A SHORT TERM TREE IMPROVEMENT PROGRAMME THROUGH VEGETATIVE PROPAGATION

R. MARIE RAUTER
Forest Research Branch, Ontario Ministry of Natural Resources

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ABSTRACT

A programme, originated in 1972, for selecting, vegetatively reproducing and testing nusery stock of black and white spruce in Ontario is described. Height, diameter and branching habit are the criteria used for selection. Results of experiments in terms of rooting and field performance will provide information on effectiveness of selection, the clonal repeatability and total genetic variation of certain characteristics, prior to selection of the best clones for large scale propagation.

INTRODUCTION

Black and white, spruce (*Picea mariana* (Mill.) B.S.P. and *P. glauca* (Moench) Voss respectively), are the most important species in Ontario's extensive regeneration programme. Both species are economically important in the northern part of the Province; only white spruce plays a major role in the southern part. We have initiated several approaches to improve spruce stock, one of which is the selection, vegetative reproduction, and testing of nursery material. In this approach we can obtain a great deal of genetic information as well as a supply of genetically superior material for use in the artificial regeneration programme.

Indications are that trees which are superior in the nursery maintain their superiority in the field after outplanting (King *et al.,* 1965). In Ontario, white spruce nursery selections have still maintained superior height growth and branching habit seven years after outplanting, although there is a possibility that some of the height growth effect may be due to the influence of size differences at planting. Both black and white spruce seedlings root with relative ease (Girouard, 1970; Rauter, 1971). Great variability in rooting and performance allows for selection of particularly desirable clones. Large scale production of rooted cuttings has been suggested by Fielding (1963) for radiata pine (*Pinus radiata* D. Don) and actually practised in Finland and Germany with Norway spruce (*Picea abies* (L.) Karst.) For example, in 1972 Finland rooted more than 140,000 cuttings of this species (Anon., 1973) and Germany 240,000 (Kleinschmit, 1973).

Our first selections in white and black spruce were made in 1972 and by the end of this decade we will have rooted cuttings of this material in field trials. This approach produces test results in considerably less time than would a breeding programme. Furthermore, a large number of trees are subject to a very intensive selection with relative

ease compared with the selection of plus trees in the field. In our short term approach, cuttings can be taken within two years of nursery selection, and within five years field tests can be established. In contrast, at least twice the time is required before field tests can be established in a plus tree selection and controlled pollination programme of spruce.

SELECTION OF MATERIAL

Six of our Provincial nurseries are included in the selection programme (Fig. 1). The three northern nurseries are selecting both black and white spruce; the three southern nurseries white spruce only. Selection intensity is 1 : 100,000. The numbers of selections to be made in each nursery at this intensity are shown in Table 1. The criteria used are (1) height, (2) diameter at root collar, and (3) branching habit. The trees are selected and marked upon completion of their final growing season in the nursery. Average trees amounting to 10% of the select trees in number are chosen as controls and vegetatively propagated as cuttings.

Since Ontario consists of a large forested area with differing climatic conditions, the Province is divided into site regions as shown in Fig. 1 (Hills, 1959). These divisions are a basis for seed collection and artificial regeneration. The seedlings selected are also identified according to these site regions. Since some nurseries grow stock from regions adjacent to their own, there are instances when material from more than one region would be selected in the same nursery. To avoid confusion in growing the stock, the selected material is transferred to the appropriate nursery so that each nursery maintains selected stock from only one site region. Six nurseries select stock, but only five grow the selections (Table 1).

TABLE 1—Number of selections to be made in the nurseries according to site region and nursery where selections will be grown (selection intensity 1: 100,000).

