

# PROCEDURES USED IN MAINE FOR OVER-WINTER STORAGE OF NURSERY STOCK

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## FIELD PROCEDURES

There is nothing new or special about growing bare root conifers for cold storage. Before following my procedures, however, you need to understand that the Northeast region, particularly the State of Maine, is different from most other regions in the United States or Canada. The timing for any particular region needs to be taken into careful consideration. It must be remembered that within a short radius there can be considerable differences in temperatures, moisture, and other variations which need to be taken into account.

Our fertilization program commences about the middle of August and can run into September, depending on weather conditions. I utilize straight nitrogen fertilizer. We use Urea 45, and apply this at 50 to 85 lbs per acre depending on the species involved and the time of application. An example is digging and storing any species that continues to grow from spring until a good fall frost slows down the growth process. You do not want to induce growth in the plants late in the season because they will be seriously affected by cold storage. In addition, they can be hit with an early fall frost and top growth lost. Douglas fir, Norway, and white spruce need to be watched carefully in order to avoid secondary top growth developing from heavy rain plus high temperatures late in the season. Sometimes I apply fertilizer to these species in mid to late September, even the first week in October. Colorado blue spruce and Black Hill spruce cease growth by mid-August or early September. The idea of fertilizing at this time of the year is that the fertilizer will be absorbed in the root zone without forcing top growth. The energy is stored in the roots. Nitrogen in the roots helps sustain the plants and gives them a lot more vigor, not only for the following year's growth, but helps the plant through over-winter storage.

Another critical point in the field procedures is to monitor soil temperatures at a 6 in. depth throughout the areas where the various species are going to be dug for over-winter storage. We set thermometers in 3 or 4 separate areas. We also try to set the thermometers where there might be a slight variation in soil type. For instance, some soils are medium to moderately heavy loam, others might be a relatively light, sandy loam.

In general, the fibrous root systems of most conifers are

satisfactorily hardened off when the soil temperatures within the top 6 inches have achieved 110 degree days below 10°C. Another method of checking for the proper fall digging time is to dig samples of each species and find out how the white root tip growth appears. This growth should be about a ¼ to ⅜ of an inch in length or shorter and, as this white root tip shortens, it turns a slightly brownish color. With each species there is a difference in the time taken to shorten this root growth. Once you have accomplished the shortening of the white root tip and/or have accumulated 110 degree days, you should be ready to dig for cold storage. Deciduous tree and shrub seedlings usually vary somewhat from the conifer transplants. This depends on the cultural methods applied during the growing season. Usually white birch is the first species dug and is followed by larch, autumn and Russian olive, and lilac. The principal criteria used is to make certain all leaves have fallen or can be easily removed in the sorting process and, in the case of larch, that most of the needles have or will come off. All these species will stand a longer refrigerated storage period than conifers.

We dig our spruces first, followed by the firs, and then pines. We leave until last those species which tend to grow the longest in the fall, namely *Taxus*, *arborvitae*, and hemlock.

#### DIGGING METHODS

We normally dig our seedlings with the Egedal Type R lifter; they are pulled by hand, packed into boxes, sprayed lightly with water, then covered with a heavy burlap to be transported to our cold storage facility. There they are wet down after removal of the burlap from the top of the box, wetting the seedlings so that moisture penetrates the box completely. The burlap again is wet, and then the seedlings are put into a room at 35° to 38°F. Then we leave them in the temperature controlled room until such time as we are ready to grade and sort. We try to grade and pack all material for cold storage as soon as possible after digging. We try to get as much material dug in the shortest time and stored under controlled conditions until they can be put into cold storage for winter in boxes all graded, sized, and tied in bundles. When spring comes all we do is remove them from cold storage and prepare them for shipping.

