T H E S I S

on

NURSERY PRACTICE ON THE OREGON FOREST NURSERY

Submitted to the

OREGON STATE AGRICULTURAL COLLEGE

In partial fulfillment of
the requirements for the
Degree of

MASTER OF SCIENCE

by

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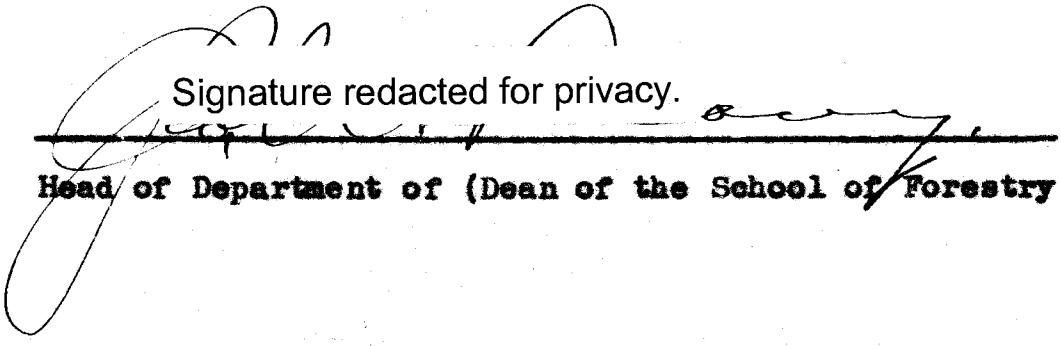
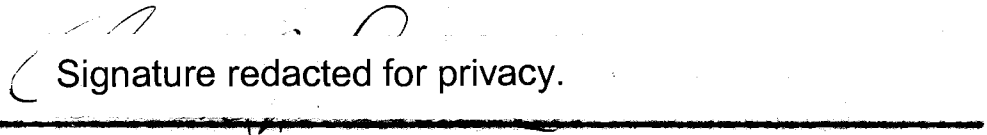
APPROVED:



Head of Department of (Dean of the School of Forestry



Chairman of Committee on Graduate Study.

INTRODUCTION

The State Forester was authorized by the State Board of Forestry to cooperate with the federal government in the establishment of a forest nursery in the spring of 1925. The terms of agreement were taken from Section IV of the Clarke-McNary Law. This section of the law authorizes the Secretary of Agriculture to cooperate with the states for the production of forest planting stock for the purpose of establishing woodlots, windbreaks, and shelterbelts. The cooperators have allotted $2000 each since the establishment of the nursery making a total of $4000, to carry on the work. Stock raised under the terms of Section IV can be used only for the stipulated purpose. However, this does not prevent the state from raising stock produced in the nursery for other purposes provided the cost is met from separate funds.

Oregon State College provided a site for the nursery on lands previously acquired for arboretum purposes. The location is seven miles north of Corvallis, near the west side highway. The Dean of the School of Forestry who is, ex-officio, a member of the State Board of Forestry was appointed supervisor of the nursery by the Board. As soon as a site was selected, a nurseryman was secured and work on the nursery commenced.

SITE FACTORS

The nursery soil is of two types. The lower ground or black soil is classed as Wapato and the upper land is

View showing growth that covered the nursery area. In the foreground are stumps that have been pulled and piled.

The small Kirston stump puller that was used in pulling stumps on the State Nursery.

Willamette.

Soil depths range from one and one half to five feet with a very heavy clay subsoil.

The slope averages about five per cent but runs from two to about eight on some slopes. The aspects of the nursery site vary from south to east.

The surroundings are very favorable for successful nursery practice. The site is bordered on the south, west, and north by higher slopes which tend to break bad storms and high winds. Tree growth practically surrounds the entire nursery. There seems to be just enough air ventilation to prevent the formation of a frost pocket. A strip of timber must be cut on the south side for proper soil drainage and light conditions.

The source of the water supply is two large springs three-eights of a mile north-west of the nursery. There is a fall of over two hundred (200) feet from the springs to the nursery, giving an adequate water pressure satisfactory for irrigation. The flow from the springs is very even throughout the year.

THE PREPARATION OF THE NURSERY GROUNDS

Owing to the fact that a heavy growth of Douglas fir and hardwoods covered the nursery site, considerable work and expense was involved in clearing the ground. Most of the timber had been cut for cordwood, but piles of logs, brush, tree tops and standing trees were left to be disposed of. The brush was slashed, trees cut down and every thing piled and

burned. The burning was carefully done so as to get rid of all of the debris possible. After burning, the area was hand raked to remove the small sticks and twigs.

Plowing the new land was a slow and painstaking task because of uneven places and hidden roots. All roots were chopped off below a depth of twelve inches. The area was repeatedly plowed, harrowed and disked in order to put the soil in proper condition.

THE PLANNING OF THE NURSERY GROUNDS

GROUND PLANS

The Oregon Forest Nursery is a hardwood and conifer nursery. Where feasible it is best to have the hardwood nursery separate from the conifer area. There are practically two distinct divisions. Each division is separated into compartments to facilitate the handling of the crop rotations, the planning of improvements, and record keeping. A complete record or history of each area is kept.

BUILDINGS

The number and type of buildings required to conduct nursery work depends upon the size, type, and location of the nursery. The Oregon Forest Nursery is located in a thickly settled farming district and only seven miles from Corvallis. The labor used at the nursery is mostly all local farmers. These men are good workers and can always be relied upon.

The buildings at the Oregon Forest nursery consist of three structures, a dwelling for the nurseryman, a

combination tool shed, work shop, and double garage, and a combination packing and machine shed for the storage of the nursery machinery. The demand for tree stock will determine the other buildings that should be erected on the nursery.

IRRIGATION AND DRAINAGE

A good irrigation system is one of the main requisites to successful nursery practice. Two important factors which must be considered in planning an irrigation system are: (1) the amount of available water during the drought period of the year, and (2) the future development and expansion of the nursery.

A gravity water system has been installed at the State nursery. The water head is three eights of a mile northwest of the nursery. The small stream coming from the springs runs through a twenty foot wooden trough into a sediment tank, 4' x 4' x 4'. The water then travels through a two inch galvanized pipe, twenty feet long, into a large, redwood water tank. This tank is ten feet wide and eight feet high with a capacity of four thousand gallons. The water is brought down to the nursery in an inch and one-half galvanized pipe.

The large pipe was buried one foot under ground. In the nursery the piping is put down at least fourteen inches. Twenty foot laterals were run from this large pipe at intervals of forty feet. The smaller piping is three-fourths inch in size. The remainder of the watering system is laid

on top of the ground with faucets attached every hundred feet.

Water is applied by a sprinkling system. Hose in fifty foot lengths, size five-eights of an inch are used. The sprinkler stands are four feet tall, equipped with Hartford sprinklers. A large main pipe is run on the top of the ground and this supplies the north nursery with water. Laterals are run down from it. All the three-quarter inch piping on the top of the ground is taken up and stored when the fall rains commence. The large pipe is disconnected and drained.

In cooperation with the State College a drainage plan for the nursery has been prepared and a great deal of progress has been made in putting the plan into effect. The lower nursery was tiled with a four inch tile, buried twenty-eight inches. A large six inch tile was laid in an old ditch channel at the west end of the nursery and the ditch filled in. These drains are giving good results. The soil conditions are much improved.

With the cooperation of the Oregon State College and County Agent, a large ditch six feet wide and four feet deep was shot along the western side of the nursery. The function of this ditch is to catch and carry away from the nursery the seepage and runoff water from the upper lands.

FENCING THE NURSERY

The fencing at the Oregon Forest Nursery is attractive

and durable, and will turn stock, dogs, and rabbits. The east or front side of the nursery is inclosed with a strong, decorative fence forty-two inches high. Douglas fir posts peeled and treated with a preservative are used. The posts are set ten feet apart. After the fence was built, the posts were painted. The remainder of the fencing will consist of posts similar to those on the front enclosure. The fencing is poultry wire, with a two inch mesh, thirty-six inches high. Two barb wires are put on the post above this mesh wire. This brings the fence to a total height of four feet. The fence rows are kept clean of weeds and trash.

THE SOIL MANAGEMENT PROBLEM

Building up the soil to its maximum production.