Nursery where stock is produced	Number of selections to be made		Site region	Nursery where stock is to be raised
	White Spruce	Black Spruce		
Dryden	40		4S	Dryden
		50	4S	Dryden
	10		3W	Thunder Bay
		10	3W	Thunder Bay
Thunder Bay	50		3W	Thunder Bay
		45	3W	Thunder Bay
Swastika	10		3W	Thunder Bay
		30	3W	Thunder Bay
	60		3E	Swastika
		60	3E	Swastika
Midhurst	30		3E	Swastika
	20		5E	Midhurst
Kemptville	10		5E	Midhurst
	30		6E	Orono
Orono	15		6E	Orono

As described by Hills, 1959.

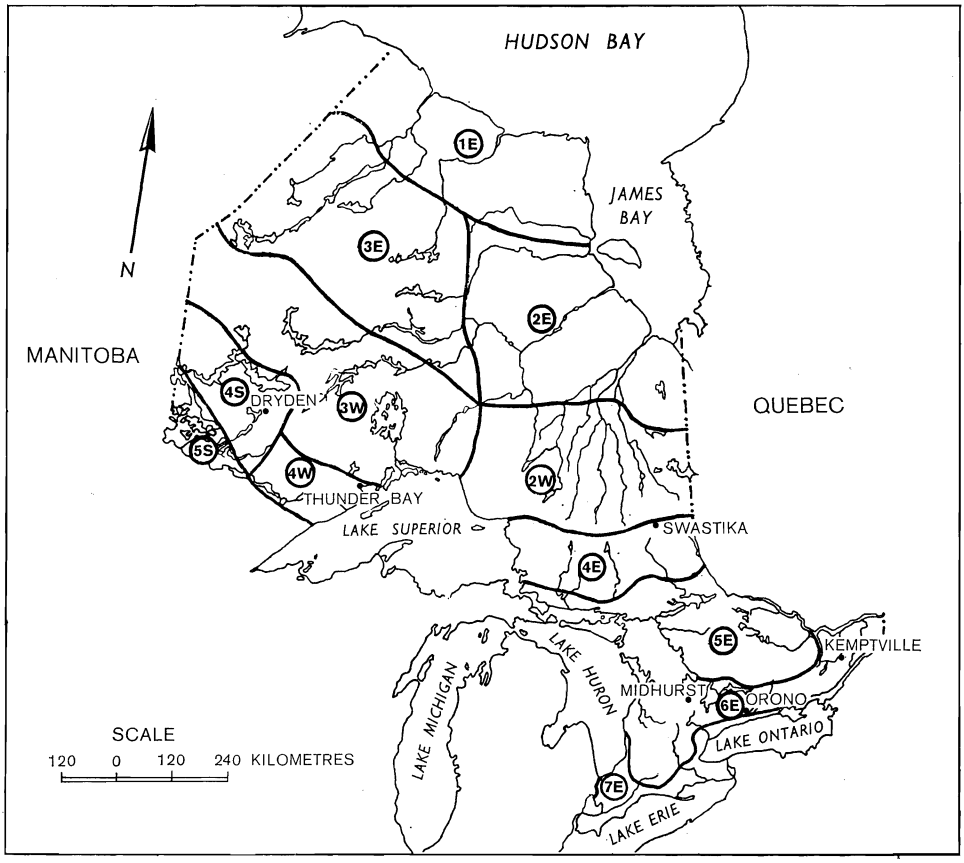

FIG. 1 **PROVINCE OF ONTARIO**
Showing
SITE REGIONS
and
NURSERY LOCATIONS

LEGEND

Humid Eastern Ontario

- 1E Hudson Bay
- 2E James Bay
- 3E Lake Abitibi
- 4E Lake Timagami
- 5E Georgian Bay
- 6E Lake Simcoe - Rideau
- 7E Lake Erie - Ontario