With the transplant material we use the Grayco Harvester to do the bulk of our lifting for over-winter storage which digs deep enough to allow for all the fibrous roots to be dug with the plants. This eliminates any tearing of the roots and gives much better survival in cold storage. In our system of planting in the field, we plant transplants in 6-row beds and our seed-

lings are broadcast sown. We have some success in digging white birch and common lilac when they are 12 to 18 in. in height with the Grayco digger, but generally it is faster and more economical for us to lift the seedlings and pull them by hand. This eliminates quite a bit of soil that would have to be returned to the field if they are dug with the machine. We have a tractor that pulls the Grayco Harvester with two men, one on each side of the digger taking the transplants from the digger bed chain and placing them in a box. A tractor with a fork lift and water spray tank mounted on the back follows the digger. Each time a box is removed from the digging unit, it is placed on the ground, and sprayed with a fine mist; then the curing blanket, being wet, is also put on the top, and then it is loaded onto a trailer. The truck driver is responsible for marking each box of trees as to age, size, and block. As they are loaded onto the trailer a canvas covering is pulled over the boxes to protect them from wind and sun. The best time to dig is when it is neither too dry or too wet. On a windy day, you need to exercise more care and perhaps use more moisture on the seedlings in the field. Once the digging operation is under way, and the diggers are digging faster than the material is being graded in the packing shed, it is important that all boxes of trees are properly marked before being put in the controlled storage room so that the trees will be graded and sorted in the same sequence as they are dug in the field. This allows for minimal amount of time from the field to actually putting them into cold storage.

Trees that are left in the cold storage unit for any length of time prior to processing need to be checked daily for the proper amount of moisture in the boxes. If moisture needs to be added, the box is usually taken down and sprayed lightly having had the burlaps removed and then put back on again.

Prior to any digging, I make a chart of all the species to be dug. This is usually run through our computer system so I know exactly what is to be stored. Up to this point all of our cold storage material, with the exception of what is to be used for retail mail order, is contracted for ahead of time by the customer stating that he wants his material in cold storage. Then I take these figures by species and compile another chart in a sequence which I want plants dug and handled. As we go through each individual species we try to get the closest we can to the right amount of material dug. This assures that all stock by species is dug as closely to one time as possible. We generally know from our spring inventory approximately how many trees per foot per bed and by species are in the field. When we fall dig we measure every species for the amount we want dug, using our June inventory on a per foot basis of that

bed and species. This does two things; first, we know exactly the footage we dig for cold storage and our inventories can be corrected for material left for spring digging. We also can determine from the initial digging how much we need to dig to come up with shortages if any occur. The biggest factor here is that our inventories are corrected from the spring inventory to get a close count of what is left in the field. When we finish our digging, each species is recorded to exactly the number of feet dug and the number of trees from that footage.

### STORAGE CONTROL METHODS

We have in our packing and shipping facility two cold storage rooms of different sizes. One room is held at 28° to 29°F throughout the winter. The other room is at 35° to 38°F to hold the stock being dug from the field until it is graded and put into frozen storage. The latter room is gradually filled with unsorted material, as the sorting crews usually cannot keep up with the diggers. Each of these cold storage rooms has thermostats to maintain a maximum variation of 3°F. At the start of our cold storage digging, the outside temperature is watched; the thermostat in the holding room may have to be varied slightly to accommodate outdoor fluctuations. We try to maintain a 6° to 10°F lower temperature in the holding room than the average outside temperature. We control humidity in the freezing storage by keeping the concrete floor wet. Once the temperature in a room is set at 26° to 29°F, it is usually unnecessary to worry about the humidity in that room since everything is sealed in polyethylene bags and is in a frozen condition. Each night all boxes in the holding room are wet down by spraying them with water. As the room begins to fill with freshly packed material from the grading tables, the controls have to be monitored daily and, as more boxes are put in storage, before they reach 29°F the temperature has to be dropped down to 26°F to create a greater temperature difference so that the stock will freeze more quickly. When the room is completely filled, the temperature has to be watched to be sure the controls are maintaining the optimum range. When the thermometers show a constant 26° to 29°F range, then the thermostat setting can be checked and left for the rest of the winter. We do check every 2 weeks to make sure that all the boxes have adequate moisture and the proper temperatures are maintained. We have alarm systems built into our control units so that if something goes wrong, we are notified immediately. After the number one room has been completely filled with cold storage material, the number two room is gradually worked down in temperature to the desired level. That room is filled in the same manner, the only difference

