SUPERIOR SCOTS PINE FOR THE NETHERLANDS

W. Kriek

RIJKSINSTITUUT VOOR ONDERZOEK IN DE BOS- EN LANDSCHAPSBOUW "DE DORSCHKAMP"
WAGENINGEN

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ABSTRACT

Selection and breeding work done in the Netherlands with Scots pine is summarized. The results lead to the conclusion that indigenous material is superior to imported material and that the production of excellent reproductive material is secured. The basic material offers good prospects for further breeding work but the feasibility of this depends on expected extra gains and the relative importance of Scots pine for Dutch forestry in the future.

INTRODUCTION

Scots pine (Pinus sylvestris L.) is the most important conifer in Dutch forestry. Some 35% of the total forested area is planted with this species. Scots pine has probably never been wholly absent from the country, but at one time its extent was reduced to a few small occurrences.

The present plantations were established with material that was introduced from elsewhere one or more generations ago (Heybroek 1974). The first planting was done in the 16th century with material of German origin.

Provenance trials were established in 1910 and 1927, in which material from Dutch stands*) was compared with material from foreign sources. Dutch provenances were the best or among the best. More recent trials in which unselected Dutch material is being tested alongside selected German material were established in 1956. Again the Dutch material is proving to be among the best.

In 1945 a start was made with the phenotypic selection of stands for the collection of seed. This resulted in 1967 in a first list of selected stands. The list has subsequently been revised several times. That published in 1967 comprised 79 stands, covering a total of 150 ha. The latest revised list comprises 89 stands, covering 200 ha.

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*Plants grown from seed collected in Dutch (planted) stands can be considered to be provenances and are referred to as such.

Due to failing seed crops and poor organization of seed collection, import of seed, mainly from Germany, continued all through the 1950's and 1960's. Difficulties were frequently encountered in the establishment of plantations, as a considerable part of the imported material showed poor adaptability to Dutch conditions. High susceptibility to needle cast disease (Lophodermium pinastri L.) was the main cause of partial or complete failures, but forestry practice did not recognize this as a provenance problem.

In 1965 a new provenance experiment was established with 13 Dutch and 4 German provenances, two of which are so-called "Sonderherkünfte", especially recommended for this trial by a German expert. One of the "Sonderherkünfte" was reported to be fairly resistant to needle cast. The Dutch provenances were selected stands. The first results from this trial were published by Koster and Van Vredenburch (1971) and Kriek and Bikker (1973). A summary of the results to date in this report shows that the performance of the German provenances is very unsatisfactory. Forestry practice could be convinced of this.

There is a strong indication from other research (Squillace et al. 1975) that needle cast susceptibility of Scots pine in our part of Western Europe increases from West to East. For further seed imports in years of shortage, attention was directed westward to England and Scotland. Some seed was imported in the early 1970's and the opportunity was taken to compare some of this material with material from a large number of selected Dutch stands. Some Polish provenances and material from a Danish seed orchard were also included in this investigation. The early results are dealt with in this report.

In the late 1950's and early 1960's, nearly 500 mother trees were selected phenotypically, some in adjacent Belgian and German areas but the majority in 110 different Dutch stands. Most of these stands are selected stands. Open-pollinated seed was collected from all trees and the halfsib offspring of the trees were tested in the nursery and in some 13 trials. Results of this investigation were reported by Squillace et al. (1975), but additional information was subsequently collected and is referred to in this report.

Early results from the halfsib testing mentioned above formed the basis of the selection of clones for the establishment of the first Scots pine seed orchard in the Netherlands. This seed orchard came into production in 1975, ten years after establishment. Progenies from the seed orchard are being tested alongside material from some Ducth seed stands. Very early results are now available.

Some clones used in the first seed orchard were control crossed. The results give some detailed information on how these clones may influence the quality of the seed orchard material.

The results of the provenance, halfsib and seed orchard material investigations from the basis of the choice of material for practical forestry and further breeding work.

