equal to the normal size at the end of two years. You were able to gain a full year's growth by controlling water.

PETE VERMEULEN: I would like to ask what effect does a mulch on a seed bed have upon the soil temperature?

MODERATOR STEAVENSON: Although the color of the mulch may effect its ability to absorb or reflect heat, in most cases the mulch is an insulating blanket so that the soil temperature may be held back in the springtime. With us, this is a real good thing because otherwise we have seeds which germinate too early and then are caught by a late frost.

CASE HOOGENDOORN: What do you use for a mulch?

MODERATOR STEAVENSON: We use sawdust.

ROBERT FARMER JR.: I would like to make a comment in regard to temperature. There is a growing body of knowledge that shows that southern seed sources require a much shorter period of cold stratification than do northern seed sources. This is true for most species although I believe the White Pine is an exception. The temperature required at germination is influenced by the amount of cold stratfication that the seeds have been exposed to. After a short period of stratification most tree species require a high temperature but the longer the cold stratification period they are exposed to, the lower the temperature they will be successfully germinated. The optimum temperature then for germination depends upon the geographical location of your seed source and the amount of cold stratification that has been used.

MODERATOR STEAVENSON: Our next paper for this morning's session will be given by Mr. Richard Bedger from Musser Forests, Inc. and he will speak on "Conifers and Hardwoods from Seed".

## CONIFERS AND HARDWOODS FROM SEEDS

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Mr. Steavenson, Society Members, and guests. It is a pleasure to discuss with you this morning the propagation of plants from seeds. I feel that the key to this whole phase of propagation is one word "seed". We can have the most beautifully prepared beds, the most fertile soil, and sufficient water, but if the germination capacity of the seed is low or if it is sterile, the beds will be poor or fail.

In our operations at Musser Forests, we store large amounts of seed in sealed jugs in refrigerated storage. In any year that nature produces a good crop, we purchase a two or three year supply of seed. Not only is the seed cheaper but the viability in a good crop year is normally greater.

As each shipment of seed is received from the supplier, it is put in the jugs for storage. A sample of approximately 1,000

seeds is kept out for testing. We test most conifers we grow except for hemlock and white pine. These species require special pre-chilling. Mr. Claude Heit at the New York Agricultural Experiment Station, Geneva, New York, does an excellent job of testing all seeds, therefore, we get Mr. Heit to test these difficult species for us. The tester we use in testing our seed is a cereal grain tester and is not the most efficient. With most of the species we test such as pines and spruces and some of the hardwoods, it does an excellent job and serves our purpose. Most of the spruces, by putting them on moist blotting paper in the tester at 70° fahrenheit from ten to fifteen days, we can tell within a reasonably good accuracy what percent of the seeds will germinate in the seed beds.

In the past ten years, we have started growing more hardwoods from seed. These hardwood seeds, in a lot of cases, are gathered locally and planted immediately. In some cases, they are cleaned and planted. The seeds with a fleshy pulp covering such as white flowering dogwood and barberry must be cleaned before seeding. The reason these seeds must be cleaned is that the pulp covering over the seed coats retards the breakdown of the seed coat. In nature, the birds and animals do this for us by digesting the seed pulp leaving the clean seed exposed to the weather so that it can break down the seed coat and allow the seed to germinate.

At the present time, we are seeding about 30 species of conifers and over 40 species of hardwoods. The most limiting factor many times in our production is seed. As the economy improves, it appears that fewer people are willing to gather seed.

The next important factor after the seed is the soil and soil preparation. Some of our seed beds have been in the production of seedlings for up to 30 years. Other areas, as we expand, are farm land, woodland, or pine plantations that have been cleared. Each of these three areas must be handled differently. The old land which has been in seed beds for many years after the seedlings have been removed in the spring, is plowed deep and put into cover crop for the summer. Sometimes we can get in early enough to get a crop of oats and plow it down by the middle of June. Also we can still get in a crop of buckwheat or Sudan grass. This gives us two crops of green manure to improve the fertility of the soil before it goes back into the beds the following fall.

On new farm land which has been in farm crops or hay, we like to plow for up to two years before we put them into seed beds. Normally putting in crops such as rye, oats, buckwheat, or corn, never letting these crops mature but plowing them down as green manure to improve the soil and its texture. Newly cleared land such as forest land, pine plantations, or old Christmas tree ground are bull-dozed with a root rake to remove all foreign material and then plowed and cover cropped the same as the other land before being put into seed beds.