being that if there is a lot of material still ungraded, then some of it has to be removed at this point to a cool area of the building. Hopefully, by that time it is the end of November or early December and certain areas of the grading room are in the 35° to 40°F range. We plan to have all of our grading tables working at maximum efficiency during the whole time. We have 6 grading tables utilizing 4 to 5 people per table. We generally work only 8 hour days.

We can store 1 to 1½ million seedlings and transplants, depending somewhat on size and bulkiness of the stored material. Once our grading is completed, we have a chart outside the large coolers where we map each box of trees, locating it by size, age, and species so that at any time during the winter material can be pulled out for shipment. We do some shipping of retail material for mail order firms and also ship material to other mail order nurseries.

We generally do not start shipping until about the first of March. The material that is coming out then is nearly all wholesale stock. We find that we can take this material from the cold storage room, pack it directly in shipping boxes, or roll it into jelly roll bundles for transportation to the customer. We do not have to thaw this material. It is not frozen hard in cold storage, so it can be handled quite readily without any damage to the branches or roots. One thing that aids in the process is not having to warm up a cooling room warmer than is warranted for an extended period of time. The material taken out, packed and shipped, reaches the customer thawed out, whether shipping by common carrier or picked up by the customer. There are no frozen materials that create problems in pulling the plants apart and preventing planting upon their reaching the customer. Usually material is taken from the coolers 24 to 36 hours prior to shipping in order to facilitate handling.

### GRADING AND SORTING

All material is tied with plastic twine, the reason being that by its use there is less chance of botrytis or other molds forming where the plants are tied. Once the trees are tied in bundles they (roots only) are carefully dipped in a bucket of water to assure that all are damp. They are placed root to root in boxes at the end of the sorting table with the tops kept as dry as possible. Once a box is full, it is moved to another area of the room where boxes are prepared for cold storage. We use a 2 mil poly bag designed to fit our boxes. Our digging boxes are the same as those used for cold storage. They are basically the same as apple boxes (45 × 48 × 30 inches). We have a

smaller box we use when digging seedlings and we sometimes store smaller stock or small quantities in these boxes.

The plastic bag is opened up, put into the box and a layer of sphagnum moss placed in the bottom of the box where the roots will be placed. Depending on the size of the nursery stock that is being put in the boxes, we put 1 or 2 double rows per box. The bundles of trees should not be packed tightly in the box. We do not use moss between the layers of trees. If the moss has sufficient moisture you can squeeze a handful, and just get some water dripping out. The moss in the bottom of the box is sufficient for that tier of trees; on the top of the box, after the last layer of trees has been put in, another layer of moss is placed over the roots.

Having experienced a winter using cold storage material dipped in a water absorbing gel, I now have some views on the use of this gel. There are several products of this nature currently being marketed, all which have similar properties. They are all designed to help hold moisture to plant root systems to reduce transplant shock as well as to assist in water absorption capacity of soils in dry conditions.

We used this material as a spray dip on the root zone at time of grading just prior to winter storage. There were problems observed at our 29°F storing temperature in that moisture was drawn into the root zone and froze. From visual observation in March and April when the trees were removed from storage for shipping, the roots and bark were discolored. It appears they virtually drowned from too much moisture being stored in the roots. Also the trees froze much harder than without the use of this material at time of storage.

My advice at this time would be to fall dig and grade with a minimal amount of moisture. Moss at the bottom and top of the boxes will keep the proper moisture level and avoid hard freezing. At the time of shipping in the spring a root dip or light spray of the water absorbing gel will reduce transplant shock and aid in water holding capacity of the roots. This aids during dry periods immediately after grading and shipping.

