ROOTING OF CUTTINGS OF *PINUS SYLVESTRIS* UNDER MIST

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ABSTRACT

Rooting of current-year shoots (length 12-20 cm) from lateral branches of 5 to 10-year-old Scots pine (**Pinus sylvestris** L.) in a greenhouse under intermittent mist, at the end of May or early June, gives very variable results. The best clones in a favourable year root with a percentage of ca. 70% in about 15 weeks. Generally many cuttings die from attack by the fungus **Botrytis cinerea** and by rotting of the basal and apical parts of the cutting. **Botrytis** can be controlled very well with a weekly treatment of 83% captan (1.5 g/l water) or with 50% euparene (2.5 g/l water).

To prevent rot relatively dry conditions are necessary during the propagation period. Cuttings from normal shoots however need much water during times of high temperatures. Cuttings from shoots developed from needle fascicles (length 8-10 cm, inserted at the end of July or early August) are preferable in this respect. Other advantages of these fascicle cuttings are that they generally produce more roots per cutting, can be hardened off more easily and give a better shaped plant.

INTRODUCTION

The vegetative propagation of Scots pine has been investigated in Holland for more than 20 years. Some rooting of cuttings from young trees up to 15 years old has been successful under conditions ranging from a cold frame to a heated greenhouse, and auxin application has sometimes been helpful. Since 1960 rooting experiments have concentrated on the use of an intermittent mist system in a greenhouse. On occasion this has been very successful, but fungal attack by *Botrytis cinerea* Pers. ex Fr. has been a major problem, killing for example all cuttings set in 1967 and 1968. This paper summarises some experiments carried out from 1969-1972 on the control of *Botrytis* and on the effect on rooting of type of propagules, collection date and type of rooting medium.

MATERIALS AND METHODS

After collection all cuttings were placed in a greenhouse under mist. The sprinkling regime is regulated by a temperature-controlled propagation equipment, developed by the Dutch Technical and Physical Engineering Research Service at Wageningen. The frequency of the sprinklings is regulated by a temperature transducer inserted amidst

the cuttings in the centre of the propagation bench. The transducer is controlled by electronic circuits in such a way that the frequency increases and decreases with temperature. Both the measure of changing of the frequency and the sprinkling time can be fixed in accordance with the requirements of a particular species.

For Scots pine a fixed sprinkling time of 5 seconds and a frequency of once per 10 minutes at 20°C, increasing to once per 3 minutes at 30°C, appeared to be most suitable.

During a typical day the air temperature in the greenhouse ranged from 18-29°C and the temperature of the medium from 17-30°C. The humidity ranged from 80-90%. As a rooting medium a mixture of peat and coarse sand was used: in 1969 and 1970 3 parts peat to one part sand; in 1971 and 1972 one part peat to one part sand. A layer of 10 cm of the rooting medium covered a layer of 25 cm of river sand. Except for the trials with shoots grown from buds of needle fascicles, all trials were established with propagules from second-order lateral branches taken

a. from rooted cuttings, which were 4 to 6 years old in 1968
b. from grafts (of selected trees) which were 7-8 years old in 1968.

In the text these are called normal cuttings, or cuttings from normal shoots.

In 1971 and 1972 a number of shoots were used which had developed from buds of needle fascicles after pruning the branches; in 1971 from 4-year-old seedlings, in 1972 from 5- and 7-year-old seedlings. From both types of propagules the entire shoot was used. The mean length of the normal cuttings was 12-20 cm while those developed from needle fascicles averaged 8-10 cm. Cuttings were treated with fungicide and inserted immediately after collection. In 1970 and afterwards the bases of the cuttings were treated with captan powder and the shoots with euparene.

EXPERIMENTAL TREATMENTS AND RESULTS

Botrytis *and rot*

In 1969 and 1970, cuttings were treated with some or all of the following fungicides in aqueous solution: captan[1] (83% powder at a 1500 ppm concentration), zineb[2] (65% powder at a 3000 ppm concentration), euparene[3] (50% powder at a 2500 ppm concentration). The solutions were watered on after setting, and this was repeated weekly. For an hour after application sprinkling was stopped to allow the fungicide to stick to the cuttings. In 1969 a sub-treatment was additionally applied prior to setting in which the bases of the cuttings of one half of each treatment group were treated with captan powder, while the other half was not treated.

Results are presented in Tables 1 and 2.