THE DUTCH AND GERMAN PROVENANCES TRIAL OF 1965

General

The trial was established in three replicates with three- and two-year old plants in the northeast of the Netherlands, an area in which the incidence of needle cast disease is fairly high. As mentioned above, 4 German provenances are being compared with 12 Dutch provenances.

The soil is sandy and of the "veldpodzol" type, a fairly good soil for Scots pine. Previously the area carried a coppice stand of oak. Systematic thinnings were done in 1971 and 1974. The results to date are summarized in Figure 1.

Survival

At the bottom of the diagrams in Figure 1 survival percentages at ages 6 to 7 and 10 to 11 are shown. The German provenances show the lowest survival, right from the start. They were severely attacked by needle cast disease during the first period. Weakened trees were subsequently attacked by Armillaria mellea, which was abundant in the hardwood stumps of the previous crop. The losses increased during the second period. The provenance "Grebenau", which was reported to be fairly resistant in Germany, suffered the heaviest losses. During the second period, some differentiation occurred in the Dutch provenances; Hoenderlo I, Junne, Melick Herkenbosch and De Utrecht suffered more losses than the other provenances. The last two provenances come from the southern part of the country, where needle cast is less frequent than in the centre and the northeast. Even the poorest Dutch provenances are more to considerably more resistant to needle cast than the German provenances.

Growth

The differences in height between the provenances were not very large after four years in the field at 6 to 7 years from seed. The largest influence of needle cast on growth was in the next period of four years. The provenances that suffered heavy death losses also show a considerable reduction in height growth. In the following periods, height increment is 0.60 to 0.70 m per year for all provenances except Grebenau and Hoenderlo I.

Diameter growth does not differ much. At age 16 to 17 years from seed the h/d ratio of the Dutch provenances is 60 to 62. Some of the poorer provenances have ratios of 58 and 59. The h/d ratios of the German provenances are 55 to 57. These lower ratios i.e. the relatively larger diameters, can be accounted for by the lower tree densities.

Conclusions

The poor performance of much of the material imported from Germany was confirmed in this trial. Relative resistance to needle cast in Germany does not automatically mean that a provenance is also resistant in the Netherlands. The poor performance of some known German provenances and the fact that German provenances, even "Sonderherkünfte" are not well defined (a provenance may contain material from a large number of stands, whose genetic characteristics may differ greatly) lead to the conclusion that the use of German material for practical forestry should be discouraged.

THE DUTCH AND FOREIGN PROVENANCES IN THE TRIALS OF 1975 AND 1976

The trials of 1975

In 1975, four trials were established with three-year old material from nine Dutch provenances, four Polish provenances, five English provenances, seed orchards and a tree bank, and one Danish seed orchard.

Material from eight halfsib families from two Dutch stands, Ommen and Junne, was included for comparison. Not all the trials contain all the material. A few provenances and progenies are absent from 1 or more of the trials.

The trials were established in Leende in the south of the Netherlands on a poor, dry sandy soil of the "haarpodzol" type. One trial consists of small plots with 4 x 4 plants, the other consist of larger plots with 9 x 9 plants. The two other trials were established in Appelscha in the northeast of the country on a sandy soil of the "veldpodzol" type. Again, one trial consists of small plots and the other of larger plots.

The trials were measured when the plants were four years in the field and seven years from seed. The results have been summarized in Table 1.

Survival in the 1975 trials

In Leende, survival is excellent. In the small plots, survival varies from 83 to 100%. The poorest survival is found in one Dutch halfsib family and one Dutch provenance. In the large plots, survival varies from 80 to 100%, with poorest survival in another Dutch provenance.

In Appelscha, survival is poorer. In the small plots it varies from 50 to 96%. None of the groups is better or worse than another. In the large plots, survival is rather poor and varies from 28 to 86%, with poorest survival in some of the Dutch material. At this stage deaths were not the result of needle cast disease but of drought conditions at the time of establishment.

