Ward: We have had some success with Douglas fir seed which was extracted in 1941 which is still germinating 64%. We ran tests on that same seed the last 4 years. In 1945 it run about 80% germination after being stratified. It held fairly consistent in 1946 and 1947 there was a drop to 54%, and it is now back to 64%. Douglas fir is very inconsistent in germination.

Chairman Webster: I do not think the germination test is a true indication of seed quality. It is only a guide.

Wells: We had seven-year-old seed germinate 75%.

Dill: What about the viability of the plants that you get from the old seed?

McDermitt: I think the viability is as good as the new seed. According to our experience, we have some very good stock from old seed.

Chairman Webster: When you get a good seed year, the germination is good and the opposite is true for a poor seed year.

Thank you, Mr. Ward. A subject not too common to some of us, who are producing nursery stock is that of Propagation of Hardwoods. This interesting topic will be presented by Vern McDaniel.

PROPAGATION OF HARDWOODS
by
Vern E. McDaniel

Introduction

The paper assigned me is "The Propagation of Hardwoods at the Oregon Forest Nursery." This nursery is located 7 miles north of Corvallis, Oregon, on Highway 99-W. The present nursery has an area of 20 acres of cleared land. It is planned to add 10 acres more for nursery practice.

The nursery is owned and operated by the Oregon State Board of Forestry with headquarters at Salem, Oregon. It was established in 1925 as a Clarke-McNary nursery. The first purpose of this nursery is to raise trees for the planting on Oregon farms. Both conifers and hardwoods are sold to the farmer and must be used for windbreak, shelter belt and woodland plantings. Several years later the State Board of Forestry purchased land near this nursery and raised conifer species to plant on their own state lands. The two nurseries were later given the name as the Oregon Forest Nursery.

Establishing the Nursery Site

The area to be cleared had been cut over by a cordwood buyer but the brush, trees, debris and stumps remained. After slashing and piling all debris, a careful plan of burning was used. The stumps were shot lightly and pulled by machine power, after which the ground was leveled, plowed and worked many times before it was ready for seedbed planting. Several tile lines were laid for better land drainage.

The Irrigation System

The nursery has a 6-million gallon lake for its water supply. A 5-inch Douglas fir treated water line brings the water to the nursery by gravity flow. Four-inch main water lines carry the water to the risers. A 6-inch similar line leads to the other nursery area that is being developed. The Skinner overhead water lines with Skinner water motors has been adopted. The water lines are 50 feet apart. They are mounted on 1-inch pipe posts. The posts are 4 feet long. They are 2 feet above ground. Both galvanized iron and aluminum alloy pipes are used. If the latter pipes give long years of service as permanent overhead lines, better water distribution can be expected. This is due to the smoothness of the metal which reduces friction to a minimum.

Nursery Buildings

The Oregon Forest Nursery has some well constructed buildings. There are two residences located on the nursery site. There are two work buildings, including a 24-foot by 60-foot machine storage building and a 22-foot by 60-foot general utility building. This structure has two stories. The ground story houses a tree counting and packing room and a tree storage room. The upper story consists of a winter work and tool room and a miscellaneous storage room. Car garages and a gas and oil house comprise the other buildings. Plans are to erect a new building on the nursery site. This structure will consist of a tree sorting, counting and packing room, a 37-degree cold storage room and a smaller room for seed stratification. In one end of this room, plans call for the construction of a zero compartment to be used for seed storage.

The Nursery Soil Problems

The soil at the Oregon Forest Nursery is classified as Olympic and Aiken clay loams. The soils are fairly heavy and difficult to work. When fine cultural methods are used, the soil crusts very readily. All nursery soils have their advantages and disadvantages. These soils are very rich in the beneficial fungi, the mycorrhizas. When the trees are lifted and pulled, a film of dirt adheres to the roots. This has been found to be very beneficial to good survival in field plantings.

No fertilizers have been added to the soil except the growing of heavy cover crops. Various grains and combinations of grains have been used, such as vetch and oats, Austrian field peas and winter barley. Winter wheat has also been planted for cover crop use.

Treatment of Seeds Before Planting

The proper pretreatments of tree seeds before planting usually give a higher percentage of germination in a shorter period of time. Experience has proved that fewer seeds have to be sowed. The soaking of black locust seeds in boiling water for a period of two minutes gave good results. The seeds must be planted immediately in moist soil. Planting of the same locality seed without pretreating gave almost as good a germination. A 10% addition of seed was used. This method has been adopted at the Oregon Forest Nursery, because black locust seed costs only $1.00 per pound.

Seeds such as Russian olive, cascara, walnuts, oaks and all larger seed are stratified in sand. When a seed stratification room is available, most all of the hardwood seeds will be pretreated.