TABLE 1—1969: Mortality percentages per treatment 17 weeks after insertion (collection date 27-5-1969; means of 2 replications of 3 clones × 15 cuttings per clone)

Treatment of the shoots	Treatment of the base	
	with captan	without captan
captan	36.7	74.4
zineb	75.6	92.2
euparene	24.4	61.1

[1] N-trichloromethylthio-4-cyclohexene-1, 2-dicarboximide
[2] zinc-ethylenebisdithiocarbamate
[3] N-dichlorofluormethylthio-N-fenyl-N[1]-dimethyl-sulfuryldiamide

TABLE 2— 1970: Mortality percentages per treatment 18 weeks after insertion (collection date 1-6-1970; base of the cuttings treated with captan; means of 3 replications of 9 clones × 15 cuttings per clone)

Treatment of the shoots	Total mortality	Distribution over causes	
		Botrytis	Rot
captan	38.0	7.8	92.2
euparene	43.0	2.8	97.2

Captan and euparene were both effective in reducing *Botrytis* infection. Treatment of the cutting base was also effective; it delayed the onset of rot in the cuttings for at least a month, and if during that time callus formation occurred, the cuttings remained alive. The rooting was very poor in both years, and only occurred when the cutting base was treated with captan. In 1969 cuttings of only one clone rooted (average 18.9%, best treatment 43.2%) and in 1970 only 5.3% of the cuttings rooted (best clone with both treatments 15.6%).

Collection Date

From earlier trials it was already known that cuttings from normal shoots should preferably be collected at the end of May or the beginning of June. An attempt was made to refine this time more accurately by means of describing the development phase of the shoots to be propagated. Although there was some variation between clones, the most workable characteristic was a measure of the amount by which the needles at the top of the shoot protruded from the sheath.

In 1970 propagules were collected on 3 different dates, in 1971 and 1972 each on 2 dates:

Mean development of needles:	Date		
	1970	1971	1972
most needles still in sheath	1-6		
about 1-2 mm out of sheath	8-6	26-5	1-6
about ½-2 cm out of sheath	15-6	4-6	6-6

Rooting and mortality percentages are presented in Tables 3, 4 and 5.

TABLE 3—1970: Rooting and mortality percentages per collection date 18 weeks after insertion (means of 3 replications of 7 clones × 15 cuttings per clone)

Collection date	Rooting	Mortality
1-6-1970	0	94.6
8-6-1970	7.0*	64.1
15-6-1970	2.5*	73.3

* clone range: 0-13.3%

TABLE 4—1971: Rooting and mortality percentages per collection date 15 weeks after insertion (means of 6 replications of 8 clones × 8 cuttings per clone)

Collection date	Rooting	Mortality
26-5-1971	35.4(1)	5.2
4-6-1971	27.6(2)	0.5

(1) clone range: 16.7-56.3%
(2) clone range: 4.2-43.8%

TABLE 5—1972: Rooting and mortality percentages per collection date 15 weeks after insertion (means of 8 replications of 8 clones × 8 cuttings per clone)

Collection date	Rooting	Mortality
1-6-1972	6.3(1)	31.4
6-6-1972	7.0(2)	27.7

(1) clone range: 0-14.1%
(2) clone range: 0-29.7%

Collection date affected rooting and mortality in both 1970 and 1971. The development phase of the shoots on May 26, 1971 corresponded with that on June 8, 1970, the date with the lowest mortality in that year. While it is not yet possible to define the development phase at which the best rooting will be obtained, the extremes are known. Propagation when the needles are still entirely in their sheaths causes a high mortality, while cuttings with needles protruding more than about ½ cm lose colour rapidly and drop their needles after some time. The most favourable time lies between these extremes.

Rooting Medium

Both in 1971 and 1972 mixtures of peat and sand were compared in different proportions. In 1971 no difference was observed between the 3 rooting media in respect of rooting percentage (Table 6).

TABLE 6—1971: Rooting and mortality percentages per medium 15 weeks after insertion (collection date 25-5-1971; means of 6 replications of 6 clones × 8 cuttings per clone)

Rooting medium (peat : sand)	Rooting	Mortality
3 : 1	44.4	5.6
1 : 1	41.3	4.2
1 : 3	46.5	1.0
mean	44.1*	3.6

* clone range: 13.9-68.8%

The root system also was similar in the different media, with most cuttings developing only one, sometimes two, unilateral roots. In 1972 rooting was negligible regardless of treatment and mortality (caused by rot) was very high (*see* Table 7). If the medium contained more peat and thus had a lesser draining capacity, mortality increased significantly.

