VEGETATIVE PROPAGATION OF JAPANESE LARCH

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ABSTRACT

Seven provenances of Japanese larch which had been studied for their adaptability to local conditions in previous experiments were tested for their rooting ability as cuttings. The influence on the rooting process of the morphology and physiology of the cuttings is demonstrated as well as the role of the substrate and the physical and ecological conditions of the chamber in which the cuttings were raised. With a cuvette specifically designed for the experiment CO_2—measurements of root respiration were carried out to follow the progress of the rooting.

A method is given for low cost mass production of Japanese larch by vegetative propagation.

INTRODUCTION

Japanese larch (*Larix leptolepis* (Zieb. and Zucc.) A. Murr.) was first introduced into Germany about 90 years ago and has since gained importance in large scale afforestation and reforestation programmes. The species has adapted itself well to local conditions; it has proved to have a wider ecological spectrum, a higher yield and a higher resistance to biotic and abiotic damages than European larch.

Hybrids between Japanese and European larch, especially *Larix lepteuropea* seem to have a still more promising future because they yield more than either parent and are almost entirely resistant to larch canker.

However the origins of these early seed lots of Japanese larch introduced into the Federal Republic of Germany are not known and even at present no absolutely guaranteed evidence of the origin of seed imported from Japan is obtainable. A large variety of provenances has been introduced so far and in adaptability they range from very good to very poor; growth rates and morphological features differ considerably.

Thus there were three basic reasons to carry out research work on the vegetative propagation of Japanese larch:

— the still-prevailing uncertainty of securing a constant supply of identified seed material from Japan:

— the evidence of existing, well adapted provenances, individuals and hybrids in the Federal Republic of Germany:

— the increasing need for high quality reproductive material of known genetic properties in this species and its hybrids.

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Experimental work previously carried out on the vegetative propagation of Japanese larch in the Federal Republic of Germany did not bring any satisfying results. Cuttings producing roots in a given experimental lot did not exceed 55-60% and there was no statistical proof of the effect of chemical rooting stimulants.

RECENT EXPERIMENTAL WORK

Aims

Research work on the vegetative propagation of Japanese larch carried out within the work programme of the "Baden Wurttembergische Forstliche Versuchs— und Forschungsanstalt" in Freiburg, Federal Republic of Germany, was done with the following aims:

— to analyse the influence of the morphology and physiology of the cuttings as well as the influence of the environmental and the physical conditions of the propagation process on rooting:

— to develop a method that allows mass production of cuttings at low costs in order to overcome the present difficulties in supply of reproductive material of this species; and to guarantee the procurement of plants of known genetic properties:

— to test the effect of chemical rooting stimulants:

— to develop a method of registering the CO_2-production of the root respiration as a device to monitor the rooting process:

— to test the growth behaviour of transplanted cuttings in relation to the growth behaviour of the parent trees (progeny testing).

Material

Seven provenances of Japanese larch, of which detailed information is given in Table 1, were included in the experiment to test specific behaviour of provenances in the rooting process.

Two categories of cuttings were used:

— Category "A" cuttings taken from one-year-old twigs.

— Category "B" cuttings from twigs grown in the year of the experiment.

In Category "A" a basal and a top section of the twig removed was formed, each one about 15 cm in length.

The cuttings were taken from parent trees aged 5-8 years.

Timing the Removal of Cuttings

In order to test the influence of the morphology and physiology of the cuttings on their rooting potential, the cuttings were removed from the parent plant in such a way that the optimum time of removal could be determined. A first series of Category "A" cuttings was taken when the buds had fully opened. At certain intervals several other series were cut until the new shoots had reached a length of 12-15 cm. At that stage these new shoots formed the secondary category of cuttings, Category "B".

TABLE 1 - Basic information about the parental stands of the provenances used in the experiment

PROVENANCE & ALTITUDE (m)	Mean annual Temp-erature (°C)	Mean annual Rain-fall (mm)	Soil conditions Geological formation	Soil conditions Parental material	Soil conditions Soil type	Stand mean ht (m)	Stand mean dbh (cm)	Age (years)
USUDA (MINMIAIKI) 1950 m	3.5	1600	old volcanic	andesite	sandy loam	17	40	29
KOMAGANE (KUROKAWA) 1800 m	4.5	1800	palaeozoic	shist & sandstone	sandy loam	14	50	150
IWAMURATA 1500 m	5.8	1400	-	-	-	19	28	52
INA (KUROKOCHI) 1800 m	4.8	1900	palaeozoic	cristaline shist	gravel-like debris	22	40	70
INA (NISHIMINOWA) 1500 m	6.3	1600	-	-	-	22	30	100
NIKKO (FUTAARE SHRINE) 1450 m	4.5	2500	old volcanic	andesite	dark sandy loam	12	25	50
YABUHARA 1920 m	2.9	2300	palaeozoic	granite	loam	22	30	100

In this category three series of cuttings were again used. The first when the new shoots did not show any signs of lignification at the base, the second when the base started to lignify and the third when the base had fully lignified.