We are using several of these materials in our transplant work in the fields. Our seedlings are dug early in the spring and stored at 36°F. At time of planting they are root pruned and dipped or sprayed with this material before being placed in the boxes, transported in the field, and placed on the transplant machines. Results so far indicate a reduction in transplant shock and enhance the water holding capacity of the roots, thus increasing survivability of the seedlings and transplants. We also will experiment with a long lasting residual

fungicide to reduce fungal bacteria from forming during handling and during transport from cold storage to customers.

Once the box is completely filled, the plastic bag is pulled up, and either stapled or tied tightly, and the plastic pushed down so it is flush with the top of the box. This is to make certain that when the fork lift picks up the boxes and stacks them, none of the plastic is torn.

Another method of checking for moisture content throughout the winter is to inspect a box of trees and if crystals of ice on the inside of the plastic bag occur, there is sufficient moisture in the box. Otherwise, something is amiss; there is a leak or hole in the bag and moisture needs to be added. The plastic bag is opened and gently sprayed with water and recovered with another piece of plastic. Finding how moisture leaked out, repairing it and immediately placing the box back in cold storage is essential.

Once the boxes are completely sealed with plastic, they are stacked and await transport into one of the cold storage rooms. We have designed a careful procedure to monitor the placing of boxes in the cold storage rooms. We keep all retail material in one area. All of the wholesale material is packed in tiers and placed in a sequence where, at any time during the winter, we will know exactly where the material is located. We have laid out our cooler floor plan by striping the floor in squares the size of the boxes. We letter the rows one way and number the other way. Thus we can pinpoint any box at any time, and since all boxes are tagged with the size, age, and species, we eliminate wasted time locating material. All this is recorded on our wall chart outside the coolers. The sooner the material can be put into the cold storage room the better the results.

We have found with larch, it is not essential that all needles be removed, but we do try to shake the plants and the bundles to remove as many needles as possible. With birch and lilac, we want to get all the leaves off so that when they come out of cold storage, there is no chance of *Botrytis* forming.

It is essential to have an accurate count of the material in each box. One of the best methods is to use the best people possible when packing so that you can rely on their count. Also once they have completed packing the box, the person in charge of the grading and sorting makes a tag with the date, size, age of the stock, and the number of trees in that box. The packer initials the card so that when you unpack the box you know who the packer was, and if the count is correct. If there are too many counts that are wrong, then that person should

not count stock in the cold storage boxes the next year. Once the counts have been made for each box, the person in charge of grading and sorting keeps a tab on them on a chart and the final figures for that particular group is given to me each day. Then I make a determination whether we need to dig more or if we have over-dug. I carry on my sheet a surplus material column so that when we get everything in cold storage, I go back to the office, run everything through the computer listing every species by age and size that is in cold storage. If we have a shortage or a surplus, then the office staff decides how to handle this. If we have a surplus, we can sell it for early shipment if a customer comes along and desires that material. If there are shortages, generally we notify the customer immediately that the balance of the order will be shipped as soon as we can fresh dig the stock in the spring. We endeavor to ship all material from cold storage prior to April 10th. At about that time we can fresh dig again for spring.

### SHIPPING FROM COLD STORAGE

Generally we do not ship material from cold storage before March 1. Occasionally we get requests from a customer who would like their material sooner, so we have it marked and placed so we can get it out early. The first 2 weeks in March we ship large quantities of material to the southern tier of states, mostly for Christmas tree planting stock. About mid-March the temperatures in the cold storage rooms are raised to 35°F which allows for a gradual thaw of all material. The boxes at the top of the stacks thaw out more rapidly than those on the bottom, so we watch this closely. Once the temperature is raised to 35°F, it is kept constant throughout the spring shipping season. This facilitates the handling of cold storage material and also allows us to dig from the fields and store in cold storage. This allows for storage of spring-dug plants until the first or middle of June. We endeavor to spring-dig all necessary material prior to bud swelling. With a temperature of 35° to 38°F we can safely store stock up to 6 weeks with no adverse effect. In the shipping of cold storage material nothing is different from other shipping procedures.

