to the rogued ecotype (female parent population) in its indices; selection of the best stands within the pollen source ecotype; ground preparation for hybrid seed orchards within the bounds of these stands (in strips, 150–200 m in width; with strips of the original stand, 30–40 m in width, between the prepared strips); the selection of pollen-producing trees within the strips (removal of minus trees and a part of normal trees); selection of a large enough number of trees to be used as female parents within the designed female parent population; vegetative propagation of these trees by grafting; establishment of hybrid seed orchards by planting grafted trees of female parent population on the prepared strips within the male parent stand; taking measures contributing to abundant female flowering and delaying male flowering of the grafted trees in seed orchards.

Hybrid orchards established according to this technique will secure a high genetic gain, guarantee the maintenance of polymorphism of natural populations in the hybrid progeny, render good crops of hybrid seed possible and guarantee a high hybrid quality of seed during a sufficient period of time.

Using hybrid seed orchards an increase in the productivity of stands can be achieved, as well as an improvement of quality and resistance to unfavourable environmental factors (diseases, low temperature and so on).

The solution of the second problem is especially urgent in the region of optimal geographic conditions, where the stands are notable for their high productivity.

We have every reason to expect that hybrid orchards, which have been established taking into account the results of genealogical research of forest trees and the results of the experiments on intra-specific hybridization will replace the conventional seed orchards in which the offspring of local plus trees is used as parent trees. This will happen since hybrid orchards allow the best use of the geographic genetic variability of forest trees for the production of genetically improved seed. The developing international scientific cooperation renders it possible to establish such orchards on the basis of intergovernmental co-operation and thereby to utilize the whole genetically valuable potential of a given species.

METHODS USED IN CUTTING PROPAGATION OF FOREST TREES IN FINLAND

JUHANI NIIRANEN

The Foundation for Forest Tree Breeding

SUOMEN METSÄPUIDEN PISTOKASLISÄYSMENETELMISTÄ

Cutting propagation of forest trees has recently been done in Finland mainly by the Foundation for Forest Tree Breeding. The aim has been to develop methods which could be used in forest nurseries for large scale production of rooted cuttings. Methods are being developed for tree species which seem to offer possibilities for economically profitable vegetative propagation. Unlike willows and poplars, the most important Finnish tree species unfortunately cannot be rooted in the open nursery without special equipment, but even they have been propagated from cuttings in a small scale. The most important object in Finland has been Norway spruce (Picea abies), the propagation of which has aroused interest in many other countries, too. A relatively reliable method has been developed for it. The applicability of this method is already experimented in practical nursery scale. Also the propagation methods developed for broadleaved trees can be easily applied in practical scale as soon as there is material for which the vegetative propagation is reasonable. At present rooted cuttings of broadleaved species are produced only in small amounts for the clonal tests of forest tree breeding.

The amounts of cuttings which were attempted to root in a greenhouse under mist irrigation during the year 1977 and the success of rooting is presented by tree species in the following:

<table>
<thead>
<tr>
<th>Tree species</th>
<th>Attempted to root</th>
<th>Successfully rooted</th>
<th>Transplanted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway spruce</td>
<td>130 000</td>
<td>132 000</td>
<td>(88 %)</td>
</tr>
<tr>
<td>Larches</td>
<td>20 000</td>
<td>16 400</td>
<td>(82 %)</td>
</tr>
<tr>
<td>Lodgepole pine</td>
<td>4 400</td>
<td>4 000</td>
<td>(89 %)</td>
</tr>
<tr>
<td>Birch</td>
<td>6 700</td>
<td>6 200</td>
<td>(92 %)</td>
</tr>
<tr>
<td>Alders</td>
<td>8 300</td>
<td>7 700</td>
<td>(92 %)</td>
</tr>
<tr>
<td>Hybrid aspen</td>
<td>5 600</td>
<td>4 900</td>
<td>(88 %)</td>
</tr>
</tbody>
</table>
EQUIPMENT USED IN CUTTING PROPAGATION

The formation of roots is an important phase in cutting propagation, in which precise regulation of growing conditions is needed, especially in the case of the tree species dealt in this connection. Special rooting houses have been constructed for this purpose. They are common plastic greenhouses which are used in seedling production and which are available in different sizes. The houses have ventilation on the roof top, mist irrigation equipment and separate heating systems for the air and the ground. All these are under an automatic control system constructed in Finland. The regulation of illumination has not been necessary. The rooting media is placed either on the ground or on tables with a height of 80 cm.

