decomposed already.

Dr. Wheeting: Commercial nurseries use an abundance of sawdust. But they need nitrogen with it. It will tie up nitrogen in the soil.

Mr. Landquist: You mentioned peat. In the Lake States in the thirties, we had emergency labor and we made compost. It was rather costly. We used peat as a medium and mixed the fertilizer. We put it in a compost pit using humus with it.

Dr. Wheeting: We have on the west side found that most peat is very hard to decompose. There is the fibrous peat from the sedges and the woody peat. The sedge peats are felty and take a long time to decompose. Same with the moss peats. You need a lot of nitrogen before you really get good luck with peat on forest land. Alders or legumes are high in calcium. Application of sawdust six inches deep and use about 80 pounds nitrogen per acre. Two or three hundred pounds ammonium sulphate, if taken with about twenty tons of sawdust. I think six inches is too much. But give the soil a chance to assimilate it and add more frequently if possible.

Mr. Stubbs: I can see the difficulty in trying to work in six inches of sawdust in the soil.

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Chairman Webster introduced Mr. Forrest W. Deffenbacher, Chief Nurseryman, Wind River Nursery, U.S. Forest Service, Carson, Washington. Mr. Deffenbached presented the following paper on "Storage of Planting Stock."

REFRIGERATED STORAGE OF CONIFEROUS SEEDLING STOCK

by

F. W. Deffenbacher

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The problem of keeping coniferous seedlings in good plantable condition from the time they are removed from the seed beds until they are planted at the planting site is not a new one to nursery and planting men. Of the many methods of storage tried, refrigerated storage appears to give the best results. It not only keeps the seedlings in good plantable condition; it also reduces the seasonal peak work loads in the nursery, because lifting operations can be carried on at a steady rate by a small crew. Refrigerated storage makes it possible to ship dormant stock whether it is ordered during the early spring planting season when the nursery is snowed in, or during the late spring season after growth has started. It reduces the heel-in job at the planting site, because trees can be stored at the nursery and shipped as needed in small quantities to the planting crews.

The cold storage of coniferous seedlings has brought up numerous questions. Some of the most important are:

1. What is the optimum temperature and humidity?

2. What is the best method of storage (bare-root, bundle, or crate)?

3. What is the maximum length of time different species can be stored under refrigeration and remain satisfactory planting stock?

4. What effect does cold storage have on mycorrhizal associations?