Every nursery has its particular problems in soil management. The soil should be kept in a good chemical and physical condition and its productivity must be maintained. The nurseryman must learn and know his nursery soil conditions. The best indicator of good soil conditions is the appearance of the nursery stock.

The history of forest nursery practice in older countries indicates that over a long period of time soil fertility cannot be maintained by the simple system of crop rotation and the use of the legume cover crops. It has been proved that either animal manures or commercial fertilizer, and possibly both, must be added to keep the soil up to its maximum productiveness.

Soil management at the State nursery is in its infancy. The present problem is to get the soil in a loose, friable condition and to maintain it in that shape. The virgin soil is very fertile and most of the stock is too large at the age of two years. Three year old stock is very large, requires extra labor to dig, bundle and heel-in, and is more expensive to ship.

The present land conditions allow only two rotations of land for nursery practice. That is, one rotation of land is planted to a tree crop and the other one is growing a green manure or cover crop, as vetch, oats or buckwheat. In June, this crop is plowed under, and the area lies in fallow until fall. If a spring planting of this area is deemed necessary, it is replowed late in the fall. The elements break down the soil particles and the ground is in excellent condition for a spring planting of trees.

The ideal soil rotation at this nursery will develop in the future. This will require three areas of land managed in the following manner: One piece of land will be devoted to growing trees, the second area will be planted to a fall sown green cover crop, and the third section will be in summer fallow. The fallow land should be plowed and worked several times during the summer and to be ready for the fall planting. Fall planting at the State nursery will probably develop to such an extent that the digging and shipping of the trees will be the principal work in the spring.

Due to the difficulties of getting stable manures and the great expense involved, it will be necessary to use green cover crops and commercial fertilizers for building up and maintaining the nursery soil fertility.

THE STORAGE OF SEED

The seed storage problem at the Oregon State Nursery has not yet been solved. At present most of the seed can be secured annually as needed. It is kept in large sheet metal cans in a cool, dry place over winter, when storage is required.

When fall planting is practiced, the seed probably will have to be purchased one year in advance of use. If this is done more care must be exercised in storage. The seed will need to be stored in a cool place with an even temperature. Glass containers seem to be the best containers. Charcoal kept in the bottles with the seed absorbs the excess moisture.

THE PRODUCTION OF NURSERY STOCK

SCOPE OF WORK

The Oregon Forest Nursery commenced its operations in September, 1925. In the spring of 1926, one and one-half acres of nursery ground was in condition for the growing of nursery trees. The inventory in the fall of 1926 showed 150,000 trees in the nursery with more than 60,000 seedlings and transplants ready for shipment. Since its establishment the nursery has developed until it is capable of producing

from 750,000 to 1,000,000 trees annually.

Many different species of trees are being raised in the nursery. The principal conifer species are western yellow pine (Pinus ponderosa), Scotch pine (Pinus sylvestris), Norway pine (P. resinosa), Austrian pine (P. Austrica), Douglas fir (Pseudotsuga taxifolia), Port Orford cedar (Chamaecyparis lawsoniania), western red cedar (Thuya plicata), Norway spruce (Picea excelsa). The principal hardwoods are black locust (Robinia pseudoacacia), Arizona green ash (Fraxinus velutina), eastern green ash (F. lanceolatta), box elder (Acer negundo), Chinese elm (Ulmus pumila), Russian olive and Russian mulberry (Morus alba).

The purpose of the nursery is to produce the tree stock best fitted to the various conditions in the State. In addition, many native and exotic species are being tried out, in order to discover, if possible, some tree particularly adapted to Oregon conditions. It is to be hoped that the farmers of the State will avail themselves of the service which the nursery is prepared to render.

SOURCE OF TREE SEED

All the tree seed is bought by the supervisor of the nursery, from various seed companies in the United States, Europe, and China.

DETERMINING THE VALUE OF TREE SEED

The number of seed per pound for all species of tree seed used varies immensely. Fresh seed is always used when ever

it can be obtained. In some cases, viability decreases rapidly with the age of the seed.

Germination tests of all seeds are made by the Oregon State College Seed Testing Department. Check tests are made by the cutting process and germination tests by the blotter method.

AMOUNT OF SEED TO SOW

The proper amount of seed to sow varies according to the size of the seed, the germination test and the density desired. Some nurserymen merely test the seed by the cutting method and sow according to what they have learned from experience. However, one must consider every factor in detail before the seed is sown. He must give the seed a correct germination test. He must consider the density in the seed beds and whether the stock is to be used for transplants, or as 1-0 stock. Fully twice as many seed can be sown in a given area if the seedlings are to be transplanted. The rodent and bird damage must not be overlooked. This source of damage is great, more seed must be sown per unit of area.

The amount of seed to sow per unit of area to obtain the desired density, may be obtained by the following formula.

$$P = \frac{A \times D}{G \times S \times Z}$$

P = Pounds.

A = Area in square feet.

D = Density of seed per square foot.

G = Germination percentage of seed shown by tests, expressed as a decimal fraction.

S = Number of seed per pound.

Z = Variable factors, such as, difference between green house test and seed bed germination, or some evenly distributed loss that may be expected which does not endanger the desired density.

Example: Determine the amount of yellow pine seed to sow in a four foot by twelve foot seed bed for a density of 2400 trees in the resulting stand (50 per square foot), with seed which runs 10,000 per pound and has a germination test of 50 percent.

$$P = \frac{48 \times 50}{.50 \times 10{,}000 \times .96} = \frac{2400}{4800} = \frac{1}{2} \; : \; P. = \frac{1}{2} \text{ pound}$$

The seed bed germination was .96 of the green house test.

SEEDLING PRODUCTION

SELECTION OF SUITABLE GROUND FOR CONIFER SEED BEDS

The raising of seedlings requires more care than the culture of transplants. The best ground should be chosen for the conifer seed bed area, and it should be cleaned of rocks, sticks, and debris. The seed bed ground should be close to the nurseryman's house in order that it can be under constant observation. The reason for this is that birds and rodents do less damage and the nurseryman does

Method of seed bed preparation showing the raking, tamping and sowing by the broadcast method.

not lose time in giving the area necessary attention.

PREPARING THE SEED BED GROUND

The seed bed area should be most carefully plowed and worked. Most of the seed sowing is done in the spring. After the June green cover crop has been plowed under the area should be cultivated during the summer, to keep it free of weeds. Late the next fall, with the exception of the ground to be used for fall-sown seed beds, the area should be plowed from ten to twelve inches deep and left all winter in this rough state. The soil, as a result, is in a fine, workable condition in the spring and as soon as weather permits, the spring seed beds are ready to be made.

ARRANGEMENT AND SIZE OF THE SEED BEDS

The seed bed area is planned according to the length of time the trees are left in the beds. If some species are to be left in the beds for two years, the beds are located along the side of each other next to the road where they will not be in the way of handling the remaining area. The usual practice is to leave the seedlings in the beds for only one year. All seed beds are four feet wide and vary in length from twelve to forty eight feet. The paths between the beds are two feet wide. This width gives ample space for a man to work.

MAKING THE SEED BEDS

In the beginning the beds and paths are marked by

stakes twenty-two inches long connected with heavy twine. All paths are kept free from cross strings.

After the beds have been marked off, the ground is very carefully raked to a depth of from two to four inches. All clods, sticks, and debris are raked into the paths and disposed of later. The beds are elevated about two inches above the path level which insures good drainage. Finally, the beds are smoothed off with a light board, four feet wide.

Care is taken to prepare only enough beds for the working crew to plant during the day. This is desirable because seed-bed making may be interrupted by several days of rain, necessitating reworking.

TIME OF SEEDING

The proper time to sow varies with the different species of seed. For example; western yellow pine germinates better with spring planting and western white pine gives a better germination if the seed is fall sown. Local conditions and species vary, hence a planting schedule has to be worked out in every locality.

Early spring sowing has been almost entirely followed at the Oregon Forest Nursery. Several conifers such as Port Orford cedar and Norway spruce seem to give better germination if sown in the fall. Fall sowing of all hardwood species and most all conifers appears to be desirable at the State Nursery.

