Greenhouse Transplants for Bareroot Stock Production[1]

Robert A. Klapprat[2]

Abstract.--The propagation of tree seedlings at very dense spacing in greenhouses, then transplanted with an automatic transplanter into nursery beds, has become an operational method of producing forest regeneration stock at the Thunder Bay Forest Nursery. This system optimizes; reliability, production capacity, seed utilization, stock quality and operating efficiency

The stock requested by clients of the Thunder Bay Forest Nursery is mainly the black spruce species and the transplant stock type. Its production is a two phase process; the seedling phase and the transplant phase. It has been the seedling stage that has presented extraordinary production challenges at this Nursery.

When black spruce seed is sown directly into the soils of the Nursery many elements and conditions over which we have little or no control immediately begin to work against the successful production of that crop. Even some of the precautions taken to alleviate a particular threat can have detrimental effects as well. Some of these concerns include; <u>seed placement</u> which can be: too shallow, too deep, too close together or delayed, <u>soil</u> <u>erosion</u> which can result from: wind (saltation, rain (wash-out and compaction), run-off (wash-out), irrigation (wash-out and compaction), <u>hydro mulch</u> which can be restrictive to emergence <u>shading</u> which can impede surveillance restrict or limit applications, destroy seedlings from frame legs, create drip-lines from wires, restrict machine manoeverability, <u>hand weeding</u> which can cause trampling uprooting seedlings with the weeds, and compaction, <u>pre-emergent and post-emergent herbicides</u> can be somewhat toxic to tree seedlings, <u>insects</u> can cause deformity and mortality from feeding,
<u>diseases</u> such as damping-off and snow mould can cause deformity and mortality,
<u>birds</u> can cause deformity and mortality from their feeding,
<u>traffic</u> from people and machines can cause compaction, trampling, deformity and mortality,
<u>weather conditions</u> may retard germination and growth, can cause frost killing and frost heaving and flooding can cause destruction and mortality.

All of these elements are not constant. They do not have the same impact each year. During some years the combined impact may be significantly greater than in other years. Though our long term records indicate the necessity to place up to 12 seeds in the ground for each tree shipped, the fluctuations in any one year can cause drastic detractions from our reliability in achieving targets. It is this concern which prompted us to move toward a more controlled method of producing transplants; hence greenhouse transplants.

Reliability in meeting targets is achieved by more successfully nurturing germinating seeds to become surviving trees. The use of seed is optimized since each seed is placed in a microenvironment that is conducive to growth hence a greater survival percentage can be expected. Production costs are reduced as the very slow and costly processes of harvesting, grading, sorting and packaging seedlings for transplanting, and transplanting with semi-mechanical equipment are eliminated. Stock quality is improved as the stresses induced from root pruning, exposure time and nutrient depletion during transplanting as well as deformities resulting from the planting processes and frost heaving are eliminated. The production capacity of the Nursery is increased as the rotation period is reduced to two years and as compartments formerly used as seed beds can now be transplants. Harvesting costs are expected to be reduced from resulting uniformity as bed-run harvests become a reality and bulk

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[2]Robert A. Klapprat is Superintendent of The Thunder Bay Forest Nursery, Ontario Ministry of Natural Resources, Thunder Bay, Ontario, P7C 4T9 Canada.

shipments are accepted.

The decision to proceed with the Techniculture system is the culmination of many tests, trials and investigations on container types and handling systems over several years. Different products had different advantages to offer for the various stages in the production process. But the one that pulled it all together from our point of view was the Techniculture system as developed by Castle & Cooke of California. Some of the considerations which made the system particularly attractive to us include:

<u>The medium is ready to use;</u>
There is no necessity to purchase several components such as peat, vermiculite, perlite, wetting agents, etc., which must be accurately blended and mixed in special mixing vats. Also avoided are the filling lines and warehousing requirements of alternate soil medium and tray choices.

<u>Greenhouse space optimized;</u>
Each tray has 400 cavities. A typical 9.2 x 42.7 meter greenhouse will hold approximately 1.2 MM trees in a single crop. With three crops per year, one house will produce 3.6 MM trees. <u>The design and configuration are culturally correct;</u>
The plug shape can accommodate the tap root of coniferous seedlings. The indentation/cavity within the plug permits ideal seed placement for even germination and growth. <u>The system lends itself to mechanization;</u>
Since plugs retain their conformity they can be handled mechanically. The square dimensions of the trays permit easier alignment at all stages of production and handling.

<u>The concept is a "system;</u>
All components are readily available to assemble a system: trays, seeder, benching, handling, transplanting.

