Softwood seedling production by cuttings

Michel CAMPAGNA, Ing.f., M.Sc.
Pepiniere forestiere de Saint-Modeste
Ministere de l'Energie et des Ressources du Quebec

Paper read at the Northeastern State, Federal and Provincial Nurserymen's Conference, Montréal, Quebec, July 24 to July 27, 1990.

Abstract

Since 1989, the Saint Modeste nursery has had the responsability of operating a large scale softwood cutting production center. This new type of production has been added to the already existing bareroot and container production. The cuttings are harvested on juvenile mother plants of 3 years or less. Using special hermetical compartments made of polyethylene, to create favorable conditions to improve rooting of the cuttings, is a unique technique called the *Bouturathêque.* Twenty-four compartments divided into 6 groups of 4 stacked compartments constitute the heart of the system. Actual production rate allows the center to deliver 1 million rooted cuttings per year for reforestation or research purposes. Present work aims at obtaining a rooting percentage of 90% or more. Cutting operations concern mostly black spruce *[Picea mariana* (Mill.) B.S.P.].

Résumé

Depuis 1989, la pepiniere de Saint-Modesto, M.E.R. a la responsabilite de gerer un centre de bouturage d'essences resineuses.Ce type de production complete les cultures de *semis a racines nues et en recipient déjà existantes. Les boutures sent prelevees sur des pieds-mares juveniles de moins de 3 ans. L'originalite du systeme repose sur les enceintes hermatiques construites* avec *du polyethylene qui sent disposees les unes par dessus les autres par groupe de 4. Cet ensemble d'enceintes superposees se nomme n bouturatheque ". Le rythme de production actuel permet de fournir un million de boutures racinees par armee. Les semis genetiquement ameliores qui proviendront de la bouturatheque seront destines au reboisement ou a des fins de recherche. Les travaux entrepris devraient permettre d'obtenir un pourcentage d'enracinement de 90% et plus. L'essence qui accapare la majorite de la production par bouturage est repinette noire [Picea mariana (Mill.) B.S.P. j.*

Introduction

The M.E.R. nursery of Saint Modeste is located 20 km from Riviere-du-Loup, which in turn is about 200 km from Quebec City.

The nursery has been operating since 1961. Eighty hectares are presently used for seedling production but the total area available for that purpose covers 150 hectares. Some sectors are devoted exclusively to bareroot production (60 hectares) while some others are used for container seedling production (20 hectares).

Bareroot production

The actual production rate of bareroot stock allows the delivery of 7 million seedlings every spring. Species involved are black spruce *(Picea mariana* (Mill.) B.S.P.), white spruce *[Picea glauca* (Moench) Voss], Norway spruce *[Picea abies (L.)* Karst.] and jack pine *(Pinus banksiana* Lamb.). Most seedlings are shipped to the planting site after four years in the nursery. The production cycle involves a lifting and transplant operation in the beginning of the third spring, hence these seedlings are commonly called 2 + 2.

Production rate could be enhanced to 14 million available seedlings each spring. This rate has been reached once, in 1985.

Container seedling production

Actually container production supplies 7 million seedlings each year for planting. This type of production concerns the same species as the ones mentioned earlier for bareroot production. However, the production cycle is cut in half since the seedlings are fit for planting two years after seeding. The first year of growth is done under unheated production tunnels. The second year is completed outside. The total capacity of the container seedling production at the nursery was reached and maintained since 1986 when 16 million seedlings were produced. Two types of containers are commonly used. The first is a 45 cavity container that offers a capacity of 110 cm^3 per cavity. The second container has 67 cavities of 45 cm^3 each.

Bareroot and container seedling production are the most common ways of producing quality stock for reforestation. However growing concerns are being focused on the genetical quality of the seedlings produced. The cost of producing, planting and maintaining artificial regeneration justifies growing genetically improved stock to rise the performance of future forests.

A tree improvement program necessarily involves testing different families of a same tree species in order to find the best genotype in relation to field type.

In order to realize these trials, a reliable source of genetically identical seedlings have to be available on a regular basis. Seed orchards do not allow geneticists to reproduce seeds descended from the same parents year after year. However this need can be fullfilled by propagating conifer cuttings from juvenile material. Propagating seedlings by cuttings maintains the genetical identity from donors to plantlets and offers the regularity associated with ordinary seedling production.

Since 1989, Saint Modeste has been given the responsability of operating a large-scale cutting production center. Three main fields of activities are related to the production of coniferous cuttings. Species involved by this improvement program are black spruce, Norway spruce, white spruce, hybrid larch *(Larix eurolepis* Henry) and jack pine.

1- Growing the donor seedling

All the cuttings originate from juvenile donors. This means that the mother plant has a productive life of about 2 to 3 years. The donor seedling can originate from:

a) Seeds coming from controlled crosses between trees belonging to the best known provenances, progenies and clones for a given breeding zone.

b) Seeds coming from selected half-sibs collected in seed orchards.

Cuttings can be harvested as soon as the donor has reached a reasonnable dimension (about 15 cm tall). Afterwards harvests will be performed every 10 to 13 weeks so 4 to 5 harvest can be done each year. Donors growing in the 45 cavity container give as much as 15 cuttings per year. After each harvest, long remaining shoots are trimmed to stimulate growth of vertical shoots. This intervention is very tricky. Trimming to severely reduces the donor plant's vigor, but leaving to much foliage favors a fast canopy closure that promotes infection by *Botrytis cinerea.*

Donors must keep a continuous and vigourous growth throughout the year despite the stress related to the regular harvests and trimmings. In order to fullfill this requirement a special growth calender must be followed and ajusted to the changing needs of the donors.