Seed Bed Preparation

Spring sowing of seed beds is practiced at the Oregon Forest Nursery. The seed bed areas are drilled the fall before to common vetch at the rate of 70 pounds per acre. This produces a growth 3 to 5 inches high before cold weather and acts as a protector against soil leaching and erosion. When conditions permit, these areas are plowed and left to aerate for a while. They are worked down to as fine a condition as possible a short while before seed bed sowing time.

Seed Sowing

In past years, the hardwood seeds were sowed in rows 3 inches wide and 2 feet apart. The seeds were broadcast in these 3-inch bands and covered by hand rakes with natural soil. The seeds were covered from 1/2 inch to 1-inch deep depending on the size of seed. Nursery plans were to obtain from 10 to 15 trees per lineal foot of band.

During the 1948 season, a new method of sowing hardwood seed was used. Our Forestry Department shops constructed the tree seed drill used by many Forest Service nurseries such as Wind River Nursery and the Bend Pine Nursery. The seeder is carried by the new Ford tractor. The rows of sowed seed are spaced 6 inches from center to center. This gives a bed width of 42 inches from outside to outside row. Most all of the hardwood species can be sowed with the nursery seeder. Green ash is sowed with a single row Planet Junior planter by removing the seed gauges. Large seeds such as oaks, hickories and maples are sowed by hand. The seeds are sowed from $\frac{1}{4}$-inch to 1-inch deep according to their size. A density of 5-10 trees per lineal foot is desired.

Sprinkling the Seed Beds

All nurserymen must work out their own watering schedules. This depends upon many factors such as type of soil, temperature and humidity conditions, species of seeds planted, and nursery aspect. The Oregon Forest Nursery plans are to apply an average of about 1-2 inches of water per week during dry, hot weather. Care must be exercised at germination time on the heavy clay loams because of its crusting factor. This requires frequent light watering to soften the crust hardness. The soil must not be kept too moist. This condition encourages damping-off damage and root rot. As the growing season advances, watering periods are lengthened to every 10 days to two weeks intervals. Usually about August 15 to September 1 sprinkling of hardwoods is stopped.

Cultivation and Weeding

Cultivation of the hardwood species is done with a 7-row cultivator. It might be called a working mate machine with the drill. Two men are required to operate it. One man drives the tractor and the other handles the cultivator. Difficulties are being experienced in trying to develop a successful set of weeding knives in the heavy clay loams.

Hand Weeding the Hardwoods

Weed control thus far has been done by cultivation and hand weeding. Women weeders are preferred at the Oregon Forest Nursery. The hardwood seed bed areas usually require 3 to 4 weedings annually.

Digging, Storage and Packing

Hand digging was first practiced. This work required care and experience. Machine digging by means of a Ford tractor and U-shaped blade was adopted in 1940. This method was more successful. It saved labor costs, time, and a better job of lifting was done. The heavy soil conditions required that every other row be dug.

The depth of digging varied from 8 inches to 10 inches. Since the adoption of the 8-row seed drill, the conifer digger blade will be used to lift the hardwood seedlings.

Broadleaf trees are pulled, sorted and counted in the field unless they are small. They are then sorted and counted in the packing room. Bundles contain 25 or 50 trees each, depending upon the size of the seedlings. They are stored in the tree storage room for several weeks pending shipment.

The packing of farmer tree orders presents a nursery problem. A standard system of packing can never be adopted because practically all the orders consist of mixed hardwoods and conifers. The trees are packed in moist shingle-tow and wrapped in waxed paper. The bundle-shaped package is sewed up in burlap. It is then ready for tagging and weighing. Often trees are packed in strong pasteboard cartons. Larger orders are shipped in wooden boxes. Trees are shipped by Railway Express, parcel post and truck freight. Every bundle or box of trees shipped must have two shipping tags. State of Oregon laws require an inspection tag on every tree order.

Prevention of Tree Losses in the Nursery

Toumey says, "Successful nursery practice demands fully stocked seedbeds and transplant beds."

Some losses in the nursery are impossible to prevent. It is the preventable losses that every nurseryman must be ready at all times to control. Some preventable losses have occurred at the Oregon Forest Nursery. The loss of hardwood stock from adverse weather conditions is very small in comparison to the losses that occur in conifer beds. Losses due to freezing and sun scorch have never caused damage at the nursery. Several very late frost threats to small hardwood trees were controlled by timely use of the sprinkling lines. Sun scorch damage can be prevented by frequent short watering during very hot weather. This is called shading with water.

Birds sometimes attempt to feed upon Russian olive seed. No losses on other species has been experienced.

Insects have caused slight damage to hardwood seedlings. The use of D.D.T. dust of 3 to 5 percent has controlled the attacks of the spotted cucumber beetle. The larvae of these pests have caused some damage to hardwood seeds and small seedlings. This dust treatment also keeps under control leaf hoppers and the white flies that attack Chinese elm and Caragana.