TABLE 7—1972: Mortality percentages per medium 15 weeks after insertion (collection 2-6-1972; means of 4 replications of 6 clones × 8 cuttings per clone)

Rooting medium (peat : sand)	Mortality
3 : 1	70.8
1 : 1	56.3
1 : 3	33.9

Propagation by Shoots from Needle Fascicles

To stimulate the development of fascicle buds branches from 4-year-old seedlings were pruned at the end of March in 1971 and in 1972 branches from 5- and 7-year-old seedlings were pruned at the beginning of March. The shoots which developed from the needle fascicles were collected in the summer when they were still unlignified and had a mean length of 8-10 cm. Indole-butyric acid (IBA) was included as a treatment at two concentrations. Results obtained in 1971 showed that it is possible to get a nearly as high rooting result from shoots from needle fascicles as from normal shoots (cf. Tables 6 and 8). Both hormone concentrations gave an increase in the number of rooted cuttings.

TABLE 8—1971: Rooting and mortality percentages per treatment 13 weeks after insertion (collection date 21-7-1971); means of 3 replications of 15 cuttings each)

Treatment	Rooting	Mortality
captan	28.3	5.0
captan + 0.5% IBA	40.0	10.0
captan + 1% IBA	41.7	3.3

In 1972 (Table 9) only a few cuttings rooted from shoots from needle fascicles, but again the rooting percentage was comparable with that of cuttings from normal shoots in that year. Although rooting was poor the mortality 15 weeks after insertion was low.

TABLE 9—1972: Rooting and mortality percentages per collection date and treatment 15 weeks after insertion (means of 2 replications of 18 clones × 6 cuttings)

Collection date	25-7-1972		7-8-1972	
Treatment	Rooting	Mortality	Rooting	Mortality
captan	11.1	5.1	4.2	0.5
captan + 0.5% IBA	5.6	11.1	6.0	0

In both years the quality of the root system and the shape of the plant from cuttings from needle fascicles were markedly better than those from normal shoots.

HARDENING-OFF

After rooting the cuttings were potted and then hardened off for a period in the greenhouse.

In the middle of April of the year following rooting the potted cuttings were placed in a cold frame for a month before planting out in the nursery.

During the hardening-off-period in the greenhouse many rooted cuttings died (Table 10).

TABLE 10—Mortality percentages of rooted cuttings during hardening-off in the greenhouse

Type of cuttings	Collection date	Number of potted cuttings	Mortality (%)
Normal lateral shoots	25/26-5-71	517	52.6
Normal lateral shoots	4-6-71	106	19.8
Shoots from needle fascicles	21-7-71	74	10.8
Normal lateral shoots	1/2-6-72	36	91.7
Normal lateral shoots	6-6-72	44	45.5
Shoots from needle fascicles	25-7-72	36	11.1
Shoots from needle fascicles	7-8-72	37	21.6

In both years the mortality was less in the fascicle cuttings than in the normal ones, presumably in part because of their better root systems. The higher mortality in the normal cuttings in 1972 compared with 1971 may simply reflect more frequent failure of the mist equipment in the latter year. The cause of the post-rooting mortality generally is believed due to moisture loss during the first few days after potting, and as such it should be preventable with improved techniques.

DISCUSSION

The experiments show that while the rooting of cuttings from Scots pine is possible (at least until an age of 15 years) the percentage of success in any one year cannot be guaranteed. The difference between clones in rooting capacity was very high and there were examples of clone and year interactions.

Mortality due to attack by *Botrytis* can be almost completely controlled with the fungicides captan and euparene.

A method to control rot has not yet been found and to obtain this a better control of the environment during the rooting period will be necessary especially with respect to temperature. High temperatures cause frequent mist applications which are necessary for the survival of the lateral shoots as these wilt easily and do not recover well. Cuttings from needle fascicles are less susceptible in this respect: they are sturdier and their needles are further apart from each other; thus they hold less water which results in less top rot.

The better the medium is drained, the less rot occurs at the base of the cuttings and therefore media with a relatively high proportion of sand should give better results. However in earlier trials it was found that cuttings in pure sand produced callus only but no roots.

Vegetative propagation by unlignified cuttings grown from the buds of needle fascicles after pruning the branches of the ortet has a few clear advantages over propagation by cuttings from normal long shoots. The cuttings are less susceptible to the environmental circumstances during and after rooting, they form a superior root system and the plants are better shaped. Therefore it is worthwhile to investigate how to obtain sufficient of such shoots early in the season from relatively easily-rooted clones selected for superior growth and health.

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