SUCCESSFUL PROPAGATION BY CUTTINGS OF *PICEA ABIES* IN FINLAND

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ABSTRACT

Propagation of Norway spruce (**Picea abies** (L.) Karst) by cuttings, begun experimentally on a small scale in 1962 at the Foundation for Forest Tree Breeding in Finland, was greatly expanded in 1969. The object is to evolve a method capable of producing planting stock in amounts large enough for forest establishment.

At present rooting takes place in two plastic greenhouses which are automatically ventilated and irrigated. One of the greenhouses is also provided with a heating system. The material used in the experiments consists of the best individuals selected from young progeny tests with spruce. Rooting has been successful during the past years, increasing to 95% of a total of some 150,000 cuttings in 1972.

INTRODUCTION

Vegetative reproduction is of the greatest importance both as a tool in forest tree breeding and in the production of selected material for use in afforestation. Among the methods best suited for the latter purpose is reproduction by cuttings. In Finland experiments with cuttings were started in 1962 by the Foundation for Forest Tree Breeding. Larger experiments, for example, with considerable numbers of Norway spruce (*Picea abies* (L.) Karst.) cuttings, were set up in 1969. The aim of these experiments is to develop propagation of spruce by means of cuttings into a method to produce planting in amounts large enough for practical use. In Finland spruce is planted out at present on a total area of some 40,000 ha (requiring about 75 million transplants) annually, and consequently using fast-growing cuttings in at least a part of this area would substantially increase timber production.

EQUIPMENT

With the cutting experiments in mind, a plastic greenhouse (10 m × 25 m) was erected in 1969 at the Haapastensyrjä Tree Breeding Centre (60°38′N; 24°27′E; elevation 125 m) of the Foundation for Forest Tree Breeding in Finland. The greenhouse was provided with equipment allowing for heating both the rooting medium and the air. Heating was made so effective that the temperature remained above 10°C even in the coldest frost nights during late March when the work was started. At the time of

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rooting the temperature was +20° to +25°C in the daytime and +10° to +15°C at night.

Irrigation was arranged in the form of an automatically controlled intermittent mist. An attempt was made to keep the relative humidity of the air at a level of 80 — 100%. During hot days, however, when ventilation had to be increased, humidity dropped below 80%. Temporary decreases in humidity did not visibly hamper rooting of the spruce cuttings.

When the number of cuttings to be rooted increased, another greenhouse (12 m × 25 m) was erected. As the new greenhouse was not provided with a heating installation, rooting is slower there than in the older one. While the new greenhouse was being built automatic ventilation was provided in both greenhouses.

THE CUTTING MATERIAL AND ITS HANDLING

The material used in the cutting experiments is from superior individuals of spruce produced through breeding. That is, the best individuals from superior families have been selected from extensive progeny and provenance tests. This makes it possible to use at least some of the clones from the rooting experiments for future large-scale afforestation. Work was started in 1969 based on some 1,200 clones; later, however, by continued selection, the material was reduced at first to 300 clones, and then to the best 60 clones of the original material. This will be roughly the number of clones used for mass reproduction. As breeding work continues, however, and new fast-growing clones appear, the best ones will be accepted for mass propagation to replace inferior clones. Ranking of the clones is done by early tests covering a period of 4-5 years and, more conclusively, by field experiments.

Due to the nature of the early test, the cutting material used has come essentially from young, usually one-to ten-year-old trees although the material collected in 1972 and 1973 was mainly from two- to four-year-old trees. The use of such young material improves success in rooting. The best of the selected clones have been reproduced and planted out into a scion garden which, in the summertime, is covered by a plastic greenhouse. Cuttings are collected in November and December. The cuttings which are to be rooted in the heated greenhouse are immediately placed in their substrate and transferred into the greenhouse, whereas those to be rooted in the unheated greenhouse are stored in plastic bags during the winter at −3° to −5°C. Cutting the scions into their final length (4-10 cm, the whole of which consists of the previous season's shoot), and transferring them into the rooting house, is done in April.

METHODS OF ROOTING

The earlier rooting medium was a mixture of living peat moss and gravel (1 : 1) following experience in Norway. The advantages of this substrate are its capacity to retain moisture and to inhibit fungal pests. During recent years success has also been obtained with the use of pure peat moss or a mixture of peat moss and garden peat. Plastic boxes 30 × 50 × 8 cm were first used for rooting, but later, in order to make transplanting easier or to make it possible to dispense altogether with this phase of the work, peat moss or peat rolls made with the Nisula method were introduced. After a few experiments it was concluded that cuttings of spruce rooted just as well without the use of hormones.

In the heated greenhouse rooting begins after the heating is turned on in late March, whereas, in the unheated greenhouse, this phase is reached about a month later. In the former greenhouse, rooting has taken place by early May, and in the latter, 2-3 weeks later. Previously, fertilisers were not applied during the rooting phase, but in the present year fertilisation will be carried out as soon as rooting is well started.

TRANSPLANTING AND TENDING

Up to the present time cuttings once rooted have been transplanted by hand to other plastic greenhouses. Transplanting is done in greenhouses to produce a rapid growth from the very beginning to build up a further supply of new scion material for the preparation of new cuttings. As we now have sufficient scion material, most of the subsequent growth can now take place in the open.

Transplanting has been the most expensive phase in the whole cutting work. For this reason we have attempted to find ways of avoiding it. It may prove possible to root the cuttings solely in unheated greenhouses; if so, the time required for transplanting would be unnecessary. Desisting from heating would also mean a decrease in the total costs. The whole yield of spruce cuttings of the present year (1973) was inserted into Nisula rolls with a height of about 15 cm in which it is intended to grow the cuttings without transplanting. When the cuttings have taken root, they will be transferred as they are in the rolls into the open under an irrigation system. The cuttings may grow in the open during the rest of the summer and over the next summer and after that they will be mature enough for planting out in the forest. Fertiliser application and other tending are similar to those used for spruce seedlings of similar size.

It is also worth mentioning that the use of Nisula rolls facilitates mechanisation of the cutting work. Preparation of the rooting medium, i.e., of the rolls, is done mechanically. Combining the insertion with the preparation of the rolls is being studied at the present time. The rolls are in units of a size which are easy to handle, for example, in the phase of transferring to and from the rooting house.

RESULTS FROM ROOTING

Since 1969 the following numbers of spruce cuttings have been inserted and rooted:

		Rooted	
	Inserted number	Number	%
1969	15,013	9,099	70
1970	5,125	3,965	77
1971	28,104	24,381	87
1972	149,081	141,363	95
1973	ca. 265,000		

The figures in the table show the numbers of rooted cuttings before transplanting. During transplanting some mortality occurred (10-15%), so there has been a decrease of corresponding magnitude in the final yield. If transplanting can be abandoned as a result of the introduction of the roll method, it would mean elimination both of this mortality factor and the transplanting costs.

CONCLUSIONS

It can be stated that the biological problems involved with the reproduction of spruce by means of cuttings have been solved in Finland. The remaining problems are consequently technical and economic. The roll method and the possibilities of mechanisation offered by it may solve the problems of handling and growing cuttings on a large scale. At the present time the costs of producing spruce cuttings are two to three times those of producing spruce seedlings of a similar kind. Increasing the numbers to be produced will decrease the unit cost of production, and this means that the costs of producing cuttings will gradually reach a level where they can compete with seedlings. It is the forest owner who must decide whether he wants to use fast-growing cuttings at a slightly higher price or whether he will be satisfied with slightly cheaper seedlings and reduced production. On the whole, the former alternative is the more profitable one.