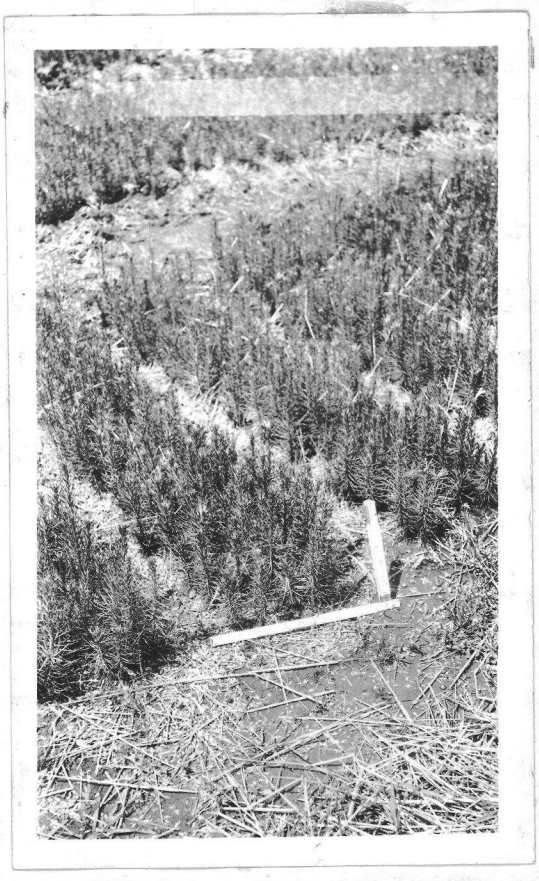
Douglas fir (1-0) stock raised by the drill method of seeding.

SEED SOWING

The first conifer seed bed sowing at the State Nursery was by the row or drill method. This method gave good results in both germination and the production of stock, but it requires more time to sow, to care for, and also more land than the broad cast method. When there is plenty of land and cheap labor, drilled sowing has the advantage over thickly sown beds. Drill sowing permits cultivation, requires less seed, and tends to induce a stronger root development. Damping-off can be better controlled, a vital factor in some nurseries.

A combination of the drill and broad cast method was practiced for one year at the Oregon Forest Nursery. This was called the band system. Bands varying in width from three and one-quarter inches to as wide as twelve inches were planted. There are possibilities that this band method will be used in the future for planting certain species.

Broad-cast seeding was also used at the nursery. The seed are broad-cast over the finished seed beds by an experienced nurseryman. In practice the sower walks along and sows the seed by hand. This method of sowing is now used entirely at the Oregon Forest Nursery. It is cheaper and works more towards simplicity in seed sowing. The method requires less ground per thousand trees, less weeding



Western yellow pine (1-0) stock raised by the band method of seeding.

and cultivations. It is the cheapest method, by far, when the transplanting of the seedlings is practiced.

The following table gives the average number of western yellow pine seedlings raised in a seed bed four feet wide and twenty-four feet long, for the different methods of planting discussed above.

	3½ inch band	3½ inch band	12 inch band	Broadcast bed
1.	90 seedlings to the band.	130 seedlings to the band.	300 seedlings to the band.	125 seedlings to the square foot for 96 square feet.
2.	56 bands to the 24 foot bed.	38 bands to the bed.	20 bands to the bed.	
3.	Total number of seedlings was 5040.	Total number of seedlings was 5940.	Total number of seedlings was 6000.	Total number of seedlings was 12,000.

The hardwood seeds are all sown in long bands the length of the land. These bands are four inches wide and vary in depth from one to four inches. A small garden tractor is used to make the rows. Two rows are made at one time. All bands are two feet apart allowing ample room for root growth and cultivation between the rows. The seed is sown by hand being broadcast lightly in the narrow bands. Future planting of hardwood seed will probably be done by a small garden planter. A double sower can be operated at the rear of the rear of the small garden tractor and it will be much faster than the operation of a hand machine or sowing the seed by hand.

View showing broadcast seed bed area of (1-0) conifer species.

After sowing, the conifer seed are pressed into the ground by small tampers made from one inch lumber twelve inches square. A handle four feet long is attached to the small square. This presses the seed into the ground and places it so that it does not bunch up or roll about when the sand is scattered. By using this method, there is a considerable saving of sand because the seed is just at the surface of the ground and is firmed into position.

COVERING THE SEED

After the seed is firmed into the ground the strings around the bed are removed. All coniferus seed beds are covered with a sharp-pointed, fine, sterile, clean sand. The depth of covering varies according to the size of the seed and the season of planting. Small seeds, as the cedar and others, are covered to a depth of one-quarter inch. Larger seed has a deeper covering of clean sand from three-eights to one half inch.

Fall planted seed beds are covered about one fourth inch deeper than spring sown beds. This deeper sowing compensates for the loss in sand cover when freezing weather tends to push the seed up during the cold months.

In covering the seed, the hand method is used. The men carry the sand to the beds by wheelbarrows. Some men can cover faster by using a round-pointed shovel, while others make better time by scattering it by hand from large buckets. This hand method is very inexpensive because of the small

Mulching the seed beds after they are sown and covered by sand.

number of coniferous seed beds planted. In larger operations it may be economical to use a machine to scatter the sand. After the scattered sand has dried on the top surface, it is smoothed off with a small, special-made, light board. This smoothing-off process makes the sand about even in depth.

Hardwood seed is covered with the soil pushed from the trenches made by the tractor rowers. The spring sown seed is covered to a depth of about one inch. Fall-sown or late winter-sown hardwood seed is covered two inches deep. Large seed as black walnut, oaks, etc. is covered from three to five inches deep.

CARE OF SEEDLINGS

MULCHING

After the seed beds have been covered with sand all conifer broadcast beds are covered with old burlap which can be bought at low cost. This material, without exception, is the best mulch for seed beds. It protects the planted seed from mice and birds, keeps the hard rains from washing the seed out of the ground, keeps down weed growth, prevents the frosts from heaving out the seed, and allows warmth and sunshine to start germination in the newly planted seed. Roller shade frames are carefully put on top of the burlap so that high winds can not blow it from the beds.

Winter-mulching of seedlings is sometimes necessary

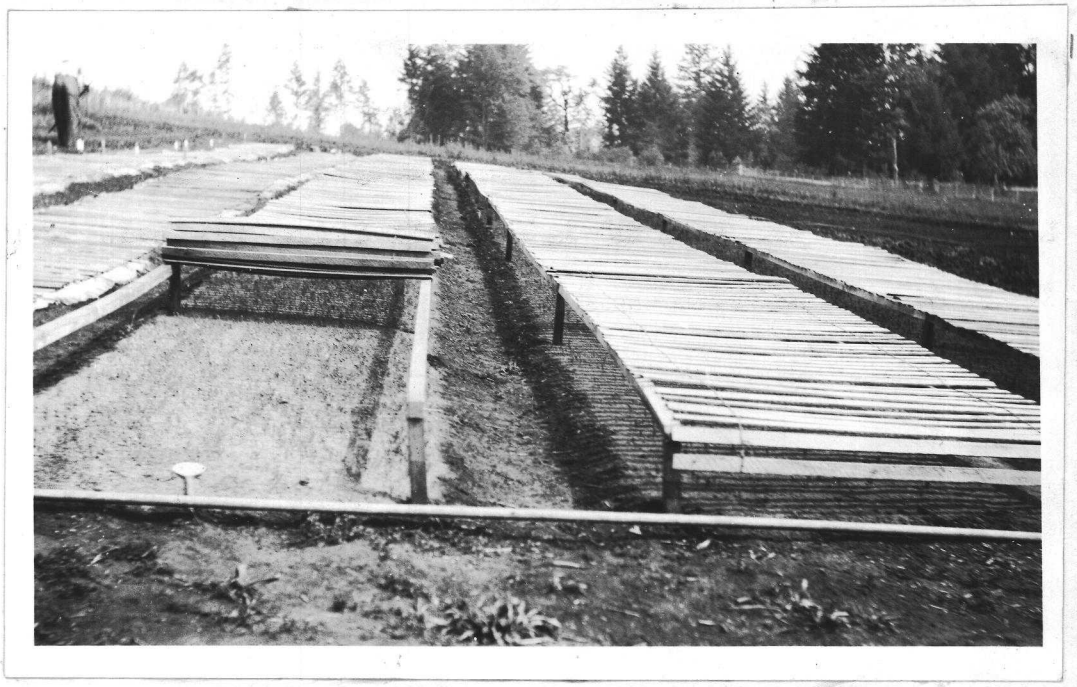
when there is a late spring germination and the seedlings are very small with a shallow root system. The beds are lightly covered with very clean spring barley or oat straw.

