FOURTH SESSION

THE PROPAGATION OF CONIFERS BY CUTTINGS

IR. B.C.M. VAN ELK
Horticultural Advisory Officer
Boskoop Experimental Station, Boskoop, Holland

The propagation of conifers by cuttings in Boskoop differs a little from the methods used elsewhere in the world, though this does not mean that part of the research cannot be modified for use in other areas. It is rather difficult to translate the results gained in a cold double frame outside to a glasshouse, with or without mist equipment.

Cutting material used in England is quite different from ours. In Boskoop we usually take weak-growing side tips of young plants in full growth. It must be remembered that in Boskoop we have to send you small plants because of import taxes, transport costs, etc; so we have to take our cuttings from young plants, whilst you, perhaps, may take them from larger plants which we do not have.

Conifer cuttings are taken during autumn which, as I shall subsequently show you, is usually the best time. So far as I know the selection of the right time is largely by trial and error and with the art of "green fingers". The Adivsory Service takes it for granted that root formation is disminished if cuttings are taken during rainfall.

In Boskoop the length of the cuttings is 5 to 7 cm (2 to 3 inches), but there are some growers who take cuttings double or three times this size; by doing this they will obtain a saleable plant in a shorter time. Although the rooting time is the same the growth from the larger cutting is much better.

Most of the cuttings are placed in a mixture of 4 to 2, or 4 to 1, parts of brown peat and coarse river sand. These mixtures have a rather low pH, 4.5 down to 4.2, but this is excellent for rooting cuttings. Sand helps the aeration and the peat holds the moisture; these mixtures are rather sterile and are not rich in food. Of course, there have been experiments with perlite and with other sterile products beside peat but, in general, the results were either the same or a little less satisfactory than our standard mixtures, and the price of these other products is too high.

Looking ahead, I should say cutting production under pressure of rapidly changing production methods must be made in blocks of an artificial chemical compound which can be placed in other blocks and, in some cases, even into further blocks in which a saleable plant size is obtained. In Boskoop, the mixture is spread over the surface in a cold frame and pressed together a little. It can also be used in clay pots or in boxes which can be placed in a bed in a glasshouse or in a mist propagation house. In a frame the cutting will stand until September in the year following insertion. From the glasshouse

the cuttings are placed in a cold frame, depending upon the time of rooting of the cuttings, for these houses are too expensive to use them only once during the year.

The use of Captan. Most cuttings are wounded by slicing the bark; after this they may be treated with rooting compounds, such as Seradix. We use mostly 0.1% NAA or 1% IBA. Very often the nurseryman starts with a 50/50 mixture of 10% Captan dust and a growth hormone dust of double concentration. He has the advantage of a good concentration of growth hormone and at the same time protection of the base of the cutting by Captan. The bases are simply dipped in the powder mixture. Alternatively, cuttings are stood in a hormone solution for 24 hours, dried for 15 minutes, then dipped in Captan dust to provide the same protection as for dust-treated cuttings. By using mixtures of a growth hormone and Captan you will see in the tables that the rooting percentages have been improved.

After insertion, the cuttings must be watered. This is done with a solution of 2 g/litre of Captan spray material (83%) to prevent the development of fungi in the frame or glasshouse. This treatment is different from the powdering of the base of the cutting; powder application raises the rooting percentages an average of about 20%.

Captan cannot always be used. When the cuttings are placed in a warm environment as, for instance, in mist during full summer conditions, they decay at the base when treated with a soluble growth hormone, or a combination of growth hormone and Captan. This warning follows research work carried out recently concerning the improvement of rooting by heating cold frames.

Table 1. Effect of IBA and Captan on rooting cuttings of two conifer clones.

Treatment	Percentage Rooted
Chamaecyparis lawsoniana 'Stewartii'	
(1) Not treated	0
(2) Treated with 25 mg/litre IBA only	16%
(3) Treated with Captan only	0
(4) Treated with 25 mg/litre IBA + Captan	84%
X *Cupressocyparis leylandii* 'Haggerston Grey'	
(1) Not treated	4%
(2) Treated with 100 mg/litre IBA only	40%
(3) Treated with Captan dust only	12%
(4) Treated with 100 mg/litre IBA + Captan dust	68%

Table 2. Effect of different hormone treatments on rooting percentage of *Chamaecyparis nootkatensis* 'Pendula'.