One should not keep material any longer than necessary in storage so that it can be put into the ground promptly and prior to bud breaking in the planting area. We keep abreast of weather conditions in our shipping areas, so as not to ship to any area where we feel that it would be an imposition on the customer in having to hold the material and not being able to get it into the ground as soon as it is received.



## CONCLUSIONS AND OBSERVATIONS

Our cold storage period is from November 15 to April 10, and there has not been any deleterious effect on the stored material. Any problems that have occurred are not from the refrigeration, but from some handling error. With some species there is a slowing of growth the first year in the fields, particularly Colorado blue spruce. The growth rate the first year out of cold storage is probably equivalent to freshly dug stock in the spring. This can be changed by planting cold storage stock as soon as the frost is out of the ground. With most other species we got relatively little difference in the growth pattern or the growth rate that first year out of cold storage. The biggest advantage in the whole procedure, as far as the customer is concerned, is being able to get his material and get it into the ground at the proper time for planting in his area. In Western Maine we are able to dig much of our material in the fall, put it into storage, and get it shipped out prior to our being able to dig anything in the field in the spring. This allows us to increase our production capacity by the approximate capacity of our cold storage facilities.

In the fall of 1980 we dug, for the first time, Canadian hemlock and put this into our cold storage facility. We had as good success with hemlock as with any species. We have tried storing American arborvitae and *Taxus cuspidata* (Syn.: *T. cuspidata* 'Capitata') with no ill effects.

We endeavor to make the maximum use of our cold storage facilities. We use them throughout the shipping season in the spring, and have held freshly dug stock from late April until mid-June. The cold storage facility allows shipping to the northern tier of states, as well as into parts of Canada, where their planting seasons are even later than those in Maine. Another advantage is that in the spring we can dig stock that we know is going to be picked up or shipped. When time permits, we dig ahead and get this material into cold storage. This also allows us to get material ready for customers who are going to pick up stock, well in advance of the pickup date. The customer does not have to worry about inclement weather in our area in picking up his stock when he wants it. It also allows stock being available to be shipped at a specific date in order to meet a deadline that the customer might have. Also when our spring digging season has progressed to a point where we are pretty well ahead of our shipping, we pull all our seedlings that are going into transplant beds in the spring. The seedlings are placed in cold storage at about 36°F. They can be held until such time as they are root-pruned and again ready to go back into the fields onto the transplanting ma-

chines. The coolers are kept in constant operation until all material is either shipped out or gone to the field for transplanting, which will run from June 1 to 20. Then the units are turned off, the cold storage area is cleaned thoroughly, and aired out ready for the next season's use. We turn the coolers on at 50° to 55°F the first of August in preparation for our fall transplanting. Again the seedlings are dug in the fields and placed into the boxes, utilizing the plastic bags, covered, and put back in the cold storage rooms until they are root-pruned. They then go to the field for transplanting. Anytime after mid-August, when some of the planting stock has reached a desirable point of dormancy, a customer desiring shipment can have the material dug and shipped or be ready for pickup. The use of the cold storage facilities at this time of the year is beneficial in that we can dig ahead of time for the customer, store it under the cooler conditions and keep it for 2 or 3 days. We do not like, nor do we think it is advisable, to keep transplant stock in the cooler in the fall any longer than absolutely necessary. The advantages here are for the customer to be able to obtain the stock and put it into the ground in the fall under his optimum planting conditions and thereby obtaining some fall root growth prior to complete dormancy for the winter. This will facilitate more growth in the spring than would normally be obtained by cold storage or use of freshly dug stock in the spring of the year. We generally keep the cooler at 50° to 55°F until approximately the middle of September, depending again on current weather conditions. The temperature in the cooler is gradually brought down in 4° to 6°F increments to the 35° to 36°F level as the fall progresses.

RICHARD WOLFF: *Did you put a fungicide in the gel?*

ROBERT EASTMAN: *There is no need to put a fungicide in the box because you do not get any mold below 32°F.*