WATERING

The newly planted spring-sown beds need special care. They should be sprinkled by nozzle or by very fine spray sprinklers. The water readily passes through the burlap and moistens the beds below. The burlap tends to prevent the force of the water or of hard rains from disturbing the small seeds.

The burlap is removed from the beds when at least twenty per cent of the seed has germinated. The moisture conditions are watched very carefully. Care must be exercised not to water the beds too heavily because damping-off may be encouraged. In dry weather, all beds are usually sprinkled by hand every day. They are given just enough water in the evening to keep the sand covering moist.

The hardwood seed beds or seed rows are watered with the fine-spray, sprinklers every few days. The ground is kept moist until the seeds have germinated and the trees are well rooted, when the watering periods are set farther apart. In late summer, the seedlings are not watered giving them time to harden off before cold weather.



The roller shade frame mounted on the tracks.
Note small pine seedlings on left seed bed.

SHADING

All spring planted coniferous seed beds, except western yellow pine, are shaded. Shading protects the tiny seedlings against light frosts, tends to regulate the moisture conditions, and protects the tender cotyledons against sun injury. A roller type of lath shade frame is used. The frame is constructed by fastening lath, allowing fifty per cent shade, to a small galvanized wire (gauge #14) with a three-quarter inch galvanized fence wire staple. The staples are clinched into the lath which holds them in position. All frames are twelve and one-half feet long. This kind of shade frame is easily handled by one man, can be moved quickly, requires small storage space, and with little repairing will give service from five to ten years. The shade frames are raised above the beds from ten to twelve inches. A track made of two by two inch lumber twelve feet long, nailed to two by two inch stakes, supports the frames.

SEED-BED FRAME PROTECTION

Seed-bed frames were used the first year. This construction has been found to be unnecessary work and expensive. It may become necessary to use a screened protection for some pine fall-sown seed beds, to prevent mice damage. Mice will, however, work under burlap protection at certain times.

GERMINATION PERIOD OF SEEDS

There is a great variation of time between the germination of tree seeds. Western red cedar and western yellow pine start germinating ten days after sowing in the spring, and in thirty days the germination is complete. Black locust germinates very readily when soaked in hot water, 190 degrees F., from sixteen to twenty-four hours. Western white pine and Norway spruce are very slow to germinate and should be fall-sown.

WEEDING

All of the coniferous seed beds must be weeded by hand. Small weeds are pulled by the fingers but larger weeds must be cut out with a knife. They should be cut below the root collar, otherwise they sprout back and are more difficult to remove. From three to five weedings during the summer are required. Paths and bed edges are cared for with hand hoes and a small garden tractor. The hardwood seedlings, or seed bed rows, are cultivated between the rows by the tractor cultivator and the weeds are pulled from the tree rows with the fingers.

CULTIVATION

The conifer drilled seed beds have received from three to five cultivations every year. The broadcast beds have received no cultivation except when the ground is partly stirred by removing the weeds from the wide beds. More water is therefore needed when cultivation of the

ground cannot be practiced.

All hardwood species are cultivated at least once every week between the rows, usually after each watering. This method stirs the recently watered ground and helps to retain the soil moisture.

CARE OF (2-0) SEEDLINGS

The seedlings that are left over in the seed bed for the second year require little care. No shading or mulching is needed for this (2-0) stock. Very few waterings are required because the stock will get too large if it is watered excessively. Weeding gives very little trouble and the possible enemies are insects and rodents.

Band sown conifer seedlings, (1-0) stock, can be root-pruned with the spade. Very good field planting stock was obtained by this method. There is a great opportunity for this kind of practice in small nurseries.

All hardwood (1-0) seedlings left over for another year in the seed rows are root-pruned with the spade. This operation is justified because a sturdier, shorter tree is obtained than had it not been root-pruned. These trees have a large fibrous root system. No machines have been used to root-prune left-over stock, but it is hoped that a machine can be designed to do this work quicker, cheaper and in a more satisfactory way.

TRANSPLANTING

The transplanting of conifers is the most expensive

operation. In spite of the cost involved, transplanting is considered advisable with practically all species of conifers.

The several advantages of transplanting are listed as follows:

(a) The transplanting allows a wider growing space for each tree, permitting it to produce a strong, sturdy, well-developed root and top growth. It permits the pruning of the roots to the length desired, an operation which stimulates dichotomons branching.

(b) Transplanting checks the long and slender root development and tends to build up a very dense, fibrous root system through the formation of short rootlets.

(c) Transplanted stock cheapens the cost of field planting by producing a root system which makes it possible to place roots in the planting hole in a natural position and tends to lessen the labor of the field planting operation.

SEASON FOR TRANSPLANTING

Usually seedlings are transplanted in early spring or late fall when they are dormant. At the State Nursery, spring transplanting has been generally practiced. Plans are being made to shift the transplanting operation to the fall. Fall transplant beds probably will have to be mulched but this operation will involve little expense. If the transplant beds are not mulched, there is a possibility

of frost heaving during freezing weather.

Transplanting may be carried on at any time the soil can be worked, even during the summer. If carried on during this time of the year it will require more care in protecting the small seedlings from the hot sun and drying winds. The additional expense involved brings disfavor to transplanting trees during the midsummer season.

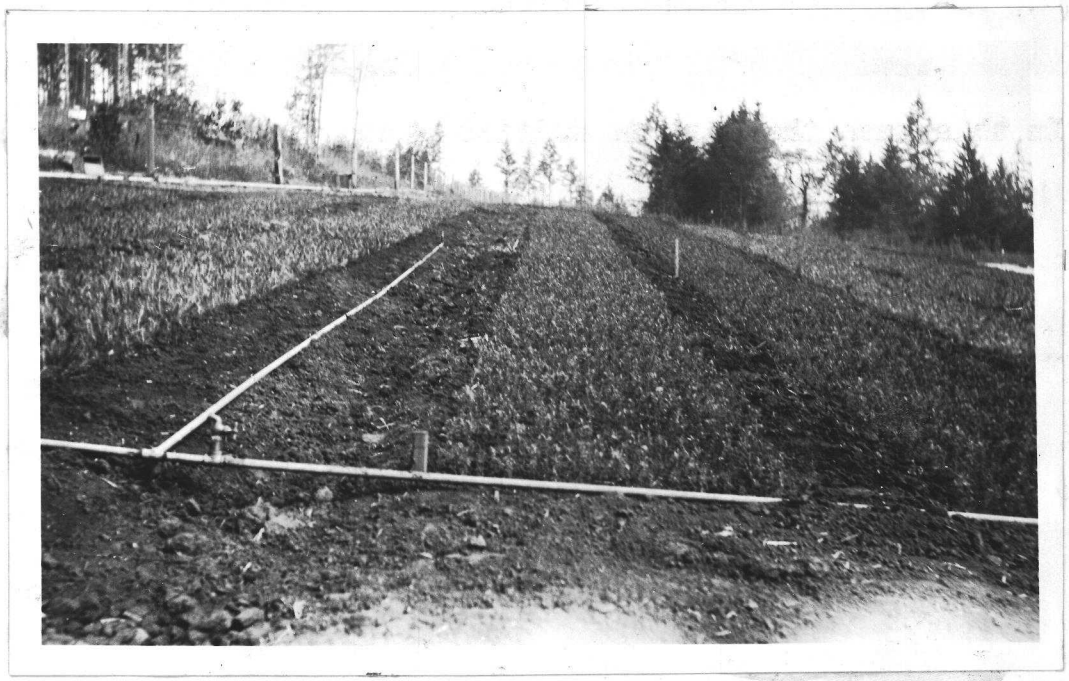
The transplanting operation lasts from four to six days due to the fact that there are only from 150,000 to 200,000 conifer seedlings transplanted each year. The work is done in the early spring, as soon as the soil is in a friable condition.

SELECTION OF THE TRANSPLANT AREA

The conifer species are all transplanted on the higher, well-drained lands. The transplants attain a large size with good root and top-development on these locations and digging is expedited in the early spring and winter months because of this location. During open winters, transplants are dug and trees shipped to those who have already placed their orders. The lands are laid off in rectangular shapes. This arrangement facilitates transplanting and other operations. The transplant beds are arranged to coincide with the watering system.

