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PROPAGATION OF SPRUCE BY MEANS OF STEM CUTTINGS

R.M. Girouard
Canadian Forestry Service,
Laurentian Forest Research Centre,
Ste. Foy, Quebec

This study has three major objectives:

- (a) To develop methods that will promote and hasten the rooting of cuttings from several species of spruce.
- (b) To elucidate the anatomical and physiological factors that influence the initiation and development of adventitious roots in stem cuttings.
- (c) To propagate trees by cuttings to establish clonal banks and seed orchards.

EXPERIMENTS IN A GREENHOUSE

(a) Experiments on rooting stem cuttings of spruce were started in late May 1967 using perlite and intermittent mist. Preliminary work involved cuttings from black spruce (*Picea mariana* (Mill.) BSP.), Norway spruce (*Picea abies* (L.) Karst.), red spruce (*Picea rubens* Sarg.), and white spruce (*Picea glauca* (Moench) Voss). The results suggest that only plain cuttings - those with a basal cut and no heel of old wood - should be collected from the lower part of trees no later than the beginning of shoot extension, that is, if the cuttings are to be rooted in a greenhouse within 1 year.

(b) In another experiment, cuttings were made from seedlings of the four species mentioned above to reduce to a minimum variables due to age of plant material, mineral nutrition, and exposure. Red spruce was one of the most difficult species to root, while Norway spruce was the easiest. In general, short cuttings (2 inches long) rooted more readily than long ones (4 inches long): the length of the cuttings did not influence the number of roots formed per rooted cutting. This information is useful for two reasons: 1) if a choice exists, those species which are difficult to propagate by cuttings can possibly be avoided; and 2) in those clones where the quantity of plant material is limited and ramets must be produced for clonal banks and seed orchards, short cuttings can be used without too much effect on the form and growth in height of the ortets.

(c) An intermittent mist system was modified to permit injection of carbon dioxide, without freezing the water at the point of injection, in part of the watering system. The purpose of this experiment was to compare the effects of carbonated versus non-carbonated water on rooting cuttings of *Picea glauca*. Information published in 1968 had indicated that carbonated water could reduce the rooting period and produce more vigorous plants in the case of *Juniperus* cuttings. Data from this work remains to be analyzed.

EXPERIMENTS IN OUTDOOR PROPAGATION BEDS

Outdoor propagation beds that require manual watering were prepared during June 1970 in a nursery at Valcartier, Quebec, to check the possible use of inexpensive propagation structures for mass production of rooted cuttings of spruce. About 10,000 semi-hardwood cuttings were made with and without a heel of old wood and/or auxin treatment. Results of this experiment will be available in late summer 1971.

PHYSIOLOGICAL STUDIES

(a) To study the physiological factors that influence the initiation and development of adventitious roots in stem cuttings of spruce, an investigation of rooting cofactors was performed. Preliminary work with total methanolic extracts indicated that few differences exist in the rooting cofactors of Norway spruce, which is easy to propagate from cuttings, and those of red spruce, which is difficult. Two-dimensional paper chromatography revealed a large number of fluorescent compounds in the total methanolic extracts. This finding clearly indicated that one-dimensional paper chromatography of these extracts, a procedure commonly used by most investigators of rooting cofactors, is inadequate. In the future, all extracts will require fractionation before chromatography and bioassay.

(b) An *Avena* coleoptile straight growth bioassay that is sensitive to plant growth regulators such as auxins, gibberellins and inhibitors, was tested and mastered. Poor germination of seed of the standard oat variety 'Brighton', available from only one source in North America, had to be replaced with another variety. Methods were developed to store and treat the seeds before germination to obtain reproducible results. Bioassay of total methanolic extracts of *Picea abies* revealed growth activity in a zone where indoleacetic acid, an auxin, is generally found. A comparison of methanolic extracts from Norway spruce (easy to propagate from cuttings) and red spruce (difficult) showed greater activity from the former. The fractionation of the extracts by liquid-liquid extraction remains to be done.

(c) A study of soluble sugar content of shoots in relation to rooting performance of cuttings was completed. Total sugar content was determined using a method described by Ebel (Phytochemistry 8:227-233, 1969). Extracted sugars were isolated by one-dimensional paper chromatography and their concentration determined by colorimetric and densitometric methods. Results of this work will be published with data which I hope to obtain in the near future from starch analyses of similar tissues.

ANATOMICAL STUDIES

Stem pieces were collected at various intervals from the basal end of cuttings, with and without a heel of old wood, that were rooting. The specimens were killed and dehydrated and then embedded in Tissuemat.

Sectioning of the stem pieces was started recently. At first, both transverse and longitudinal sections were difficult to make and stain, but gradually most of the problems, were overcome. The mounted sections will be studied to determine if differences in rooting capacity of cuttings are due to anatomical factors.