After the soil fertility has been achieved, we like to sample the soil the summer before the beds are prepared. Normally the pH in our area is on the low side and also we are normally low in phosphate and potassium. If the pH is around 5 or less we normally apply two tons of lime per acre to bring the pH up to approximately 6 or 6.5. We believe that at this level the nutrients are more available to the plants and we get a better growth than at the lower pH levels. The final phase of our soil program is a cover crop planted about the first of June which is normally Sudan grass. It is plowed down the end of July and left to rot for a month before the beds are prepared. However in the last two years, the new hybrid Sudan grasses have given us trouble because of the stems being so large that they will not rot down sufficiently to insure a good soil preparation by the first of September. We start to prepare our beds the first of September so that we can have beds ready to transplant by the 15th of September. Our bed preparation starts after the soil has been disced and harrowed. Then the soil is rotovated normally with a Howard Rotavator to prepare the soil for the throwing of the beds. The centerline of each bed is staked and the beds are mounded by a Gravely Tractor with a rotary plow. We normally do not use a bed former because in our preparation all beds are kept at a very uniform width with a uniform path. After the beds have been thrown up, in the past eight years we have used Vapam as a soil fumigant with varying degrees of results. Vapam is injected into the soil with a JP Enterprise Soil Injector. After the Vapam is injected, it is followed with a water seal of the soil. We use tank type sprayers and usually two to three applications of water is sprayed onto the surface of the soil to form a crust which holds the gas in the soil and allows it to do its job.

I feel that efficiency of the treatment is determined greatly by the weather. If the soil is too moist or too dry, or the weather is too cold or too warm, this greatly affects our treatment. In the past season of 1967, our treatment has varied considerably as to the time it was applied and the weather conditions changing. The earlier treatment which was done in early September when the soil moisture was lower and the temperature higher appears to be much more satisfactory than the treatment applied later when the soil moisture was much higher and the weather a little cooler. The later treatment was applied on some days when the weather was just beginning to change. Soon after the treatment was applied there was a heavy rainfall that night causing the gas to be forced down into the soil and therefore the surface of the beds have already begun to show weeds and grasses. This, I feel, is due to excess moisture pushing fumigating material into the soil not allowing it to come up to the surface and perform its job. At the present time, all seed beds and transplant beds required for a full year are prepared in the fall. This allows us more time

in the spring to get our nursery work done and also our shipping and packing.

As the beds are needed, we break them down with the rotavator for seeding or transplanting. The beds are laid out 54″ on the surface with a 32″ wide path. All of our tractors, trailors, and equipment, are set with the wheels on a 84″ center. This allows the wheels to straddle all the beds and also it will straddle our field rows of ornamental plants which are lined out on approximately 40″ to 44″ centers. After the seed beds are prepared, I like to fertilize all conifer seed beds with 15 pounds of 10-6-4 slow release type fertilizer per 400 square feet of seed bed before seeding. All hardwood beds are seeded without fertilizer. Hardwoods normally are much larger seeds and have a bigger food supply on which to get started. After the hardwoods are up a few inches which is usually the first of June, I like to give them a top dressing of about 15 pounds of slow release fertilizer per 400 square feet of bed. In our seeding, we like to see as much as possible done in the fall because we have more time and also germination in the spring is usually earlier and produces a slightly larger seedling than the spring seed. The spring seeding is not done until the first of June which makes the spring seeds germinate up to a month later. By the end of the first and second years, a considerable difference can still be noticed. The fall seeding has just been completed. Many of the large seeds must be put on the beds by hand. The conifiers are all broadcast on the seed bed to a width of four feet. This seeding is done with a 4′ Gandy Spreader with the axle extended to 7 feet.

After the seed is sown, it is rolled into the surface of the bed. After rolling, we cover the seed with sand ⅛″ to ¼″ thick. The sand is applied to the beds with a special sanding machine designed by Syntron Corporation which is a local magnetic vibrator company. The sander is pulled by a tractor and is powered by an electric generator. It vibrates the sand onto the bed at the desired thickness. After the sanding, the seed bed is mulched with salt hay. Salt hay is harvested in salt water swamps along the coasts of Jersey and Delaware. After the bed is mulched with salt hay, it is then covered with shades. All of our shades are made with spruce lath and hemlock rails that are 10 feet long and 4 feet wide. These shades are made without legs. We use a 24″ wooden stake driven into the ground with a 54″ cross piece over top of two stakes to hold the shades off the seed beds. Fall seed beds remain covered in this manner until early spring when the shades are raised just before the seed germinates. As the seed starts to germinate, salt hay is removed, if possible on a cloudy moist day. The removal of the salt hay is a critical phase because excessive drying of the seed at the time of germination may result in poor beds.