A near relative insect pest has caused serious damage to hardwood seed bed areas. It is called the symphylid. It remains a small white, 8-legged larva, about 1/8-inch long. This pest feeds upon the planted seeds and roots of trees that germinate. Trees that belong to the legume family such as black locust, and Caragana are most susceptible. Russian olive, a near legume, is very susceptible to its attacks. No effective control has been found for the symphylid. An

insect similar to the symphylid does the same type of damage. It is called the compodia. They are difficult to tell apart unless closely scrutinized. These two pests have about 140 host plants. There must be a cooperation of agencies to find some means of controlling these two very serious pests.

Cut worms have caused some damage at the nursery. The beneficial birds, such as the robin and bluebird, seem to help keep this insect under control. The hand weeders are taught to be on the lookout for evidences of their work. They can be kept under control with poisoned bran mashes.

Parasitic fungi damage has given trouble at various times to certain species of hardwoods.

Damping-off has caused damage in the seed bed areas of black locust, Russian olive and Caragana. Chinese elm seed has also been attacked by this disease. There is a small section of the nursery where the soil is dark, heavy and shallow. It is classified as Wapato soil. If the hardwoods are not removed from this area as soon as they have lost their leaves, root rot will result.

Heavy Botrytis (Sp.) damage to osage orange seedlings eliminated this specie from the list of hardwood trees grown at the nursery.

Rodent attacks at the Oregon Forest Nursery have caused some damage to Russian olive seed. The mice and ground squirrel raids were soon stopped by the use of poisoned grains. Moles are trapped by using the out-of-sight mole trap. Gophers are controlled by using poisoned applications of strychnine alkaloid added to chopped red clover leaves. These deposits are carefully put in their runways. Sliced carrots, potatoes and other vegetables have proved effective when sprinkled with strychnine alkaloid.

Deer damage by foraging and trampling has been very severe. Complete areas of Chinese elm and Russian mulberry seedlings have been eaten practically "to the ground" several times by these marauders. Scarecrows, noise machines, intricate electric fence installations and many other control measures were tried. The deer kept coming in. A high 8-foot fence plus other agencies finally controlled the ravages of these "almost pets."

The species of hardwood trees raised at the Oregon Forest Nursery for the farmer demand are the species commonly used for windbreak and shelter belt purposes throughout the United States. They are black locust, Russian olive, Russian mulberry, Caragana, Chinese elm, and Norway maple. We recommend the growing of cottonwood and willow cuttings by the farmer for one year before field planting. These trees are especially recommended for planting in Eastern Oregon. Black locust and cascara are recommended for farmer plantings in Western Oregon. Certain species of willows and cottonwood cuttings are also recommended to the Western Oregon farmer for stream and bank control.

Future plans call for the growing of one to one and one-half million hardwood seedlings annually for the planting on Oregon farms.

McDaniel: We have a new insect or near-relative to an insect pest in the nursery, which is known as a symphylid. This pest stays in the larva stage. Dr. Martin from Ohio has done some work on it. It is a small, white, many-legged insect which is 1/8-inch long, generally found in the first six inches of soil in the summer months. It travels down with moisture. What it will do in large areas is not known. If you have the use of a rototiller, the first movement of the machine will reduce the insects. It is very seldom that they attack the seed. They do feed on black locust seed and fine hair roots. They eat off the young fibrous roots.

Schroeder: Have you tried sterilizing?

McDaniel: We have tried everything including flooding, but have been unable to exterminate the pest.

Stubbs: How do you dig hardwoods?

McDaniel: A special nursery-built Cat. It has a blade up in front. One man can operate it.

McWilliams: Most of our hardwoods are grown from seed.

McDaniel: There is no demand for cuttings. Too expensive. They have to be picked and treated. We have encouraged the farmers to raise their own cuttings.

Chapin: How will you dig a bed with a Cat?

McDaniel: Put a false bottom on the digger.

Chapin: We damage our hardwoods with a tractor. We have an off-set plow. It does not completely turn them over.

Chairman Webster: How deep do you go for lifting hardwood stock?

Answer: 9 to 10 inches.

McDaniel: In growing of black locust, plan to hold lifting blade down to 12 to 16 inches.

Chapin: We were getting some damage so it paid us to develop a plow. Plowing one row at a time puts them in a good position for pickers to get at them.

McDaniel: Some of our farmers put the trees in gardens for one season, which seems to encourage them take care of the trees. Then when the planting season comes, if there is a 4-H Club member in the family, the parents get the trees out. Most farmers do not know where to put their trees.

Chairman Webster: Thanks, Vern, for telling us how to raise hardwoods. We are fortunate to have specialists to help us work out some of our problems. One of these specialists is R. L. Furniss of the Bureau of Entomology and Plant Quarantine, who will tell us about nursery insect pests and their control.