mancy as such or the action of various agents that remove or destroy the blocks to germination to overcome dormancy. Knowledge about these two aspects will almost certainly increase at about the same rate since they are so closely interdependent. Stratification is probably the most universal of the treatments used and, as such, is likely to figure importantly in future studies designed to shed light on dormancy and the processes that overcome it.

LITERATURE CITED

Allen, G S 1960 Factors affecting the viability and germination behavior of coniferous seed IV Stratification period and incubation temperature *Pseudotsuga menziesii* (Mirb) Franco *For Chron* 36 (1) · 18-29

---------- 1961 Testing Douglas fir seed for provenance *Proc Inter. Seed Testing Assoc* 26 (3) 388-403

----------, and W Bientjes 1954 Studies on coniferous tree seed at the University of British Columbia *For Chron.* 30 (2) · 183-196

Anderson, Harry W and Boyd C Wilson 1966 Improved stratification procedures for western white pine seed State of Washington DNR Report No 8, 11 pp

Baldwin, H I 1942 Forest Tree Seed 240 pp. Waltham, Mass

Barton, Lela V and Jane L Bray 1967 Biochemical studies of dormancy and after-ripening of seeds IV Further studies on changes in contents of some amino acids and organic acids *Contrib Boyce Thomp Inst* 23 (9) 311-318

Fowler, D P and T W Dwight 1964 Provenance differences in the stratification requirements of white pine *Canadian Jour Bot* 42 669-675

Hagner, Stig and Milan Simak 1958 Stratifieringsforsok med fro av *Pinus cembra Ingar aven i Norrlands Skogsvardsforbunds Tiaskrift* 1958 (2) · 227-275

Mahlstede, J P and E S Haber 1957 Plant Propagation, 413 pp, New York Wiley

Mackinney, A L and W E McQuilkin 1938 Methods of stratification for loblolly pine seeds *Jour For* 36 1123-1127

Mergen, F 1963 Ecotypic variation in pine *Ecology* 44 (1): 716-727

Toole, E H 1961 Mechanism of dormancy of seeds and tubers — mechanisms of dormancy in seeds *In* Recent Advances in Botany 1208-1210 University of Toronto Press

U S Forest Service 1948 Woody-Plant Seed Manual. U S Dept Agr Misc Pub 654, 416 pp

MODERATOR JACK: Thank you, Dr. Allen, for a most interesting discussion. Mr. Jack Doty of Viewcrest Nursery, Vancouver, Washington, (not British Columbia) will now talk to us on field production of tree seedlings in Washington. Mr. Jack Doty:

FIELD PRODUCTION OF TREE SEEDLINGS IN WASHINGTON

JACK DOTY
View Crest Nursery
Vancouver, Washington

In growing seedlings we try to duplicate the processes which would come about naturally. Seeds have an inherent ability to hold back germination in the fall to avoid winter-killing. By stratification we gain a quick germination at

planting time. However, with some varieties we find that it is more advantageous to plant in the fall and germinate the seeds naturally.

Source of seed is a never-ending problem. Local seed crops are always the best, as they will have a higher moisture content and require less processing for germination. Imported seeds have to be fumigated; if moisture and temperature are high the methyl bromide will stop germination. In general, we have found that it pays to keep the seeds in transit the least possible time. Air shipment may seem rather costly, but it usually pays back dividends with better germination.

Seeds in the berry form will germinate better if the outer pulp is left in close contact with the seed during stratification. Probably the acid of the pulp helps to break down the outer layer of the seed for better water penetration. At seeding time it is essential to have the best possible conditions for germination. Soil temperature is very important especially if the seed is ready to sprout. Certain seeds bcome more able to germinate at a lower temperature the longer they are held in stratification. Many times it becomes necessary to move seeds from the stratification room in which they are being held at 36-41°F., to a lower temperature—just above freezing —until weather and other conditions favor field seeding. Therefore, it is important to time the stratification process so as to be ready at planting time.