Plastic greenhouses are useful also in the raising of mother plants for the production of branches to be cut and in the raising of rooted cuttings after transplanting. For these purposes quite ordinary nursery greenhouses are used. Their use is justified and profitable at least for the production of twigs to be rooted, because twigs produced in greenhouses form roots essentially better than branches of plants grown outdoors.

When rooted cuttings are transplanted in the open nursery, the same equipment is used for the raising of them which is used for the raising of seedlings. Anyhow, special attention should be paid on the efficiency and homogeneity of irrigation immediately after the transplanting.

The methods used for different tree species at present are described in the following.

CUTTING PROPAGATION OF NORWAY SPRUCE

The twigs to be rooted are collected during autumn or winter and stored at temperature of \(-2^\circ\) to \(5^\circ\) C. The success and rapidity of rooting has been improved and the period of cuttings had been increased by growing the mother plants in a greenhouse. Moreover, the collection of twigs indoors is much easier than in the open, often in bad weather conditions.

Before sticking into the rooting medium the twigs are cut into a length of 7–8 cm. Gravel with a grain size of 4–10 mm is used as the rooting medium. The gravel bed is about 10 cm thick. Spruce takes roots well also on other media, for instance on mineral wool or sphagnum moss. At the rooting phase the density of cuttings is 500–900 twigs/m². The rooting is started in the beginning of March. The temperature of the rooting medium is attempted to be kept in 20°C and the temperature of the air 5°C lower. The relative air humidity is kept between 90 and 100%. Slight and brief changes in air temperature and humidity are not dangerous. Strong and healthy spruce twigs can be rooted without any bottom heating or even without any heating in the mist-irrigated greenhouse. In the conditions of April it takes a longer time than in heated conditions, where roots start to appear in 3 weeks.

Rooted cuttings can be transplanted already in the spring during May–June into nursery beds or pots (eg. Enso-plastic containers). The other possibility is to raise the cuttings on the rooting medium until the autumn. In the case the cuttings must be fertilized continuously, because the gravel does not keep the nutrients in itself. Irrigation can be diminished when the cuttings have rooted. Rooted cuttings can be transplanted in the open nursery onto beds or containers in the late summer since the beginning of August.

Transplanted spruce cuttings grow into a plantable size (height at least 20 cm) in one season in the greenhouse or in two seasons in the open nursery.

LODGEPOLE PINE

The branches are collected in the winter and stored in a frozen state. Sticking into rooting medium should happen at the same time as with spruce. A mixture of gravel and moss (1:3) in peat pots (Fp-620) or pure gravel as a 10 cm thick layer are used as the rooting media. Hormones IAA and IEK (0.05% in tale) have been used to promote rooting with nearly similar results. The conditions in the mist-greenhouse are kept similar as with spruce. The rooting takes about 2 months. Thereafter the cuttings are transplanted in a greenhouse, where they reach the planting size in the course of the following year.

LARCH

Slightly lignified summer shoots are used as cutting material. Best success is obtained when twigs are taken from richly fertilized mother trees and the rooting is started in the beginning of July. A mixture of gravel and moss in peat pots is used as rooting medium. Hormones IAA and IEK (0.05% in tale) promote rooting. Similar rooting conditions are maintained in the greenhouse as in the case of spruce. Rooted cuttings are transplanted with their peat pots either in the open or in the greenhouse immediately in the autumn, or they may be stored outdoors and transplanted in the following spring. After the transplanting the cutting plants need to be grown for one season in order to attain a plantable size.

BROADLEAVED TREES

Birches (Betula verrucosa and B. pubescens), alders (Alnus incana, A. glutinosa and A. incana x glutinosa) and hybrid aspen (Populus tremula x tremuloides) can be rooted from summer shoots. Mother plants are raised in plastic greenhouses under intensive management. Aspen forms roots best if the twigs are taken from root sprouts, which can be produced by cutting the mother plant into a short stump before the beginning of growing season. The new shoots to be used as cuttings should be forced to develop as early as possible in order to get enough time for the plants to grow after rooting and transplanting. This is most reliably achieved by growing the mother plants in containers and transferring them indoors into warm conditions in the beginning of March.