USING THE TECHNICULTURE SYSTEM

Central to the Techniculture system is the stabilized growing medium. It is a dimensionally stable mix of peat moss and a non-toxic binder. This medium is formed in tapered cavities which are 1.27 cm x 4.45 cm. Each resultant plug has a formed indentation which is 3.2 cm in diameter and 8 mm in depth. There are 400 plugs in each tray which has dimensions of 32.1 x 32.1 x 3.8 cm.

When trays are received from the plant in California they are already filled with the rooting medium. They usually arrive via tractor trailer and are packed on plastic wrapped pallets. The medium is moist from the manufacturing process and it is best kept that way since the plugs contract as they dry. Though trays are usually used within a short time of their arrival, we have on occasion stored them for several months without any fungal growth on their surface or any other deterioration in quality. Until recently we have discarded empty trays after use as it was not economical to return them to California. With the large quantities we are using now it is possible to make up a full load of reusable trays thus creating a back-haul for the carrier and making their return economically worthwhile.

Upon receipt at the Nursery, the trays are covered with a thin layer of the medium. This is a result of the filling process. It is actually beneficial in holding plugs from falling out prior to seeding. At seeding time this layer of material is removed with a wide putty knife. For the seeding process, a template with funnel shaped holes is placed over the tray and seeds are dropped into the cavities by the Vancouver BioMachine seeder. After seeding, the trays are moved by conveyor to the greenhouses where they are placed on a benching system made of Y-bar. This support system allows trays to be slid along the sides of the greenhouse. This also eases the handling during the thinning and removal processes. It takes about 14 hours to seed and fill one greenhouse.

Immediately after filling the greenhouse, irrigation begins. Frequent misting promotes rapid and even germination which, for black spruce takes 7-10 days. Because each seed is placed in an identical micro-environment, that is, a cavity which is 8 mm in depth and 3.2 mm in diameter with no mulch covering, germination and growth is usually very uniform. This is particularly beneficial in a crop like spruce which has tremendous genetic variability.

As soon as germination is complete and the seed caps are dropped and before lateral roots begin to develop, the crop is thinned. It is important that the stocking is reduced to one seedling per cavity since multiple seedlings per plug would result in multiples after transplanting and would not be acceptable for shipment after harvesting. This is a laborious time consuming operation which we hope to eliminate through more accurate seed placement and improved seed quality.

By the time thinning is completed lateral roots begin to develop and fertilizer is applied in solution with irrigation water. We begin with a "starter" fertilizer (11-41-8) at 50 ppm for 2 weeks, then switch to "grower" fertilizer (20-8-20) at 100 ppm N for the active growing period and finally a "finisher" fertilizer (8-20-30) at 40 ppm N during the conditioning period.

Three crops are grown in the greenhouses each year. The spring crop is grown from mid-March until late May/early June after which it is taken directly to the Nursery for transplanting. As the greenhouse is vacated of this crop the second crop is seeded and placed in the greenhouse. Dormancy is induced in that crop by July 31 and it is moved to outdoor holding areas by mid-August when the third crop is seeded and placed in the greenhouse. Dormancy is induced by mid-October and temperatures are reduced in the greenhouse in order to promote hardiness in the crop.

Frost hardiness is monitored after November 1, so that the crop can be transferred to cold storage after there have been two successive weeks of freezing tests with index of injury of 5% or less at -10°C.

For overwinter storage, the trays are placed vertically in boxes which are poly sealed and placed on pallets. The storage temperature is held at -2°C until removal for transplanting the following May.

Stock is removed from the frozen storage a day or two before transplanting to permit the plugs to thaw. They are then given a good watering prior to transferring to the field for transplanting.

For subsequent transport and handling trays are placed in large cartridges. This permits easy transport to the field by truck and handling with a fork lift. The cartridges are placed on carrying platforms on the transplanter and the transplanting operation can commence.

The transplanter is a diesel powered, self propelled four wheel hydrostatically driven short turning carrier unit which supports eight high speed *planting* heads that can extract and transplant trees from trays that are inserted into the mechanism from the two large cartridges by two operators.

The field speed of the machine can be up to 2.0 kilometers per hour and it has a capacity of planting from 160-180 thousand trees per hour. As comparison the Holland transplanter moves at about 3-3.5 meters per minute and can plant about 15 thousand trees per hour. As already indicated, the overwintered crops are planted in a dormant condition in May and the current crop is planted in an active condition in June when the danger of frost is passed.

The transplanted stock is grown in the fields of the bare root nursery for two years prior to harvesting for shipment for plantation establishment.