PREPARATION OF THE GROUND

For spring transplanting, the area is plowed in the late fall and the ground is left in the rough stage in the



Beds of recently transplanted conifers.

winter months. During the winter, the elements break down the soil particles thus reducing it to a friable condition when dry enough to work. If the winter has been severe enough to weather down the large particles of soil, a team is not used to condition the area for the transplant crew. In this case the land is cultivated and the clods mashed by the small garden tractor operated by one man. The weight of the machine and a man walking is not great enough to pack the soil as a team or heavy machinery would. After the area has been worked one or more times, it is ready for the transplant crew.

LIFTING AND PREPARING SEEDLINGS FOR TRANSPLANTING

The spade method of lifting seedlings is used. Expensive mechanical lifters could be used but are not justifiable, due to the small number of conifers transplanted. A commercial tree digger pulled by one horse and handled by one man has been acquired and will be used in the future. It is expected that this lifter will reduce the cost of operations.

The best results in transplanting can be attained if the lifted seedlings are immediately transplanted. It is sometimes quite impossible to carry on these two operations at the same time, especially in large nurseries. At this nursery, where only six men are transplanting, one man can dig as many seedlings as the transplanters can handle. To simplify work, it is advisable to dig and

Digging, counting, and bundling a rush order of (2-0) conifer stocks.

heel-in the seedlings to be transplanted before transplanting begins.

The small trees are dug and heeled-in on the grounds from which they are grown or near the transplant area. These trees are put in small bunches but are not counted nor tied. They are heeled-in very carefully. If the weather is hot, shade frames are erected over them or they are kept moist by sprinkling.

SIZE AND ARRANGEMENT OF TRANSPLANT BEDS

In the majority of forest nurseries the transplant rows are arranged crosswise of the beds which are usually six feet wide and as long as the ground permits. At the Oregon Forest Nursery, the tree rows run crosswise of the beds, but the respective beds are only four feet wide. The narrower width of the transplant beds is justifiable because of several reasons. A heavy soil condition exists and two men, operating a six-foot board, tramp the soil much more than one man running a four-foot board. It has been found that one man can transplant as many or more trees in an eight hour day than two men operating a six-foot board. The one man operating a shorter board will correct his errors sooner and easier and will also tend to be more efficient in his work. The only disadvantage of the one-man board is the problem of using more land for the same number of trees.

SIZE AND AGE OF STOCK USED FOR TRANSPLANTING

Many different species of conifers are transplanted at the State Nursery. The sizes of the species vary considerably. Maritime pine (Pinus maritima) attains a height of six to nine inches, which is very large seedling 1-0 stock. Western yellow pine, Port Orford cedar, and Douglas fir also get very large for transplanting. Norway pine (Pinus resinosa) and Norway spruce (Picea excelsa), spring sown seed, do not grow very rapidly the first year. They are some times left for two years in the seed beds before transplanting. In order to facilitate transplanting operations, it is necessary to sow these two species in the fall.

Seedlings with a length of crown and stem amounting to less than two inches are very difficult to transplant. The ideal size of seedlings to conform with the nursery's methods of transplanting is from three to five inches long which includes both stem and crown.

All conifer transplants put on a very rapid growth at the Oregon Forest Nursery and are large enough for field planting at the end of the first year in the transplant beds.

Occasionally, (1-1) stock is lifted and transplanted again. This (1-1-1) stock produces a very large, fibrous root system, and if the labor costs were justifiable, it would seem best to raise this type of stock. Experimental plantings have shown that (1-1) stock will give as good a

field planting success at the end of the first year as the older stock. The (1-2) stock at the State Nursery is also very good planting stock.

During the first two years of practice at the nursery, it became necessary to transplant the hardwood stock. A system of raising seedling stock large enough for field planting in narrow bands was perfected and the transplanting of these species was no longer done. Efforts are being made to grow conifers in this same way.

THE TRANSPLANTING OPERATION

The area for transplanting is marked off with stakes and twine in beds four feet wide and as long as the land permits. The beds are two hundred feet long. All paths are two feet wide. This path width gives ample space to work between the beds. The beds are raked clean of debris which is put in the paths and disposed of later. The beds are then leveled as nearly as possible to expedite the transplanting. Due to the aspect and slope of the land, all transplant beds run east and west.

SPACING

The spacing of the transplant rows is six inches. Tree spacing in the rows varies from one and one-half inches to two inches. Western yellow pine and Maritime pine (Pinus maritima) are transplanted two inches apart. All other species of conifers are spaced one and one-half inches in the row.

MAKING THE TRANSPLANT TRENCHES

The small trenches are made by the aid of a spade and a four foot transplant board operated by one man. Trenches vary in depth from four to seven inches depending upon the length of the transplant roots.

THE TRANSPLANT BOARD AND ITS USE

The four foot transplant board used holds from twenty-five to thirty-three trees, depending on the spacing distance. The transplant board used is of Forest Service design, sometimes called the Michigan board. It is only four feet long, while the original is six feet long. It is five and one-half inches wide and is notched at definite distances, for example, every one and one-half or two inches. The notches should be made very carefully. They should be from 1/8 inch to 1/4 inch at the tope and from 3/8 inch to 1/2 inch at the bottom. The notices are shaped and just a little larger than the diameter of the seedlings. All holes should be smoothed-out carefully. An eight inch round, or rat-tail file is convenient for doing a neat job. A strip of tin (gauge 26 to 30) from three to four inches wide and four feet long, should be put on the opposite edge and under side from the notched spade. The board is then given a good, hot linseed oil bath by brush treatment. This application helps to preserve the board, keeps it from checking and the damp soil will not adhere to it.

USE OF THE TRANSPLANT BOARD

After the trench is made, the board is inverted and the transplanter threads the trees into the notches. The next process is to put fine, moist soil from the open trench around the roots. When the roots are covered, the loose dirt is stepped on lightly by the workman. The trench is then filled level and the board is lifted away from the trees by a downward and upward movement and placed ready to make another trench. All trees are planted about one-half inch deeper than their original position. This increased depth allows for the settling of the loose dirt.

CHECKING THE QUALITY OF WORK

All nurserymen endeavor to develop methods for the transplanting of seedlings which will be as fool-proof as possible. Some try to attain high speed from their men. Good, average, speed with a practice of carefulness to do a good job attains an average transplanting success of from ninety to ninety-nine percent at this nursery. Each planter manipulates his board and works in his assigned bed.

The nurseryman supplies the transplanters with trees, checks their quality of work, keeps the bed strings tight, advises the men in their work, and even acts as a water boy to the thirsty transplanters. He also helps the man digging transplants, cultivates the planted seedlings and waters the transplants after cultivating.

CARE OF TRANSPLANTS

WATERING

The transplants are usually soaked down by the nurseryman during transplanting. If they are not, the water system is installed before transplanting commences, and immediately after the men have moved to other beds the sprinklers are kept busy. The frequency of watering depends upon the soil condition and current weather. During the hot, dry weather in July and August, the transplants are generally sprinkled every week. The sprinklers are allowed to run in one standing from two to four hours. If fall transplanting is practiced, and the beds mulched lightly after the operation, it is hoped to reduce the watering of transplants from fifty percent to seventy-five percent. Weeding will also be reduced about fifty percent.

HARDENING-OFF THE NURSERY STOCK

The watering of all nursery stock, especially seedlings, is gradually reduced a month before rainy weather commences. The watering is finally stopped to allow the stock to equalize conditions between the nursery and field. Discontinuing watering retards the tree growth, causes the tissues to harden, the winter buds to form, and the plants to become more or less dormant.

ESTIMATING THE STOCK

Almost every nurseryman tends to overestimate the amount of stock in the nursery unless certain mechanical

methods are used in the process of estimation. At the Oregon Forest Nursery, care is exercised to select average seed beds to estimate. Small frames one foot square are used. This frame is placed on average-looking plots and all the trees in the square are counted. Several different square countings are made for every species. This method usually gives a reliable estimate per bed when the number of seedlings per square foot is multiplied by the number of square feet in the bed. Conifer transplants are estimated by making check counts of a certain number of rows to get the average survival percentage in each row. This average is multiplied by the number of rows in the transplant beds.