Height growth in the 1975 trials

The better soil conditions in Appelscha resulted in better growth there than in Leende. When presenting the results, the Dutch material has been divided into the best and poorest, i.e. halfsib families and provenances with mean heights above and below the means for the trials.

Most of the Dutch provenances are growing better then average. Growth of the provenance Junne, which is also represented in the 1965 provenance trial, is shown separately. In general, the halfsib families are growing better than the Dutch provenances, even though their parents were not representative of the best stands.

Only one Polish provenance is growing generally better than average. One provenance from Windsor Park is always just above average, the other is always below average. The seed orchard material from Denmark and the United Kingdom, which is of the Scottish type of Scots pine, is generally below to well below average in growth.

The 1976 trial

This trial was established in Garderen in the centre of the country on a dry sandy soil of the "haarpodzol" type. Seven foreign provenances are being tested, tohether with thirty Dutch provenances. The plots contain 24 plants in two rows. The results of the last assessment are shown in Table 1.

The majority of the Dutch provenances are again growing better than average. The provenances Speulderbos and Junne, which are also represented in the 1965 trial, are shown seperately in the table. Among the poorest Dutch provenances, four are non-selected stands.

The Polish provenance is one of the three that is showing a below average growth in the 1975 trials. The Windsor Park provenance is the one that is doing well in the 1975 trials. The Danish and English seed

orchard material is performing in the same way as in the earlier trials. The German provenance Niederdeutsches Tiefland West is poor.

Survival in this trial is 95% and it varies from 86 to 100%.

Conclusions

In general, the Dutch provenances show better growth during the first seven years than the introduced provenance and seed orchard material from Poland, Great Britain and Denmark. The influence of needle cast during this period has been negligeable. Some of the British material and also the Danish material is supposed to be more needle cast resistant than some of the Dutch material. Unpleasant surprises, however, may occur. The poorer Windsor Park provenance proved to be highly susceptible to needle cast disease in another plantation in the northeast of the country. There is therefore every reason to concentrate on Dutch material for seed production and further breeding work.

THE HALFSIB TRIALS OF 1964

General

As mentioned above, the first results from these trials were reported by Squillace et al. (1975). Additional information largely confirming these findings has been collected from all trials. Some results from six trials have been summarized in Figure 2. These six trials were established in 1964 in one area in Loobos in the centre of the country. The soil is a poor sandy soil, sometimes rather wet, of the "haarpodzol" type. Of the nearly 400 families tested in the 13 trials, some 300 were tested in the six Loobos trials.

The findings of Squillace et al.

The report by Squillace et al. deals with height growth up to age 8 years from seed and needle cast observations at age 9 years from seed. The attacks of needle cast have been very serious in this area due to the humid conditions that occur in certain years. The main conclusions of Squillace et al. may be summarized as follows:

- About half of the genetic variation among parents was associated with the stands in which they were located. The variation among stands was associated with geographic and age patterns.
- Halfsib progenies from the Netherlands performed better than those from other countries. Since all Dutch material is of foreign origin, the Dutch progenies must have developed superiority through artificial and/or natural selection within a few generations.
- Within the Netherlands there was evidence of a geographic pattern. Progenies from the northwestern part of the forest area performed better than those from the southern and eastern parts of the country. Not only was their height growth better (Figure 2) but so was their needle cast resistance (Figure 3). This may be due to better management in the northwest or because the climate in the northwest is more conducive to severe attacks of needle cast. This may have resulted in more intense natural and/or artificial selection against susceptible trees.
- Progenies of trees planted after 1900 performed better than progenies of trees planted earlier. The genetic superiority of the younger parental stands may have resulted from improved seed collection practices in later periods. Also, younger stands were probably subjected to more severe needle cast infection.
- Squillace et al. calculated that a gain of 28% in height growth can

be obtained by selecting the best parents on the basis of the progeny tests and establishing a clonal seed orchard from them. They selected the 50 best parents out of 400 for this purpose.