To obtain the best seedlings, proper planting density is an important factor. Seeding density is determined by a cut test of the seed. The cut test is not always reliable, but is the best method we have so far. There are just too many varieties of seeds going in at this time to rely on a germination test for each one. Once the seed is in the ground, the pressure is on to obtain the best possible germination.

Conifer seed beds are prepared much like a new lawn. All beds are rolled prior to seeding. We fumigate our land with methyl bromide periodically. Conifer beds are fumigated immediately prior to seeding in the spring. This is a particular advantage as most all the germinating weeds are killed and there is no competition to the seeds.

Broadcast seeding is done with a 24″ Lawn Beauty Seeder. As our beds are 4 ft. wide, we make two passes per bed. Row seeding is still done by hand. Sometimes it is necessary to mix seed with sand, peat or sawdust to obtain a lighter density. We vary the pressure on the wheel marker to change the depth of the trench for different seeds. As yet, we have not developed a better method of covering than by hand.

When seed is in the process of germination, moisture content around the seed is very important. As most of our conifer seed is planted almost on top of the ground with only ¼″ sawdust mulch covering, it may be necessary to water for a few hours every day. As the roots grow down, less frequent watering of more quantity will do. Also we found that

it helps to stabilize the sawdust mulch from wind blowing if it is not allowed to dry out.

Certain conifer seedlings, such as spruce, do better under partial shade the first year. Snow fencing was first used for shade, but plastic screening has replaced it due to less labor and storage problems involved. We use 2 x 2 stakes driven at 10 ft. intervals; a nylon cord is stretched between them with a staple to anchor the cord. The plastic is clipped to the cord with clothes pins every few feet.

Weeding has been greatly eliminated this season, especially with deciduous stock, by use of chemicals. The fact that seedlings usually take a few weeks to emerge above the ground is put to good advantage. By using a pre-emergence spray, such as Paraquat or mineral spirits, on the beds during this period we can eliminate most of our weeds. After germination is complete and the weeds are showing, the weeding crew moves in for a very thorough job. This is necessary as we immediately follow with a post-emergence spray such as Dacthol or Dymid, and water it in good. On fall-planted seeds, a post-emergence spray is a necessity. Mineral spirits is also used on conifers as a post-emergence spray when the seedlings are well established. In the fall of the year, when our one-year-old conifer seedlings are going into dormancy, we apply a 1 to 2 pound application of 80% wettable Simazine. This usually carries us through until well into the spring. At this time there are indications of the Simazine no longer being present in the soil, thus necessitating a through weeding. During this period of lesser rainfall, we apply Atrazine at approximately the same rate. Some clover seeds usually manage to get through the methyl bromide fumigation and we have been successful in eliminating them by this system. As most conifers are lifted the following fall and spring, further weed control may not be necessary.

After transplanting conifers, we immediately follow with an application of 2 pounds wettable 80% Atrazine. If stock is not being dug that fall, an application of Simazine may be necessary. I might add we only apply Atrazine and Simazine when we see that the prior application has lost its effectiveness. In our case it usually is about 6 to 9 months. As Simazine is more insoluble, we use it during the periods of heavy rainfall, Atrazine during the lesser rainfall periods.

I would like to give caution in weed spraying, especially with Simazine and Atrazine. It is very important that these chemicals be applied accurately. Calibration of equipment is a *must*. which we do periodically. It is necessary for one to find out what his limitations are by experimentation. Varying factors, such as soils and rainfall, will have an effect on the application rates. Constant agitation of the solution is essential for even distribution.

Insecticide and fungicide spraying is a necessary evil in our operation. We do not like to do it anymore than we have

to. If we still had the predators around that we had 20 years ago, maybe insects would not be the problem that they are now.

At temperatures above 90°F, all forms of spraying should be curtailed. What some of us might call "spray injury" may be leaf tissue damage caused by rapid intake of moisture at these higher temperatures, especially if the moisture content in the leaf is low.