Growth hormone	Without Captan	With Captan
Not treated	16%	—
50 mg/litre IAA	32	66%
100 mg/l IAA	22	82
150 mg/l IAA	48	70
25 mg/l NAA	26	76
50 mg/l NAA	38	70
75 mg/l NAA	42	78
50 mg/l IBA	40	68
100 mg/l IBA	34	72
150 mg/l IBA	18	88

Temperature. In the 1963/64 season research was carried out wherein one-third of a batch of cuttings was treated in the normal way in a cold frame; a further third was given bottom heat at a temperautre of 15°C in the frame with an electric low tension cable from the time of insertion until the beginning of December, and again from the beginning of February until mid-May. The last third was only heated in the first year before winter, and the following year only after winter during the same times as for the previous group. In general, heating raised the rooting percentages by about 10%, but when the cuttings were also treated with Captan there was no difference.

Table 3. Rooting percentages obtained with 12 conifers in the year 1964/65.

Treatment	No heat	Heated before and after winter	Heated only after winter
Without Captan	42%	54%	42%
With Captan	60%	68%	63%

Table 4. Rooting percentages with 15 conifers from which cuttings had been made between September and mid-November, 1967.

Treatment	No heat	Heated before and after winter	Heated only after winter
Without Captan	43%	58%	39%
With Captan	64%	53%	44%

Table 5. Rooting percentages obtained with *Chamaecyparis* cuttings over two 2-year periods.

Temperature:	15°C		18°C	
Years:	1964 and 1965		1966 and 1967	
Captan:	—	+	—	+
Not heated	60%	82%	63%	81%
Before and after winter	71%	82%	52%	59%
Only after winter	63%	82%	48%	35%

It can be seen from Table 5 that raising the bottom temperature from 15°C to 18°C had a negative effect on rooting. At 15°C the use of Captan led to a uniformly good rooting percentage.

Table 6. Rooting percenttages obtained with *Juniperus* cuttings over two 2-year periods.

Temperature:	15°C		18°C	
Years:	1964 and 1965		1966 and 1967	
Captan	—	+	—	+
Not heated	43	60	44	74
Heated before and after winter	53	65	53	60
Heated only after winter	45	54	32	46

From Table 6 it is seen that the rooting percentage is higher at 15°C when the frame is heated before and after winter. There is the same tendency in *Juniperus* as in *Chamaecyparis* for the rooting percentages to be lower at 18°C than at 15°C and that there is, at this higher temperature, a lowering of the rooting percentage when treated with Captan.

However, good results can be obtained under mist in a warm glasshouse during the summer but, of course, the cuttings are then in a different stage of development.

Tsuga canadensis 'Pendula' reacts well to bottom heat. Cuttings rooted in a cold frame, as well as those rooted in a frame — heated both before and after winter — produced 84% rooting; in the latter treatment, however, the root system was three times the size as those on cuttings rooted in cold frames.

Juniperus chinensis 'Blaauw's Varietat' makes a lot of roots when cuttings are taken at the beginning of September and placed in a rather warm glasshouse. The roots are produced before winter. However, with this variety one can get total failure if the cuttings are not in the right condition.

When placed under mist, cuttings can be taken over a much longer period because it is possible to use material which can be either soft or hard. In general, however, too warm a glasshouse may lead to a total failure. We would not recommend large scale use of a growth hormone or Captan dust without the grower first having obtained experience in small trials.

Time of making cuttings. Table 7 explains some investigations we have carried out recently concerning the best time of taking the cuttings. Every 14 days 100 cuttings of the two chosen conifers were taken, treated, and placed in a cold frame for rooting. Until mid-September the *Chamaecyparis* cutting material was too soft for good rooting. After mid-October it was too late to root the *Juniperus* cultivar.