Further results and observations

Further development of the progenies of 5 of these 50 best parents is shown in Figure 4 (left). In contrast, the development of 5 of the poorest progenies in the same trials is shown to the right in the same figure. In between, the further development of some progenies of parents that were selected at a very early stage for establishment of the first seed orchard, is shown.

Growth in these 1964 halfsib trials is, in general, poorer than in the 1965 provenance trial. Unlike the German provenances in that trial, the poorest progenies in the Loobos trials did not improve their growth after some years. The difference in height between the best and the poorest progenies therefore increased considerably.

The influence of the needle cast attack was much more general on these progenies than on the provenances. Moreover, the trial was kept closed, without thinning, for a long time. The observations on needle cast disease were done at age 9 years from seed. The rating was on a scale from 1 to 7. The average rating for the best progenies was 1.43 to 3.20, whereas the poorest progenies scored 4.61 to 6.36 (see Figure 4). The death rate resulting from these attacks is very much higher in the latter group than in the group of best progenies.

Some of the progenies of the parents included in the first seed orchard proved to be rather susceptible to needle cast. Some progenies, such as 306-03 and 400-05, seem to resume fast height growth after some time, more or less in the same way as the German provenances mentioned earlier. Some parents (391-03 and 306-04) are included in the list of 50 best parents given by Squillace et al. Their progenies continued to perform well up to age 12 years. In the last few years their height growth has lagged behind as the result of a fire that swept through one of the trials.

Conclusions

The progenies that were considered the best at age 8 years from seed continued to perform well up to age 16 years. The fact that a stand such as Hoenderlo I does not do too well in a provenance trial does not mean that no good material is present in such a stand. Some of the trees selected in this stand proved to be among the best parents in the collection.

Not all the parents selected at an early stage for seed orchard establishment are sufficiently needle cast resistant, although their progenies grow reasonably fast.

The exclusive use of the best parents in seed orchards will result in a considerable improvement of the quality of planting material for Dutch forestry.

THE FULLSIB TRIAL OF 1972

General

Some of the parents of the first seed orchard were used in controlled crosses in 1967. The seed of the fullsibs was sown in 1970 and the trial was established with two-year-old plants in Oostereng in the centre of the country. The soil is a fairly good, moist sandy soil of

the "veldpodzol" type. The families are represented in 1 to 13 replicates in 12 blocks.

Results

The trial was measured when the plants were 9 years from seed. The results are shown in Table 2. Survival in the trial was 93%, varying from 78 to 100%. No severe attack of needle cast has yet occurred. The following significant differences could be established (T-test 5%):

no.	1. 400-05 x 391-03 >	nos 12 to 22
	2. 380-01 x 391-03 >	14 to 22
	3. 362-02 x 306-06 >	22
	5. 400-05 x 306-06 >	18, 20, 21 and 22
	6. 391-03 x 362-05 >	20 en 22
	7. 391-01 x 391-03 >	18, 20, 21 and 22
	9. 400-05 x 362-05 >	18 to 22
	10. 391-03 x 391-04 >	22
	12. 391-03 x 306-06 >	22
	14. 391-04 x 362-05 >	22

The parents 391-03 and 362-02 appear to be good mothers, 380-01 and 400-05 give varying results as mothers and 306-06, 391-01 and 391-04 give poor results as mothers. Good fathers are 306-06, 362-05 and 391-03, whereas 306-03, 306-04, 362-04 and 391-04 are poor fathers.

Conclusions

These results provide interesting additional information about the performance of the material from the first seed orchard. Parent 391-03, which is relatively needle cast resistant, is in general very good. The very susceptible parent 362-02 gives good results in the absence of needle cast. The susceptible parents 380-01, 400-05, 306-03, 306-04 and 391-04 give varying to rather poor results in absence of needle cast. The performance of 306-04 is particularly disappointing.