Hardwood stock is estimated by counting the number of trees in a certain distance, as twelve feet. Many different counts are made on certain average-looking rows taken diagonally across the patch of trees. The length and number of the rows is known and the average number of trees per foot has been found. It is then a simple case of multiplying the number of trees per foot by the length of all the rows to ascertain a reliable estimation.

DISTRIBUTION OF STOCK

One of the most important problems at any nursery is a smooth and well-regulated tree selling and stock distribution plan. Some states have employed extension foresters. The duty of these specialists is very important.

He must be able to meet with civic clubs and farm organizations to endeavor to teach people the value of tree plantings. He should establish experimental plantings throughout the state, make thinnings on established woodlots and carry on many other related tasks.

The State of Oregon does not employ an extension forester. The Dean of the School of Forestry at The Oregon State College is supervisor of the State nursery. He sends information regarding the selling of tree stock at the nursery to all newspapers within the State. The County Agents cooperate with the supervisor's office and the State Forester in obtaining tree orders from farmers over the entire State.

THE QUALITY OF STOCK FOR SALE

The nursery stock, ready for shipment, at the State Nursery, is large, strong-rooted and well-selected. The age classes of stock varies from seedling (1-0) stock in both conifers and hardwoods, to (2-1-1) stock in some conifer species. Most of the conifer stock for sale is two years old. It has been transplanted for one year. Hardwood seedlings of all species raised attain a very large size in one year. If these hardwoods are not sold when seedlings, they are root-pruned and held over for another year.

LIFTING AND HEELING-IN

The trees are lifted by the spade method. This method

Transplant beds of (1-1) conifer stock of various species.

Looking south across the same transplant beds. In the background are shown the nursery buildings.

is slow and requires considerable hard work. Both conifers and hardwoods are lifted with the spade. The hardwoods are dug from both sides of the tree row in order to obtain a large strong root system. A tree digger has been purchased. The frame and handles of this digger are those of a walking plow. The mold board and part of the shear are have been removed. A long blade two feet long and on one-quarter inch thick is attached to the left side of the land slide.

Two horses hitched in tandem pull the tree digger. One man operates the plow and another man leads the front horse. It is expected that this horse-drawn digger will reduce digging costs fifty per cent.

The trees, after being dug, are counted and tied in bundles. All dead and sickly looking trees are thrown away. The number of trees per bundle ranges from twenty-five to fifty, depending upon the size of the stock. The conifers are dug several days before shipping and are heeled-in. Many hardwoods are dug as soon as they have lost their leaves. These are counted, tied, hauled to the storage area, and heeled-in. Oiled string must be used to tie these bundles because common tying string rots during the winter months.

The hardwood trees are top-pruned if they are over one foot tall. Generally this stock attains a growth of one and one half feet, to seven feet tall, in one growing season. The black locust sometimes reaches a height of

six to seven feet. These trees have a very large root system, which is also pruned.

PACKING AND SHIPPING

The shipping period of forest trees from the State Nursery lasts for several months. As soon as the stock is dug in the fall, orders for fall planting must be filled. The farmers of western Oregon plant trees during the fall and winter months. This planting period is the best for setting out woodlots, windbreaks and shelter belts, for the region west of the Cascade mountains.

The farmers of eastern Oregon must spring plant their trees because of the long, cold, dry winters. Many purchasers in the eastern part of the state have planted trees during the fall months and usually good field planting survival has been reported.

The supervisor of the nursery sends order blanks to all farmers making applications for tree stock. In return, they send in their orders and payments for the trees. These orders are sent to the nurseryman and the trees are shipped as soon as possible, by express, parcel post, freight, or auto truck.

A small price of two and one-half dollars per thousand is charged for the trees. This charge just pays for the digging, tieing, heeling-in, packing, and hauling the trees to their shipping point. The trees are usually packed in wooden or paste board boxes. A very fine oat or barley

straw is used for packing. For long distance shipments, moss is used for packing around the trees. No complaints have been received concerning this method of packing. Each species in each order is labelled separately with its common name. The boxes or packages are carefully labelled. All shipments by express must have two shipping tags.

The stock at the Oregon Forest Nursery is free from insect or fungus damage. The trees are inspected by the County Agent of Benton County. Every tree order that is shipped must according to law, bear a horticultural inspection tag signed by the county agent.

STORAGE OF STOCK

The growing season at the Oregon Forest Nursery begins very early. Some trees continue root growth during an entire mild winter. Certain species as box elder and Chinese elm, commence leafing-out in early March. Farmers should order the trees in the fall or early spring to avoid cost of storage. Fall ordering would be preferred. Many hardwoods are dug during the fall of the year and are heeled-in near the packing shed. This storage process for overwinter must be very carefully done to prevent molding. Bundles are tied loosely and when spread out in a sloping trench must not be over three trees deep. The string holding the bundle of trees is not cut.

ENEMIES TO THE STOCK

Damage to the stock at the Oregon Forest Nursery from

pests has been very small. For this reason little experience has been developed combatting them.

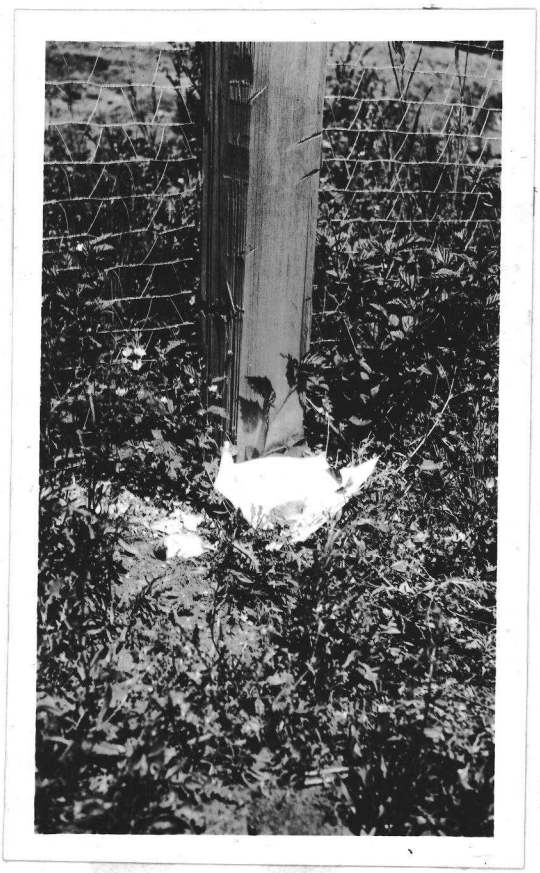
Some workers are at times careless and injury to the stock results. Tramping over seed beds, dragging hose carelessly over the seeded areas, leaving stock exposed to the wind and sun, are some of the injuries caused by the workmen. Visitors tramp around carelessly at times. Stock, cats, dogs, and rabbits contribute to the mechanical loss of the trees.

The use of machinery usually causes more direct damage to the stock than results from the slower, painstaking hand work. The tractor cultivator and the tree digger account for some mechanical loss. When an operation is speeded up and the quality of stock is improved, a certain percentage of loss is justifiable. Other losses are accounted for in weeding and cultivating the trees.

BIRD DAMAGE AND CONTROL

Many birds in and near the State Nursery are seed eaters. The species that do damage to the conifer seed beds are protected by law. Since this is true, methods other than shooting and poisoning must be used to control the bird damage. Covering the beds attacked with screened frames is effective.