The investigations were extended to cover some other species and cutivars, as shown in Table 9.

Only with 'Grey Owl' is the seasonal rooting pattern constant. The other three conifers do not react uniformly. After four years we have come to the conclusion that, in general, best results are obtained by taking cuttings of these conifers between the beginning of September and early December.

Experiments with *x Cupressocyparis* over two years showed clearly that the best time for taking cuttings was before the end of October.

For rooting under mist the best advice that can be given is to make the cuttings as early as possible. Try to have a low

Table 7. Effect of timing on rooting obtained with two conifer clones.

Date	*Chamaecyparis obtusa* 'Nana Gracilis' No Rooted	*Juniperus virginiana* 'Grey Owl' No. Rooted
15 Aug.	49	98
29 Aug.	57	95
12 Sep.	54	96
26 Sep.	93	96
10 Oct.	90	68
24 Oct.	98	15
7 Nov.	99	23
21 Nov.	99	11
5 Dec.	100	3
19 Dec.	100	8
16 Jan.	99	38
30 Jan.	98	31
13 Feb.	99	10
27 Feb.	100	9
13 Mar.	98	4

Table 8. Effect of timing on rooting obtained with cuttings of two *Chamaecyparis* and two *Juniperus clones*. Number of cuttings rooted from 100 inserted.

Date	*Chamaecyparis*		*Juniperus*	
	lawsoniana 'Silver Queen'	nootkatensis 'Lutea'	squamata 'Meyeri'	virginiana 'Grey Owl'
28 Aug.	85	79	61	98
11 Sep.	69	80	26	100
25 Sep.	46	35	20	97
9 Oct.	84	55	44	85
23 Oct.	73	78	33	50
6 Nov.	74	38	39	1
20 Nov.	13	12	33	5
4 Dec.	52	30	30	1
18 Dec.	12	19	32	0
22 Jan.	71	43	33	14
5 Feb.	30	3	10	2
19 Feb.	17	18	19	9
4 Mar.	25	1	42	4
Mean	50	38	32	36

Table 9. Rooting percentages and root quality index for *Cupressocyparis* cuttings, as influenced by time of taking cuttings and by Captan applications.

Date cuttings taken	Rooting Percentages (with quality of root system)	
	Without Captan	With Captan
1965-66		
6 Sep.	66 (2.8)[1]	70 (2.4)[1]
5 Oct.	68 (2.4)	62 (2.5)
3 Nov.	16 (1.9)	32 (2.3)
2 Feb.	4 (2.0)	16 (2.3)
1966-67		
20 Sep.	57 (3.3)	76 (3.6)
9 Oct.	68 (3.4)	83 (3.6)
23 Oct.	72 (3.5)	73 (3.7)
6 Nov.	27 (2.5)	39 (2.5)
12 Feb.	21 (2.1)	50 (2.6)

[1]See discussion at end of paper for method of calculation.

temperature in the glasshouse and do not water the cuttings too much during winter. At that time it is better to water only when necessary, perhaps once a week, and to cover the beds with a sheet of plastic (0.02 mm thick) until the mist can be started again at the beginning of February.

Which growth hormone? New proprietary materials are introduced onto the market with clock-work regularity. Up to now they are all based on IBA, IAA, NAA or a combination of these, with or without a fungicide. These introductions provide a constant and time absorbing field of research.

In one series of experiments we compared the growth hormone according to the "Stekboek"* with Veratine, Jiffy Grow and two normal powders of NAA and IBA. Veratine, of which the base is unknown to us, requires the cuttings to be soaked for 15 minutes in a solution of 20 ml/litre. Jiffy Grow is a quick-dip product imported from America which can be used at full strength or at 1 in 9 water dilution.

*The "Stekboek" recommendations mean treatment with 50, 100, 150 or 200 ppm of either IAA, IBA, or NAA, depending upon the cultivar.

Results with a number of subjects in 1966-67 are summarized in Table 10.