S E E D O R C H A R D M A T E R I A L

General

The first seed orchard, which contains 15 clones, came into production in 1975. One of the first seed collections was made clone-wise. The seed was sown separately. In the same series, seed from the provenances Speulderbos, Junne and Scherpenberg (another provenance that proved to be one of the best Dutch provenances in the 1976 provenance trial) was sown. The seed was sown under controlled conditions and the plants were measured after three years, when the average height of all plants was 0.30 m.

Results

The table of significance (T-test 5%) is as follows:

306-06, 362-02 >	Speulderbos, Junne, Scherpenberg, 380-01, 391-01 and 362-04
391-04, 362-05 >	Junne, Scherpenberg, 380-01, 391-01 and 362-04
400-05, 391-03 >	Scherpenberg, 380-01, 391-01 and 362-04
Speulderbos I >	391-01 and 362-04
Junne and Scherpenberg >	362-04

The progeny of one of the other parents was significantly poorer than the three provenances in the test. The average for the 15 progenies was the same as that for the three provenances.

Conclusions

These early results are largely in line with the results from the fullsibs The offspring of 306-06 and 391-04 are doing much better than expected in this early stage. In the absence of needle cast, the material from the seed orchard is doing as well as that from the best Dutch provenances.

G E N E R A L C O N C L U S I O N S A N D R E C O M M E N D A T I O N S

Considerable effort has been put into the search for superior Scots pine material for the Netherlands. Some aspects (provenance and halfsib testing) are well represented, others (controlled pollination and testing of seed orchard material) are still weakly represented. The results in the trials give sufficient basis for the following general conclusions and recommendations.

- Extensive provenance investigations show that Dutch provenances generally perform better in Holland than foreign provenances.
- In selected Dutch stands, excellent parent trees have been found for seed orchard establishment and further breeding work.
- The parent trees that were selected at an early stage for seed orchard establishment are of no more than average quality. The susceptibility to needle cast of their progenies is fairly high and their performance as mother and/or father in controlled crosses is variable. Yet in the absence of needle cast, growth of the seed orchard material appears to be as good as that of the best Dutch provenances.
- The quality of the material from seed orchards established later is bound to be much better, since these orchards are composed of parents whose progenies have proved to be hightly needle cast resistent and have maintained superior growth to at least 16 years from seed.
- The fifty best clones represented in the younger seed orchards could be used as a breeding population. Proposals for a breeding programme have been formulated.
- The feasibility of a further breeding programme depends on the gains it can be expected to produce and on the importance of Scots pine in the planting programme. Future gains will be less than those achieved so far; also the importance of Scots pine is tending to diminish. Douglas fir is competing strongly with Scots pine. On the somewhat better soils of the "holtpodzol" and "veldpodzol" type, production of Douglas fir is twice that of Scots pine and the latter will be replaced by the former in the course of time. The area under Scots pine will therefore decrease from the present-day 100 000 hectares to some 60 000 hectares in the future. On the dry "haarpodzol" soils on which Scots pine will continue to be the main species, its annual production is now 6 to 7 m^3 per hectare. If the best available material were used this could be raised to 8 to 10 m^3 per hectare per year. Further breeding will not be able to raise this production by more than another 1 m^3.

R E F E R E N C E S

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Squillace, A.E., J.G.A. La Bastide and C.L.H. van Vredenburch. 1975. Genetic variation and breeding of Scots pine in the Netherlands. Forestry Science 21(4): 341-352.

