

McDermitt: (cont'd) from which it is grown. If the seed was good, you can expect good seedlings. I am a strong advocate of good seed. You cannot get good stock from poor seed. We are planting a great deal of seed that is not good enough.

Chairman Webster: Thank you, Norman and Earl. Our next topic on Seedling Storage will be presented by Forrest Deffenbacher, Nurseryman, Wind River Nursery of the U.S. Forest Service, R-6.

SEEDLING STORAGE  
by  
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Inevitably time elapses between packing of the seedlings at the Nursery and planting them in the field. This period varies from a few days up to as much as three and one-half months, and is caused by two factors.

Weather conditions at the Nursery and at the planting site frequently are two extremes. The weather at the Nursery in fall and winter may be such that it would make it impossible to lift and pack trees, while at the planting site there would be good planting weather; on the other hand, during the spring there may be good weather at the nursery and a snow bank at the planting site. In either event the trees must be lifted prior to the time of planting; in the fall before the soil freezes at the nursery, and in the spring before new growth starts.

During distribution season trees must be lifted in advance of shipping dates, due to coinciding of orders at peak seasons. It is better management to organize the distribution crew so that extreme peak work loads are reduced to a minimum.

Storage is the only solution to these problems. Successful storage of conifer seedlings actually begins before the trees are lifted from the seed beds, for if they are not dormant then the best of storage facilities cannot keep the stock in good condition. Not only must the trees be dormant when lifted, but proper handling and packing is also necessary to insure good plantable stock when it is removed from storage.

The prime requisites of seedling storage are accurate control of temperature, humidity, and air circulation. While the seedlings are in storage, the roots must be kept moist and air circulating through the tops. There are three different types of storage that may be used: heel-in beds, cool room or cellar, and cold storage room.

The heeling-in of nursery stock is gathering together in bundles a large number of trees and placing the roots back into the soil. By doing this, a larger number of trees are placed in a smaller area, thus making control of temperature easier. A small amount of temperature control may be obtained by shading the beds in the spring, and covering them with straw in the fall to prevent freezing of the soil. Fall heel-in beds are very costly, due to the labor required to cover the beds to prevent freezing. Shade frames are first placed over the beds, then straw over the frames. The frames hold the straw from direct contact with the trees, thus reducing possible fungi damage.

The cool room or cellar usually utilizes lower night temperatures by opening doors, windows, or ventilators at night and closing them during the higher temperatures of the day. This method of storage is better than heel-in beds for spring storage because lower average temperatures can be maintained. The average

temperatures for this type storage vary from 37 to 45 degrees. This is not advisable for periods longer than two to three weeks, because top and root fungi will grow at temperatures above 38 degrees. The seedlings may be packed in bundles or bales ready for shipment and then stored in piles. There should be strips of 2"x4" lumber separating the layers of bundles, so that air may circulate around the entire outer surface of the bundles. The packing paper or other material used may help greatly to hold the moisture around the roots.

Ocean wrap is one of the best materials if the bundling or baling method is used, as it is waterproof, durable, and self-sealing. The moss or shingle tow used in a bundle wrapped with this material loses its moisture content very slowly. If the loose pile method is used, adequate space between the piles must be provided to insure air circulation to the seedling tops. Also, ample moisture-holding material should be placed between the layers of trees to prevent drying of the roots.

Storage under refrigeration is better than either method previously mentioned because temperature, humidity, and air circulation can be controlled accurately. Also, storage of this type is more economical, in that the possible loss of stock due to storage is greatly reduced. Where winter shipping demands are heavy, cold storage is the only solution because temperature control in either cool room or heel-in beds is very costly and even at times impossible. It has been found that a constant temperature of near 35 degrees and humidity above 90% is the most ideal storage condition. This condition can be maintained only by a cold storage room. The cooling unit fans keep air circulating, which helps to reduce the possible growth of top fungi.

The efficient operation of a cold storage plant depends largely on insulation of walls, ceiling, and floors. There are a great many materials that may be used, such as glass wool, cork, sawdust, and many others. The type to use depends largely upon which is the most economical in the locality where the unit is being built. The size of the cold storage room will be governed by the storage requirements: 1½ million 2-0 and 3-0 bundled stock can be properly stored in a room 20' x 30'. For this size room, three medium sized cooling units give good temperature and circulation control. A 2 H.P. and a 3/4 H.P. compressor are adequate to supply refrigerant to the three cooling units.

By obtaining insulation material, compressors, and cooling units from War Surplus, and utilizing an already existing building, the Wind River Nursery was able to construct a 20' x 30' cold storage room for just a few dollars more than the cost of heeling in stock for one year. A hygro-thermograph was installed in the cold storage room to obtain a graphic picture of temperature and humidity variations. Temperature variation at this plant is only 3 degrees, and humidity 4%.