Our soil fertility needs are usually determined prior to seeding and taken care of in a pre-application. During the peak growing season ammonium nitrate is applied through the sprinkler lines at an approximate rate of 3 lbs. per 1000 gallons of water. Late summer application of a potash foliar spray for hardening-off seems to be advantageous.

In conifer seed beds it is necessary to get optimum growth to lessen the chances of "heaving" the first winter. The amount of food stored in the plant prior to harvesting has a direct bearing on mortality when it is transplanted. A good stored food supply will give it an added "boost" for quick spring growth.

Root-pruning this season was done in June with no adverse effects. Where possible, all conifer seedlings are root pruned yearly. In some cases stock is pruned as shallow as 2 inches. Limited root-pruning is done on deciduous stock where it is necessary to consolidate root growth.

Fall harvesting of conifer seedlings usually starts sometime in October, with harvesting of deciduous stock following around mid-November—after leaves have dropped. Stock is lifted with a crawler tractor equipped with lifting blade and fingers. Field transportation of stock is done in boxes or crates. Recently we eliminated field trailers by mounting semi-permanent pallets behind our tractors for better maneuverability. If possible we like to ship as we dig. Storage of seedlings can be a problem, especially with conifers. Deciduous stock holds well in cold storage. From the time the seedlings leave the field, until they are in the customers care, we try not to allow roots to dry out. By use of fogging nozzles connected to hoses, we are able to keep the roots moderately moist. Nozzles are mounted over each grading table and throughout all shipping and storing areas. Stock is kept cool as much as possible and remains in the grading room only a short time. Operations are speeded up by the use of roller conveyors and small pallets.

Standardization is important. Our seed beds are four feet wide, transplant beds, and row seeding beds are made up of 5 one-foot rows to make a four-foot bed. All but one of our eight tractors have their wheels set six foot on centers so as to straddle the beds. We use three types of irrigation which are all standardized to 50 ft. centers.

Mechanization has been the greatest asset in our business. However, one must also consider cost factors against hand

operation. In developing our 5-row transplanter, we had to wait until our quantities were large enough to offset the initial investment in the machine. We hope to develop a universal seeder for next spring capable of handling all types of seed. Our present thought is to develop an endless belt for each of the five rows.

MODERATOR JACK: Mr. Eugene Baciu, Mistletoe Sales, Santa Barbara, California, has been collecting, testing and selling seeds for the past 18 years. He will talk to us now on the interesting subject of, "Hydro-seeding". Mr. Baciu:

HYDRO-SEEDING

EUGENE BACIU
Mistletoe Sales
Santa Barbara, California

Hydro-seeding, in essence, is the application of seed by high pressure water spraying. This is quite a simple and efficient method of getting a job done in a hurry.

Most of the work up to date has been done with sowing grass seed. This is done with hydro-seeding machines which have been built on several different carriers. Some small ones are built on two-axle truck chassis while others are built on trailers and semi-trailers. The tanks in which the slurry is mixed are of different sizes, as are the high pressure pumps. The tanks will hold enough mix to cover a given number of acres with so many seeds per acre.

The slurry is made of seed, water, fertilizer and mulch. The mulch may be made of different materials, such as grounded straw or hay, held together with oil or thin asphalt. However, the fact that straw is flamable makes it a distinct hazard. Some companies make a wood fiber mulch that holds together very well and its moisture retaining power is quite satisfactory. A relatively new mulch is fiberglass plus a light resin. Experiments are still being carried on with the fiberglass mix.

Many new highway areas are being seeded by this relatively new method, mostly because of the ease, speed, and efficiency with which the job can be done. As an example, a stretch of highway near Seattle was seeded in less than 22 hours and the area covered would be equivalent to more than 1,887 lawns. This is about one lawn per minute. Actual time per acre is about ten minutes, plus the time it takes to mix a new batch of slurry, plus the time for cleaning the equipment at the end of the day.

Planting of lawns, large and small, can be done with hydro-seeding. A 13 acre lawn was installed in four days using a total of 5,600 pounds of grass seed.

Now many landscaping jobs are having tree and shrub