The twigs with a thickness of 3–7 mm are cut into 5–10 cm long pieces so that one leaf and 1–2 buds is left on each of them. Such cuttings are very susceptible to drying, so that sufficient moisture is maintained at all stages of their treatment. A mixture of gravel moss in peat pots is used as the rooting medium. IBA is used as the hormone promoting root formation. The roots appear into the cuttings in 15–20 days. Thereafter the cuttings with their peat pots are transplanted into greenhouses. If it is possible to transplant the cuttings in June, in the greenhouse they reach the plant size (60–100 cm) already during the same summer. If transplanting is delayed until late summer, plantable size is not attained until the following summer. In such cases the overwintering of cuttings becomes threatened and the percentage of plantable cuttings certainly is lowered.
SELOSTE:
SUOMEN METSÄPUIDEN PISTOKASLISÄYSMENETELMIÄ

Metsänjalostustuotannossa on kehitetty metsa-
puiden pistokastamien kasvatustehokkuudet. Pää-
paino on ollut kuusen menetelmissä, mutta myös
haapa, koivu, kontorta, lehtikuusi ja leppä on
saatu juurutumaan hyvin. Muovihuoneiden käyttö
emotaimien kasvatukseen on parantanut onnis-
tumista ratkaisevasti. Juuruttamiseen käytetään
huoneita, joissa on automaattinen ilmankustuttus
ja tuuletus, sekä erilainen lämmitys ilmalle ja
alastalle.

Kuusen oksat juurutetaan sorassa aikaisin
keväällä ja kouluutaan heti juurumisen jälkeen
paakkualustoihin. Istutuskelpoisia paakkutaimia
saadaan 2 vuodessa käytettävillä muovihuonekas-
vatusta. Juurutetut oksat on mahdollista koulu
avomaalle loppukesästä tai pistämistä seuraavana
keväään. Tällä menetetystä kasvatassa on
vuotta pitempi. Kontortan pistokastaimia tehdään
samalla tavalla, mutta juurumista edistetään
hormoniaktiivisesti.

Lehtipuiden lisäksi käytetään kesäöksiä,
jotka pyritään saamaan pistämiskuntoon mah-
dollisimman aikaisin keväällä taimien jatkokesa-
vatukseen varmistamiseksi. Juurutusalustana on
soraa ja samalle seos. Hormoneja käytetään.
Juurutetut pistokkaat kouluutaan muovihuoneisiin,
joissa ne kasvavat istutuskokoon saman kesän
aikana.

Lehtikuusin juurutetaan kesäöksiä soran ja
samanen seoksessa hormoneja käyttäen. Taimet
saadaan istutuskokoon yhdessä kasvukaudessa
kouluunen jälkeen.

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SOME RESULTS ON THE REGULARITIES OF SEED CROPS IN
SCOTS PINE SEED ORCHARDS

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SELOSTE:
MÄNNYN SIEMENVILJELYSTEN SIEMENSATOON VAIKUTTAVISTA
TEKIJÖISTÄ

The establishment of a permanent source
of genetically improved seed which started
in the USSR in the 60's and which has
developed especially during the past 5—7
years is of great importance in the programme
of forest improvement through the methods
of genetics and forest tree breeding. It is
proposed that after 10—15 years, the area
of seed orchards, mainly consisting of
coniferous species, will be increased up
to 21 000 ha, and that the genetically improved
seed share of the total seed production
will reach 50 % (Yonovskov, 1974). Research
aimed at determining the factors of seed
yield formation in seed orchards and at
developing stimulating measures for seed-
bearing is, therefore, particularly topical.

A restricted set of genotypes, a low
planting density and intensive soil main-
tenance call for a new approach to the
analysis of the generative development
of trees in seed orchards. The main targets
of research are: 1) to determine the potential
and actual crop capacity of seed orchards
of different age and with different methods
of establishment; 2) to study the flowering
process and the regularities of yield forma-
tion in connection with environmental
factors and the individual characteristics
of trees; 3) to determine the physiological
characteristics of the trees of different
generative type and different reproductive
capacity; 4) to study the reaction of seed
production trees to experimental treatments.
The results obtained will make it possible
to solve a number of practical problems of
seed growing, for instance, the elaboration
of methods for the prediction and calcu-
lation of seed yield, stimulation of seed-
bearing, selection of clones for the establish-
ment of second-generation seed orchards,
planning of the working phases in the
establishment of seed orchards, etc.

In the central part of the forest-steppe
of the European part of the RSFSR, the
seed orchards of Scots pine are established
by two different methods: by grafting
(clonal seed orchards) and by planting
seedlings which have been grown from
the seed of plus trees (seedling seed
orchards or half-sib family seed orchards).
It has been found that the age dynamics of
the flowering of the grafted and ungrafted
trees have different characteristics. Grafts
made with scions from physiologically
mature trees begin flowering relatively
early, within two or three years after
grafting. However, during the first 5—7