By and large, seedling storage is merely one phase and must be tied in very closely with every other part of the distribution job for good planting stock at reasonable cost.

Augenstein: Have you stored spruce?

Daffenbacher: Only one year, so we are unable to give results.

Augenstein: We do not have good luck in Engelmann spruce and find that it molded at 34°. It is the only species we had that molded.

Question: In what period of time? Answer: In about the third month.

McDermitt: Does one unit take care of your refrigeration in a 20 x 30 room?

Deffenbacher: No, I would say one on each side blowing across the room. One unit faces the other.

McDaniel: What percentage of humidity do you maintain?

Deffenbacher: We run about 90%.

Augenstein: I believe you should have more than one unit in case the other should go out.

Hagenstein: How long do you have the seedlings in there?

Deffenbacher: Approximately three months.

Hagenstein: We usually have them in no more than three weeks, but we do not have a cold storage unit.

McDermitt: A good deal depends on weather conditions and whether trees are wet or dry.

Cronmiller: Do you find much fluctuation when putting in 50 or 60 thousand in storage?

Deffenbacher: Not more than a few degrees. The temperature would be back down in a day.

Augenstein: Are yours all in bales? Answer: Yes.

McDermitt: There is a question in my mind as to complete dormancy. Our planting crew wanted trees before they are dormant. Sometimes it is hard to get complete dormancy. I have seen seedlings come out of storage with buds on them.

Rindt: I have transplanted trees in the nursery that were putting out buds that did very well. So it can be done, but it is not good practice if you run into dry weather. All our planting sites were of high elevation and the planting season could extend into June, but our nursery season ends in May. Our planting season is very short and some of the sites we cannot get into at all.

McDaniel: Do you know what storage costs?

Deffenbacher: We installed a 2 H.P. compressor and 3/4 H.P. compressor, which we got on surplus and was installed very cheap. Our labor on it cost a little over \$700. We were told that one of our units cost \$800 without the room.

Augenstein: We have tables built 7' x 30" high where we pack bales or crates and they get mold in the trees if one is on top of the other. We packed some in bales and put some in loose. Two years later the loose was still good and got fine survival on it. It seems that the secret of storing seedlings is to keep them moist.

Chairman Webster: Do you wet them between fall and spring?

Augenstein: No. In packing them loose the shingle toe is not wet but damp and we lay a wet burlap on top that we sprinkle. The tops should be kept dry or you will get mold. Our humidity is 70 to 80%. We lay trees in a circle with roots toward the middle. Then cover with burlap and shingle toe in the middle around the roots. We just keep the top wet and the bottom never dries out. Fifty trees to the bunch and packed tight.

Chairman Webster: How long do you keep them that way?

Augenstein: A year ago last fall in September we put them in and took them out in April. This year we had rain so we started in August and quit for a week and started again and the ones we put in early did as well as those we pulled later.

Deffenbacher: We had trouble with burlap molding but not with the ocean wrapping.

Engstrom: How do you explain that? Deffenbacher: Just the burlap molds, not the trees.

Augenstein: If you keep humidity and temperature down, you won't have mold.

Rindt: I had the idea that the cool temperature was for keeping mold down.

Wright: If you keep temperature down, you get a superficial mold that will do no damage. It is on the burlap. It would not get on the roots or trees.

Rindt: My question is this. If mold develops on burlap in temperature of 34°, will that mold rot the trees inside the burlap?

Wright: If you leave it beyond the normal storage period, it is likely to.

Rindt: What do you consider normal storage? Answer: Three or four months.

Question: Then there is some merit in wrapping and packing trees in material that is mold resisting?

Wright: You have less danger of the trees being molded or rotted.

Chairman Webster: What about some of these bacteria-killing lights? They are being used by florists and butchers. Do they have any effect on mold?

Wright: You do get some effect on fungi from light that will kill them.

Barrett: I would like to ask what has been done on transpiration of trees in storage while dormant.

Chapin: They will lose weight. According to the amount of weight loss your survival will be down accordingly.

Stubbs: Using 34° temperature in storage is that the optimum or minimum? Why the 34?

Deffenbacher: As near as I know, when you start to freeze your plant, you will reduce the moisture content. Therefore, it should not be frozen.

Stubbs: Should the temperature be held the same throughout the storage period?

Rindt: Any place between 32° and 40° appears to be satisfactory for retarding mold and maintaining the seedlings.

Augenstein: A cold storage unit, if properly adjusted, automatically defrosts at 34° F. but does not defrost well at lower temperatures.