Table 10. Effect of several hormones on rooting obtained from cuttings of a number of conifer clones. 1966-67.

	Growth hormone "Stekboek" + Captan	Veratine +	Jiffy Grow +	NAA 0.2% +	IBA 2% +	Verapon —
Chamaecyparis						
C. lawsoniana 'Naberi'	56	54	—	48	6	—
C. l. 'Silver Queen'	98	52	36	6	2	8
C. l. 'Stewartii'	98	98	14	56	50	58
C. l. 'Stewartii'[1]	100	98	32	100	70	84
C. l. 'Triomf van Boskoop'	90	90	72	76	46	38
C. l. 'Triomf van Boskoop'[1]	94	90	74	80	62	76
C. nootkanensis 'Glauca'	68	86	52	66	56	50
C. n. 'Lutea'	78	88	10	74	50	52
X Cupressocyparis						
C. leylandii 'Haggerston Grey'	60	12	—	0	12	—
Juniperus						
J. chinensis 'Blaauw Varietat'	46	94	—	98	100	94
J. c. 'Plumosa Aurea'	94	82	0	84	94	76
J. communis 'Repanda'	100	100	1	95	99	—
J. communis 'Suecica'	98	98	—	98	97	—
J. Scopulotum 'Spring Bank'	22	4	—	22	0	0
J. virginiana 'Skyrocket'	96	94	—	92	94	—
Taxus						
T. baccata 'Semperaurea'	76	72	—	66	32	—
Tsuga						
T. candensis 'Pendula'	96	90	8	12	—	—

[1]Cuttings taken from young plants.

It can be seen that "Stekboek" and Veratine have given very similar results. Sometimes it does not matter which hormone is used; in some cases these varieties will root satisfactorily without a growth hormone. When using an adapted growth hormone both the rooting percentage and the quality of rooting will be better. With a number of varieties there will be a difference of 20% from one year to another.

One thing can be noted. In the two cases in Table 10, where cuttings were taken both from older and from younger (4-yr.) plants, the reaction to some of the powder treatments was much better with the cuttings taken from the younger plants than from the older ones.

It can, therefore, be seen that the mean rooting percentages with "Stekboek" growth hormone, Veratine and 1/10 Jiffy Grow are more or less the same. Jiffy Grow at full concentration is too strong for almost any cutting; it causes them to rot at the base. Again the powdered cuttings rooted less satisfactorily than the soaked ones.

This experiment was repeated in 1968-69 and the results are summarised in Table 11, but even now we do not advise the use of these hormones, for a good advisory man in our country must be safe with his recommendations. Of course we pass on these results but we leave the decision on the use of the materials to the growers.

Finally, some results are given in Table 12 with four clones of *X Cupressocyparis leylandii.*

We have come to the conclusion that more experience is needed before the use of Veratine and the weak, quick-dip solutions of Jiffy Grow can be advised officially. With other well-known IAA, IBA and NAA preparations we already have 25 years experience.

Table 11. Effect of several hormones on rooting obtained from cuttings of a number of conifer clones. 1968-69.

	Growth hormone "Stekboek"	Veratine	Full Strength Jiffy Grow	1/10 Jiffy Grow	0 2% NAA
Captan	+	+	+	+	+
C. lawsoniana 'Forsteckensis'	98	100	8	100	100
Chamaecyparis					
C. l. 'Tharandtensis Caesia'	76	65	3	69	61
C. obtusa 'Filicoides'	70	60	0	72	48
Juniperus					
J. chinensis 'Keterleeri'	26	80	0	52	0
J. c. 'Pfitzeriana'	96	98	2	94	92
J. c. 'Plumosa Aurea'	81	55	0	52	18
J. virginiana 'Skyrocket'	85	74	0	92	82
Tsuga					
T. canadensis 'Pendula'	74	78	0	77	26
Mean	76	78	2	76	53

Table 12. Rooting percentages and root quality index of four clones of *X Cupressocyparis leylandii* as influenced by the auxin used and by Captan.