Donors are grown inside greenhouses where temperature, photoperiod and humidity are kept as favorable as possible. Eighteen hours of continous light is maintained by high pressure sodium lights which provide 8000 lux.

Fertilization must be studied carefully. Indeed, after each harvest, doncr must be stimulated greatly so they can produce new cuttings. However a few weeks before the harvest, vegetative growth must be slowed down so the cuttings will have begun to lignify.

Irrigation is also critical since leaf biomass is always changing. Indeed, less water is needed after trimming than in exponential growth periods so water supply must respect seedling's demand.

Many tests involving different types of containers are underway so we can identify an optimal species-container relation so donors will always be very healthy. This is our major concern because success of rooting seems to be directly related to the vigor of the donor.

2 - Harvesting the cuttings

Four to five harvests can be performed every year, thus 10 to 13 weeks separate each harvest. Shoots are cut with regularly desinfected scissors. During this period, light in the greenhouse is greatly reduced in photoperiod and intensity. This intervention reduces the evaporation demand. Our goal is to maintain optimal conditions so the cuttings will not experience a water deficit during all the operation. The cuttings chosen must be 5 cm in length and exhibit a proportionally good diameter. Semi-lignified cuttings are prefered to the fully turgescent or fully lignified cuttings. The ideal cutting would have an almost lignified stem at the bottom half and a more turgescent stern in the upper half. As cuttings are taken from the donors, they are brought to the staff who transplant them in containers. The container is usually the same type as the one used in normal container seedling production, that is the *45-110.* The rooting substrat is a mix of 75% peat, 25% vermiculite. As soon as the containers are filled with cuttings, they are moved in the *bouturatheque* which allows cuttings to begin the rooting process.

The time spent between the harvest and the putting cf the cuttings in the *bouturatheque* is around 20 minutes. The faster this operation is completed the better the results.

Cutting propagation system :
The "Bouturafheque"

The *bouturathêque* system of cutting propagation was developped by Gilles Vallee and Richard Noreau, research officers at the tree improvement service of the research branch in Quebec's ministry of energy and resourcesi. The cutting propagation center of the Saint-Modeste nursery is a pilot plant constructed in 1988 to put the *bouturathbque* system on an operational scale.

The *bouturathbque* is made of many shelves covered with polyethylene which form hermetically sealed enclosures. No sunlight reaches those special compartments which are located in a room without windows. Total obscurity can be obtained when desired. The Center operates 24 of these special compartments which are divided in 6 sets of four storied shelves. Twelve compartments have the following dimensions: 14.5 m in length, 2.5 m in width and 0.4 m in height and can accommodate around 17 000 cuttings if transplanted into the *45-110* container. The remaining 12 compartments have the same height and width but are 12 m long and contain up to 14 000 cuttings if the same type of container is used. Temperature and humidity are kept around 20° C and 95% respectively in each compartment. Artificial light generated by daylight fluorescent tubes provide 18 hours of photoperiod. Shades keep the light intensity around 2000-3000 lux at seedling height. Four compartments are under 18 hours of continuous photoperiod while all the others are under a 2 hours of light and 1 hour of darkness regime. Irrigation, misting and fungicide application are done with a remote controlled automotive robot. The robot replaces the usual permanent fog or mist system. Our goal is to maintain water droplets on the foliage without saturating the substrate. This prevents a water deficit of the cuttings and reduces the risk of stem rot. Day by day monitoring is done to evaluate the needs of the cuttings depending on the container weight, the amount of water droplets on the foliage and the condensation on the polyethylene ceiling and walls.

The cuttings are allowed 8 weeks to initiate and complete rooting. Then they are put into sections of the greenhouse where special environmental conditions are kept so they can slowly acclimatize to normal greenhouse conditions. These sections are specialy managed so light can be reduced to low levels and high humidity can be achieved to restore conditions similar to those found in the rooting compartments. Cuttings stay 2 or 3 weeks in those sections. Fertilization begins during that period and quantity increase weekly to reach the normal production calendar. These 2 to 3 weeks after rooting period are critical and decide which cuttings will survive.

3 - Growing the cuttings into full size seedlings

When the rooting period finishes in late spring or in summer, cuttings will be grown into seedlings right away if they are already in a suitable container. Otherwise, the rooted cuttings will be transplanted in the field like bareroot stock or transferred to an adapted container such as the *IPL 45* before growth is stimulated again.

Continuous cutting production means that some rooted cuttings will be available in autumn, in winter and in early spring. Cuttings originating from those periods will be kept in cold storage until they can be put outside in the field or under the unheated production tunnels.

After one year of operation, we evaluate that there is a lot of work to be done to improve all steps of the process. However, our last cutting operation realized in last April averaged a rooting success of 75%. Our aim is to obtain 90% of success repetitively, first with black spruce and then with other species. Our present work involves evaluating the effect of donor age on rooting success. We are also concerned by the type of container used in growing the donors. Different types of container are also tested to compare rooting success. Variables like nitrogen foliar analysis, fresh and dry weigth ratio of cuttings may become good indicators of rooting capacity of the cuttings. Propagating coniferous seedlings by cuttings is a promising method that we intend to use to its full potential.