The hardwoods and a few of the conifers such as the *Juniperus virginiana, Taxus cuspidata capatada,* and the *Cedrus*

*atlantica* are handled differently. These seeds are rolled into the soil with a good layer of sawdust, then they are covered with shades. Some of the larger seeds such as chestnuts, black walnuts, etc. are covered with a thick coat of sawdust and also with salt hay to insure that the seed is well covered and protected from winter. We have found in the past that if the chestnuts, for instance, are not planted sufficiently deep in the soil, a poor germination results the following spring. These beds are then covered with shades and the shades remain on the bed until the plants start to grow and the tips of the new growth come up and are touching the lath on the shades. On the coniferous species and on a few of the hardwoods such as the birches, the shades are raised. On all other hardwoods, when the plants are two to three inches tall, the shades are removed and the plants are left unshaded for the balance of the season. To insure proper germination, it is sometimes also necessary to irrigate the seed beds. At the time the seed is starting to germinate or perhaps even before germination occurs, it is necessary to irrigate. For the seed to properly germinate, we must have sufficient moisture in the soil and mulch.

Seeding is only a part of the total operation. Fall seeding normally takes place the last two weeks in October and the beginning of November. Spring seeding is normally done the end of May. By the middle of June all the seedlings are up and ready to be cared for from three to four years. Bringing the seedlings through the first summer and first winter is the most critical period. All conifers are shaded the first growing season. Some of the spruces and firs are shaded through the first and second growing season. In our area some hot, dry weather occurs in June, July, and August, which makes shading necessary. Also during this period irrigation is often very necessary to insure the seedlings proper growth.

About the middle of August when the nights start to get cooler and days not quite as warm, we begin to pull the shades off the beds to harden the plants for the winter. Normally we pull the pines first, leaving the spruce and hemlocks until later in the fall. After the shades are removed, the girls give the beds a good weeding before the cold weather sets in. About the first of November mulching of the first year beds can begin. All one year conifer beds are mulched with salt hay to prevent frost heaving and winter burn. The mulch remains on the beds until early in the spring when the danger of heavy freezes which would cause heaving is passed. The mulch is then removed and stored for use the following year.

The largest single cost and the largest single problem in the growing of the seedlings is control of weeds. The treatment of the beds with Vapam is a great help but it does not eliminate hand weeding. I have done work with pre-emergence type weed control on one, two, and three year seedlings with varying degrees of result. Simazine appears to do the best job in

most cases whenever the plants show any tolerance. Most one year pines are tolerant and can be treated with granular Simazine in September and held throughout most of the second year with very little weeding. Other chemicals used have been: Dyamid, Enide, and Casaron. All these chemicals are useful in species not tolerant to Simazine, especially in the control of some grasses and a few weeds. With the cost of labor continually going up, we have found that it is necessary to resort to some of these chemical controls in order to survive in the cost-profit relationship of modern business. We also transplant a sizable quantity of coniferous seedlings. Most of the transplanting is done at the age of two years and occasionally at the end of the third year. A considerable amount of transplanting is done in the fall of the year when more labor is available. However, fall transplanting requires more mulching and special attention to pull them through the first winter. We still feel that it is a definite advantage to transplant in the fall since our other work in the spring often holds off transplanting until late in the season. We have been very successful in the fall transplanting of Colorado blue spruce, Norway spruce, white spruce, balsam fir, Frazer fir, and Scotch pine. Most of the transplanting in the spring does not get started until late in May when the trees are removed from refrigerated storage. The trees are lifted early in the season, perhaps as early as the beginning of April and put into the refrigators to hold them until we can have sufficient labor and the soil in working condition so that a reasonably good job of transplanting can be done. After the trees are moved from the refrigerators, we like to soak them overnight in water and transplant them the following day. This gives them a chance to acclimate themselves to the warmer weather outside the refrigerator. We have had some good results with this and it extends our normal planting season until the first week of June. With this operation, however, constant irrigation is necessary sometimes even in the middle of the day to insure that the trees do not dry out from the hot sun which we experience at this time of the year.

I have not mentioned anything about lifting, packing, and shipping of trees. As propagators, we forget this phase of the operation and I feel that it is very important to the consumer to receive the plants in the best possible condition. We should continually strive to improve our shipping and packing methods as well as finding new methods of handling the plants so that the consumer receives them as fresh as when they came from the seed beds.

MODERATOR STEAVENSON: It is always a great pleasure to introduce our next speaker, Mr. Peter Vermeulen. I know of no one who approaches things in a more scholarly and thorough-going manner than our recent past president. Pete is going to discuss "Seedling Propagation of Some Broadleaf Evergreens and Deciduous Azaleas".