The three species of birds that do damage in the conifer beds are the junko or snow bird, toohee, and the song sparrow. All birds are encouraged to stay in and near the



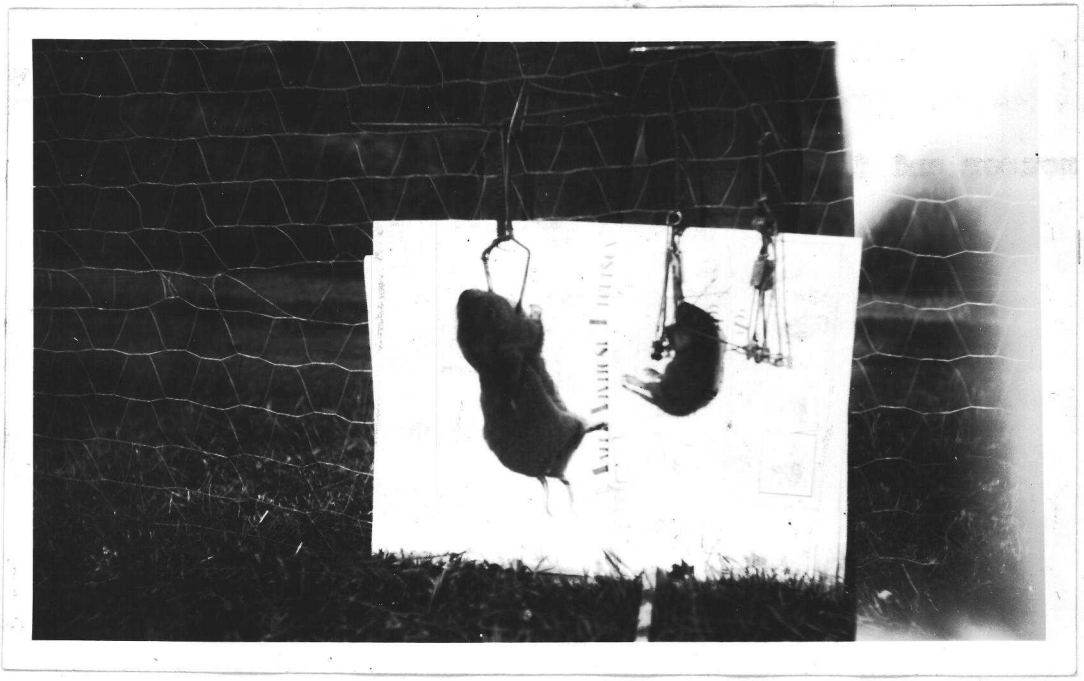
The results of strychnine poisoning. Dead mice are shown as found the next morning after scattering the poisoned grain.

nursery.

MICE DEPREDATIONS

Due to the vast amount of wild land that surrounds the Oregon Forest Nursery, the fight against mice will be a continual one. Two species of mice are to be combated. They are the long tailed white foot or house mouse (Mus musculus) and the short tailed field mouse (Microtus). These two species damage the pine beds, principally those sown to large seed. No damage is done to the hardwood seeds. Nursery sanitation is fundamental. All sticks, logs, and brush in and about the nursery must be picked up, piled, and burned to destroy breeding places. Poisoning has given effective results. Poisoned grains, such as wheat, barley and hulless oats are used. The grain is treated with strychnine and thallium. Both of these chemicals are deadly poison and should be kept in a dry secluded place out of the reach of children and stock. Trapping the mice with small traps placed near the seed beds has proved very successful. The traps are baited with small pieces of bread, bacon, cheese, or some other good bait. The baits must be changed often or the mice will seldom touch them.

The best method of preventing mouse damage is by using screened frames. These are made of screen netting, one-third inch mesh, with a width of four feet. This wire is nailed on the top of a frame made of one inch by five inch planed lumber. The frame is twelve feet long. It fits



Two gophers that have been caught in different gopher traps. The large gopher is twelve and one-tenth inches from tip to tip.

tightly over the beds and loose dirt is put around the out side. An occasional mouse may dig under but can be caught in a trap. The natural enemies of the mice, as the owl, skunk, minks, and snakes are protected in and around the nursery. The large "blow" or "bull" snake is a wonderful mouser and is especially protected.

GOPHER AND MOLE DAMAGE

Gophers have given very little trouble at the State Nursery. The gopher in this section of the country is the large Willamette valley pocket gopher, (Thomoys bulbiverous). This rodent sometimes attains a length of twelve inches from tip to tip. Gophers are usually poisoned because this method of eradication is faster than trapping. Green clover leaves free from dew and treated is the best "all-round" bait for this use. The leaves are treated with strychnine at the rate of ten pounds of clover to one ounce of poison. Carrots, parsnips, and potatoes are sometimes treated with strychnine and used for bait.

Moles are usually trapped. The out-of-sight or scissor-jaw trap is used to catch this rodent. It must be properly set in the main runway of the mole. Another type of trap called the choker-loop trap, has proved very successful. A small trap-gun, loaded with a 38-caliber cartridge, is used where children are not playing.

RABBIT DAMAGE

The black-tailed jack rabbit (Lepus tounsendi)

occasionally invades the nursery. A few hardwoods and some conifers have been found nipped off by this animal. The chicken wire fence which surrounds the nursery, keeps out most of the rabbits. A small fox terrier dog will assist in destroying rabbits which get inside the nursery fence.

SQUIRREL DAMAGE

The common gray digger or Douglas ground squirrel (Citellus beecheii) is very numerous in this section of the Willamette valley. This is due in part to the large amount of wild land that surrounds the nursery and to the fact that farmers and land owners adjacent to the nursery are very negligent in poisoning the pests. The poisoned area around the State Nursery, for mice control, acts as an effective control measure for these squirrels.

FUNGUS DISEASE DAMAGE

DAMPING-OFF

Fungus diseases are usually the nurseryman's greatest enemies, especially to coniferous seedlings. Hartley points out that there are at least four different types of damping-off organisms that damage tree seedlings. These types are: 1. The germination type or the pathogenes that attack seedlings during the germination period. 2. The common or normal damping-off type, when the roots or hypcotyl are attacked soon after the seedling appears above ground. 3. The late damping-off, which occurs when

the roots are attacked after the stems have become woody. 4. Top damping-off type which occurs when the cotyledons and upper part of the seedlings are affected.

The best control measure seems to be the chemical treatment. Many chemicals have been used experimentally. Some have controlled damping-off, while others have damaged the seedlings. Sulphuric acid has proved to be the most dependable chemical for this use. At most nurseries, if the minimum amount of acid is used to prevent damping-off, no fear need by given for seedling injury.

Slightly acid soil seems to be partially exempt from serious loss due to damping-off fungi (Ref. #8 P. 15). If this is correct, the seed bed soils should not be treated with lime to counteract the acids in the soil.

The large Forest Service Nurseries, as Wind River and Savenac, use sulphuric acid to control damping-off. The PennsylvaniaState Nurseries combat damping-off fungi successfully by spraying the infested beds with a Bordeaux mixture.

Damping-off has given very little trouble at the Oregon Forest Nursery. All conifer seed, except the cedars, are treated with Bayer dip-dust before planting. A teaspoon full of this fungicide is added to every quart of tree seed. If damping-off damage is discovered, the shade frames are removed at once and the beds are not watered until the top surface has dried just enough not to

cause sun scorch. Drill sown beds are cultivated. Cultivation and sunshine are the deadly enemies of the damping-off spores.

TOP FUNGUS

A most peculiar enemy attacked a small percentage of western yellow pine and maritime pine seedlings in the fall of 1927. Due to it, the tops of the infected seedlings bent over and some died. The roots, however, were healthy and a strong lateral bud tended to take the place of the terminal one destroyed. Indications pointed to insect injury but research work by the Oregon State College Entomologists found no signs of insect punctures. The Botany Department at the College could not detect any pathogene work.

New specimans were sent to the Bureau of Plant Industry at Washington, D. C. Mr. Carl Hartley, pathologist, concluded that it was the top fungus (Botrytis sclerotia), which did the damage. Causes of the fungus attack were due to warm, humid weather in the late summer. Control measures were considered necessary if weather conditions favorable to the fungus, continued. The shade frames were removed and sprinkling discontinued. The infested seedlings were sprayed with a Bordeaux mixture (5-5-50) with plenty of spreader. The infected trees were destroyed where the disease occured in definite patches.

WHITE PINE BLISTER RUST

The blister rust pathogenes have not been found in or

near the nursery. Blister rust spores have been found on the red flowering currant in the Mary's Peak region thirty miles south-west of the nursery. Work is being carried on to eradicate all species of the alternate hosts of the genus Ribes within a mile of the nursery. The two Ribes found surrounding the nursery are red flowering currant and wild gooseberry. The object is to keep Ribes out of this mile radius because spores cannot travel such long distances from the Ribes to young white pines.

BLIGHTS

SUN SCORCH

Sun scorch is sometimes referred to as drought injury. The damage in some nurseries is somewhat patchy but usually affects individual seedlings in the beds. Thickly sown seed beds show more sun scorch than those thinly sown. The small seedlings affected are generally the weaklings in the beds. They have poor root-absorption powers in proportion to the rapid transpiration in the tops. Light sandy soils show more sun scorch injury than the heavier soils.