Clone	Rooting Percentages (with quality of root system)		
	IBA 100 mg/litre		NAA 0.2%
Captan	—	+	+
'Green Spire'	83 (4.2)[1]	93 (4.2)[1]	50 (3.2)[1]
'Haggerston Grey'	78 (4.4)	92 (4.1)	32 (3.1)
'Leighton Green	84 (4.0)	86 (3.9)	9 (2.3)
'Naylor's Blue'	55 (4.6)	95 (3.7)	0 (0)

[1]See discussion at end of paper for method of calculation.

JIM WELLS: Can the speaker explain how he arrives at the figures which relate to the quality of the rooting system and which were included in some of his rooting percentage tables?

B. C. M. VAN ELK: Yes, we grade our rooted cuttings on a five point scale, the grading taking into account both the quality and the quantity of the rooting system. Grade 1 is very light rooting; 2, light; 3, good or average; 4, heavy; 5, very heavy rooting. The number of cuttings in each grade is then counted. This number in each grade is then multiplied by the grade number itself, the numbers added together and the total divided by the number of cuttings. The resultant figure gives the quality assessment of the root system.

An example will show this more clearly: —

GRADE	1.	2.	3.	4.	5.	TOTAL
Number of cuttings in grades	10	10	30	40	10	100
Multiplying above number by grade number	10	20	90	160	50	330

Thus 330 divided by 100 gives 3.3, which is the quality grade assessment of the root system in this case.

BRIAN HUMPHREY: How do you obtain your 1/10 strength Jiffy Grow?

B. C. M. VAN ELK: Merely by diluting 10 ml of the product with 90 ml water.

BRIAN HUMPHREY: But is this, in fact, effective? A quick-dip technique requires an alcohol solution to ensure the rapid penetration. By diluting with this amount of water surely the material can no longer be effective as a quick-dip? For example, IBA in 50% alcohol is effective as a 5-second quick-dip, but the material in water requires soaking.

B. C. M. VAN ELK: We find it effective as a diluted quick-dip.

JIM WELLS: We have abandoned Jiffy Grow as we cannot get consistent results. However the material does, I believe, contain boron. We have used boron at 50 ppm, which has given good results when added to a hormone; it seems to increase the potency of the hormone.

B. C. M. VAN ELK: We have used boron widely without finding any significant results. But then we use cow manure at 70 tons per hectare every 2 or 3 years, so obviously our boron level is well maintained in the soil.

A. D. WEGUELIN: In France they are using CO_2 to hasten the rooting of cuttings. Has any work been done on this at Boskoop?

B. C. M. VAN ELK: Yes, but a 0.06% concentration gave no results. In the peat in which we place our azaleas we have CO_2 concentrations approaching 0.11%. We have not tried higher concentrations.

JAMES KELLY: At Kinsealy, a pilot trial has suggested that the illumination of cuttings in winter may give very good results. With *Chamaecyparis lawsoniana* 'Fraseri' and *Juniperus chinensis* 'Pfitzeriana', rooting occurred more quickly and thoroughly where the natural daylight was supplemented by mercury vapour lamps. We hope to continue our experiments and collect more substantial evidence.

LIGHTING — ITS EFFECT ON ROOTING AND ESTABLISHMENT OF CUTTINGS (A SHORT REVIEW)

A. B. MACDONALD
Glasshouse Crops Research Institute,
Littlehampton, Sussex

Searching through the literature, one finds that a considerable amount of research and experimentation has been carried out relative to this subject, particularly in the United States, U.S.S.R. and some European countries. Lighting has three main roles. These are —

1. *Rooting of cuttings.* This can be subdivided into —
   a) treatment of the stock plant;
   b) application to the cutting in the actual rooting bench.
2. *Establishment of rooted cuttings.* This can be interpreted as the continuation of growth to delay or prevent dormancy, with the aim of reducing losses of specific deciduous subjects during the winter.
3. *Breeding.* To speed up a breeding programme when plant breeders are anxious to see the results of their crosses earlier, e.g. *Rhododendron,* which has flowered after 3 years instead of 6 years. It may be practical with some subjects to