Humid Western Ontario

- 2W Big Trout Lake
- 3W Lake Nipigon
- 4W Pigeon River

Subhumid Western Ontario

- 4S Wabigoon Lake
- 5S Lake of the Woods

BOUNDARIES OF REGIONS

REGIONS BASED ON EFFECTIVE TEMPERATURE

——— Thermal site regions

LIFTING AND PLANTING OF SELECTIONS

In the autumn, the trees are lifted out of the beds with the surrounding seedlings and placed in 23-cm whalehide pots with little disturbance to the root systems. The surrounding trees in the pot are cut to soil level so that only the select tree remains. The control trees are lifted and treated in the same manner. The trees from different site regions are transferred at this time. All of the select trees and the controls are overwintered outside, but protected from sun and snow. The following spring the trees are planted at a 1.5 × 3.0 m spacing in a 'holding area' on or adjacent to the nursery. The area is cultivated and fertilised prior to planting, and kept cultivated to avoid any growth reduction due to competition. Once the trees are established, grass will be allowed between the trees, but it will be kept mown.

COLLECTION AND ROOTING OF CUTTINGS

One to two years after the trees are placed in the 'holding area', 50 cuttings from each tree will be collected for rooting trials in the manner described by Rauter (1971). The cuttings collected from the various nurseries will be sent to a single nursery in southern Ontario equipped to handle rooting techniques. The cuttings, identified by clone, are set into a replicated randomized block design. To date the best results have been obtained with cuttings taken in the spring just prior to bud-break and established in coarse sand in split plastic tubes under intermittent mist. In the autumn, the rooted material will be removed from the mist chamber, the rooting performance evaluated according to clone, and overwintered outside in the southern nursery.

PLANTING OF ROOTED CUTTINGS

The rooted cuttings will be shipped back to the appropriate nursery in the early spring, planted in a transplant bed in a replicated randomised block design, and kept in the bed for three years. During the first year they will be shaded and watered, but treated in the same manner as regular transplants thereafter.

Two outplanting locations will be selected for each species for each site region. Thus in the northern areas, four locations will be required in each region and in the southern areas two will be required. The locations will be the best spruce sites available. They will be prepared prior to planting. For each species within the site region, the material will be divided into two parts and half planted at each location. The cuttings will be put in at 1.85 × 1.85 m spacing in a replicated block design.

ASSESSING DEVELOPMENT

Detailed data are kept on the original selections and controls. Measurements will continue to be taken on the selected trees while they are in the 'holding area'. These data can then be related to the future performance of the offspring of the rooted cutting in both nursery and field.

Since rooting ability is one of the prerequisites of this approach, clones which have a low rooting ability will be eliminated from the programme and removed from the 'holding area'. Height and mortality of the rooted cuttings will be assessed at the end of each year in the nursery bed. After outplanting in the field, mortality counts will be taken at the end of the first growing season, with height and diameter growth measurements being taken at the end of the second and third growing season and every five years thereafter.

To obtain heritability and variation information for characteristics other than growth and form, records will be kept on such features as time of bud-break, length of active growing season, bud dormancy, frost damage, and other visible characteristics. This material could also be used as a basis for determining heritabilities of wood characteristics of spruce.

By keeping records of individual clones over an extended period of time, we should obtain a great deal of genetic information still lacking in these species, e.g., (1) the effectiveness of early selections under our conditions, (2) the repeatability of given characteristics, and (3) the total genetic variance of these characteristics.

VEGETATIVE PROPAGATION ON A PRODUCTION SCALE

The best of the clonal material evaluated in the tests can be reselected and mass-produced through rooting. Since this method is more expensive than the conventional raising of seedlings, we must have sufficient gains to merit the increased cost of production. With the great natural variation of both black and white spruce, and with the high intensity of our selection, we feel we can obtain these gains and subsequently reduce the rotation age by increasing our yield per unit area per unit time. Since selections will continuously be made in the nursery, we will always be eliminating old clones and adding new ones, thus improving the quality of the material being reproduced and reducing the hazards of monoclonal cultures.

Although I do not think this approach will replace seedling and transplant practices in our Province, I believe it will play an important role in production of improved stock. With increasing emphasis on intensive rather than extensive forestry, this type of propagation takes on greater importance.

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