The first indications of sun scorch shows a pale, lifeless green color. The needles tend to dry and later turns to a straw color. Transplants are not affected by sun scorch as much as seedlings. These may recover but the seedlings very seldom survive sun scorch damage. Very few cases of sun scorch have been observed at the Oregon Forest Nursery.

WINTERKILLING

In some localities, young nursery trees are killed because on a warm winter day, transpiration is rapid in the tops when the roots and ground are frozen. The inactive roots are unable to supply soil moisture to the transpiring tops. This condition results in the death of thousands of small trees and sometimes even large trees are killed. Many exotic trees at the State Nursery have not lived thru severe winters as during the year of 1929-30. The Eucalyptus species were all killed outright by the sudden changes in the weather. Part protection may be secured by mulching the trees with a covering of light straw, leaves or burlap.

FROST HEAVING

Frost heaving damage was noticed during the second year of nursery practice at the State Nursery. Heaving takes place during freezing nights. During the following day, the sun melts the frozen ground causing it to settle back in place. This process may happen several times causing the little seedlings to be lifted out of the ground. A light covering of clean straw, leaves, burlap, or excelsor prevents frost heaving.

FROST NIPPING

Frost injury occurs when the stock continues growth during the early fall or when there is an early spring growth. Forest Pathologists claim that in some instances

the fast growing, watery parts of the plant are frozen, causing the water within the plant to crystallize and explode the plant cells. This damage may be prevented by not watering the young trees from several weeks to a month before frosts are expected. This precaution taken to prevent frost injury is called "hardening off". Early spring frost injury may be prevented by covering the young trees with shade frames. This shading helps to retard early growth.

Frost nipping very seldom occurs at the Oregon Forest Nursery. The genera Eucalyptii, Sequoia, and many warm climate trees have been frozen back by frost injury. The injury generally kills back the new growth which results in deformed trees but very seldom kills the tree.

INSECT DAMAGE AND CONTROL

Insect injury, at the State Nursery, has been of very little importance. As conditions change, insect damages may be severe due to the growing of both hardwoods and conifers.

MITE WORK

The work of a tiny, microscopic mite (Erioyhyes fraxini), was noticed affecting the Eastern green ash (Fraxinus lanceolatta), Arizona green ash (Fraxinus arizonica) was substituted for the former and the mite work disappeared. To control this mite, a spray of miscible oil should be used before the young growth starts.

CUTWORM DAMAGE (Noctuidae spp.)

Evidences of cutworm work have been found at the Oregon Forest Nursery but the amount of damage is not enough to warrant control. The cutworms are the larvae of the common "miller" seen at night around the lights. The larva are of a dirty, gray color. They are voracious feeders usually feeding at night.

The best control measure for cutworms is the use of poison mash. The area should be treated before it is planted and just before dark. The poisoned mash formula is as follows:

Coarse bran	16 pounds
Sodium fluoride	1 pound
Molasses	2 quarts
Water	2 gallons

Dissolve the fluoride in water, stir in the molasses, and add the bran. Mix to a crumbly mash and scatter.

WHITE GRUB DAMAGE

Different control measures which have been tried with success at various nurseries are as follows: 1. Practice crop rotation at least two years before planting the area back to trees. 2. Treat the land with carbon disulphide. 3. Apply three and one-half pounds of lead aresenate to one hundred square feet of ground, working the arsenate into the soil before planting the tree crop.

ELM LEAF BEETLE DAMAGE

The elm leaf beetle (Galerucella luteola) second brood of adults was found infesting the (2-0) Chinese elm stock at the State Nursery. These insects are small (1/8-1/4 inch long), reddish brown to a greenish color, with a dark stripe down each elytron and several dark spots on the thorax. It is very easily controlled. The method is to spray or dust with arsenate of lead about ten days after the leaves are developed. Repeat the control plan for the second brood. In the spray, use four or five pounds of lead arsenate to fifty gallons of water.

TWELVE SPOTTED CUCUMBER BEETLE DAMAGE

The cucumber beetle (Diabrocta soror) is a leaf feeder, attacking most any kind of vegetation. It is injurious to farm crops and even attacks forest nursery stock. The adults are voracious feeders. The beetles are one fourth inch long, of a yellowish, green color, with twelve black spots on the wing cover. D. soror is a very difficult pest to control. The insects are restless and migrate about every ten days. The trap crop has proved successful in control measures. Spraying with lead arsenate is repelling but a contact spray applied directly on the pests kills the beetles and larvae attacking hardwood trees. The spray should be applied in the early morning before the beetles are very active.

STRAWBERRY ROOT WEEVIL DAMAGE

All three species of the strawberry root weevils have been found in Oregon attacking strawberries, raspberries, and other crops. These three species are the small weevil (Brachyrinus ovatus), the medium weevil (B. rugifrons), and the large species (B. sulcatus). The three species are very destructive at the Crown-Willamette Forest Nursery, located near Willamette, Oregon.

The adult weevils are dark brown in color and vary from three-sixteenths inch to nearly five-eights inch long. The beetles and larvae feed on many wild hosts as wild blackberry, wild strawberry, loganberry, raspberry, clover, timothy, sorrell, quack grass, and many others. The severest injury to forest nursery stock is done to the roots by the larvae. Some grubs may feed on the foliage of the small trees. The adults feed about the ground but seldom do serious injury.

The poison bait method has proved to be the best control measure for these pests. The bait consists of dried apples (10-15 % moisture content) ninety-five per cent and calcium arsenate five per cent. The bait can be broadcast lightly over the seed beds and along the tree rows. From seventy-five to one hundred pounds of bait per acre is required for complete broadcasting. The first application of bait should be made when about seventy-five per cent of the weevils have emerged. A nurseryman's berry patch is

one source of getting the weevils started in the nursery, but may serve as a trap crop after infection.

No weevil work has been noticed at the Oregon Forest Nursery.

WHITE ANT (Termite) DAMAGE

The most important, destructive white ants are: Leucotermes, L. virginicus, and L. lucifugus. These resemble the tree ants in their colony life.

The white ants feed on foundation timbers, dead wood, poles, clothing, shoes, paper, and forest nursery stock. The damage to nursery trees, at certain times is considerable, especially if the nursery has been established on new ground recently cleared of timber. The ants feed on the young roots and trees.

To control termite damage, all sticks and roots should be cleaned from the nursery area and then clean cultivation and crop rotation practiced. Some termite damage has been noticed at the Oregon Forest Nursery.

Valuable cooperation has been received from many departments at the Oregon State College in assisting or giving constructive advice in special problems along their respective lines of work. The United States Biological Survey has helped in solving many problems encountered at the nursery.

COSTS OF OPERATIONS

The cost of land clearing at the State Nursery was very

high. Many factors increased the costs, such as working during unfavorable weather. The land must be ready for a tree crop as soon as good weather the following spring. The land clearing costs included the slashing, piling, and burning of the debris; raking the area by hand; shooting the stumps; pulling the stumps with a stump puller; pulling the stumps off the ground and burning them; digging roots left in the ground; filling in the holes; and plowing and working down the area.

The cost per acre averages between $225.00 and $250.00. The nurseryman's time was figured at what it would cost to hire another man at $4.00 per eight hour day. The costs of powder, caps, fuse, new rigging, trips to town for repairing rigging, and the costs of fixing the same were also included.

RAISING OF STOCK

The costs of raising (1-1) stock not including the digging comes to about $3.25 per thousand. This item includes the cost of the seed.

The costs of digging, tieing and heeling-in (1-1) conifer stock under average weather and soil conditions total about 80¢ per thousand.

The costs of raising hardwood (1-0) stock is about $2.00 per thousand.

Packing costs are very difficult to obtain due to the mixed orders of conifer and hardwoods and also the great

variation in the number of species. It is much cheaper to pack an order with only three species than one dozen different trees.

Nursery practice at the Oregon Forest Nursery is just beginning. It will be difficult to predict what plans will be used in the future. The methods described in this paper are simple, inexpensive, and have given satisfactory results. As time goes on, there will be a greater demand for nursery stock. This will mean that the present methods will change. An increase in the number of trees will mean a larger working budget. The Oregon Forest Nursery will eventually be a large nursery raising and shipping from one to several million trees a year.

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