Treatment

For the treatment of the cuttings with rooting stimulants three kinds of chemicals were used:

— chemical rooting stimulants commercially available and commonly used in horticultural practices:

— special chemicals used in research work on vegetative propagation of forest tree species:

— chemicals known to eliminate compounds in the cuttings which retard rooting.

The chemicals were used either as liquids or combined with talc. They were applied in concentrations ranging from 0.1-3.5% and the cuttings were placed in the liquid for a maximum of 12 hours.

Substrates

In order to test the influence of the substrate on the rooting process the following types of substrates were used in the experiment:

— pure sand:
— a mixture of crushed porous volcanic stone, sand and peat in a proportion of 3 : 2 : 1:
— pure gravel with an average grain diameter of ca. 5 mm:
— a mixture of sand and granulated foam at a ratio of 1 : 1.

The substrates were not sterilised.

Sheltering, Irrigation and Substrate Heating

The cuttings were housed in ordinary shallow, glass-covered greenhouses as generally used in horticulture. For specific tests a greenhouse unit was constructed consisting of a chamber with a volume of one cubic metre. In it was installed a semi-automatic overhead atomizer irrigation device. The air was kept slowly revolving by a fan in the top section of the unit.

In the other greenhouse units a low cost, semi-automatic overhead irrigation system was installed and for comparison ordinary sprinklers were also used.

A system of heated wires, spaced at 18 cm intervals installed in some sections of the propagation units, kept the temperature of the substrate at 22°C.

CO_2-Measurements of Root Respiration

In order to obtain evidence of the rooting process without disturbing the experiments by repeated removal of cuttings and especially to be able to follow the development and intensity of the rooting process a special cuvette was designed and installed in which cuttings were raised. The cuvette was connected to an infra-red gas analyser by which the CO_2 concentration around the base of the cuttings in gravel substrate was measured.

The determination of the shortest possible period after which the rooted cuttings may be removed from the propagation substrate and be transplanted is of interest because it allows for a second population of cuttings to be raised in the same substrate during the same vegetation period, thus saving considerably on nursery space.

Transplanted Cuttings

As cuttings developed a sufficient root volume they were transplanted to the field without shelter. Special observations were carried out to compare their growth with that of the parent trees.

SUMMARY OF RESULTS

Vegetative Propagation

The capacity and readiness of all types of cuttings to produce roots is related to provenance. Those provenances which had proved in previous studies to be fast-growing, showing low susceptibility both to drought and excessive soil moisture, i.e. those with a wide ecological spectrum, have the highest rooting percentage as cuttings.

None of the chemicals tested had any significant effect on the rooting of the cuttings.

The physical structure of the substrate and the environmental conditions of the chamber in which the cuttings were kept during the propagation process were the major determining factors in the rooting of cuttings.

Cuttings rooted with 100% success in a special propagation chamber with semi-automatic, overhead atomizer irrigation, in gravel substrate and with substrate heating.

A "relative moisture optimum" in the propagation chamber appears to be the dominating factor that stimulates the cuttings to root. If moisture conditions are created which are surplus to this, the stimulating effect on the cuttings is lost. Only under a certain moisture stress and in combination with conditions described in the preceding paragraph is full rooting of the cuttings obtained. Under "absolute optimum moisture" conditions the cuttings stay alive throughout the vegetation period without forming any roots.

Basal and top cuttings do not differ in rooting percentage; the latter develop a slightly higher root volume.

The volume of roots (number, length, degree of ramification) is highest in gravel substrate.

The optimum time for removing Category "A" cuttings is when the new shoots are about 5 cm long.

The optimum time for removing Category "B" cuttings is when the base of the cuttings starts to show the first signs of lignification.

CO_2-Measurements of Root Respiration

With the cuvette specifically designed for the experiment it was possible to register the root respiration of the cuttings and to trace the rooting process.

Transplanted Cuttings

After transplanting, top cuttings develop secondary height growth during the same growing season; basal cuttings do not.

The growth habits of the cuttings in the years following the transplanting is again a provenance-related matter and three groups can be defined:

Group 1: Cuttings forming one distinct leading shoot. Provenances: USUDA (MINMIAIKI) and KOMAGANE (KUROKAWA).

Group 2: Cuttings forming more than one leading shoot but with no distinct leader; Provenance: INA (NISHIMINOWA)

Group 3: Cuttings retaining the growth habits of twigs forming no leading shoots at all; Provenance: YABUHARA.

The remaining provenances range somewhere between the last two groups; at that stage of the experiment it was not possible to allocate them to one distinct group.

The two provenances found in Group 1 are identical with those shown in previous studies to have the highest rate of adaptability and the highest growth rates.

DISCUSSION

The results obtained indicate a method by which Japanese larch can be satisfactorily propagated by cuttings in a mass production process using simple, low cost equipment.

It remains to be tested whether the method described also applies to hybrids between Japanese and European larch.

It also remains to be tested whether the method recommended applies also to higher age classes of parent trees than those dealt with in the experiment.

Since it has been proved that the success of the vegetative propagation of Japanese larch depends substantially on the control of the physical and ecological conditions of the chamber and the substrate in which the cuttings are kept, the possibility exists for further drought resistance breeding of cuttings of Japanese larch.