Annexes

(Figures, tables, photos)

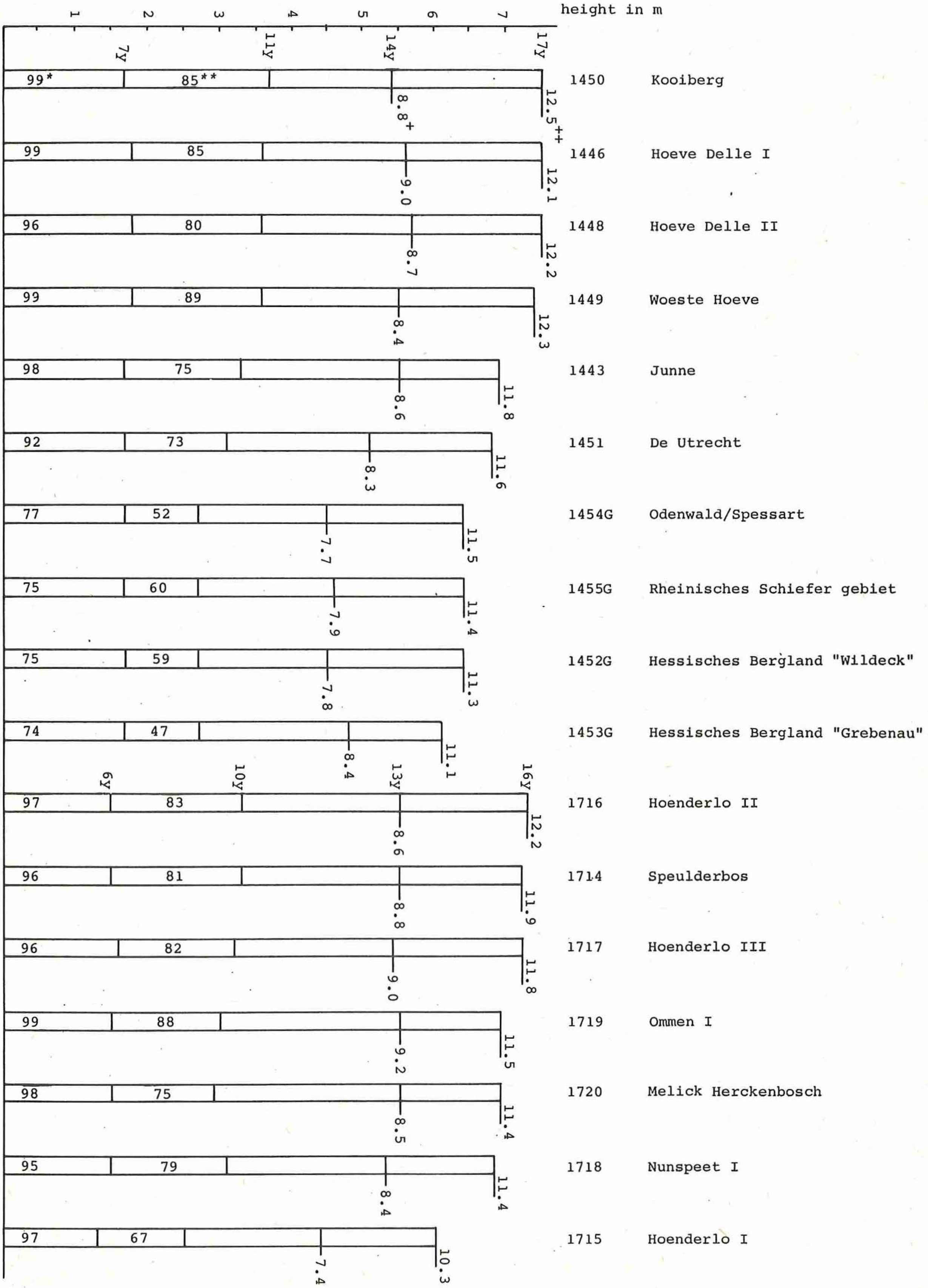


Figure 1 Growth in the Dutch and German provenances trial of 1965 up to ages 6/7, 10/11, 13/14 and 16/17 years.
N.B. Survival at ages 6/7 (*) and 10/11 (**) years, diameter at ages 13/14 (+) and 16/17 (++) years in cm.

FIG. 2. Progenies of parents growing in Northwestern areas tended to grow more rapidly then progenies of parents from Southwestern areas. Numbers in circles indicate the numbers of families on which the average value (standard deviations) is based. (Squillace et al. 1975)

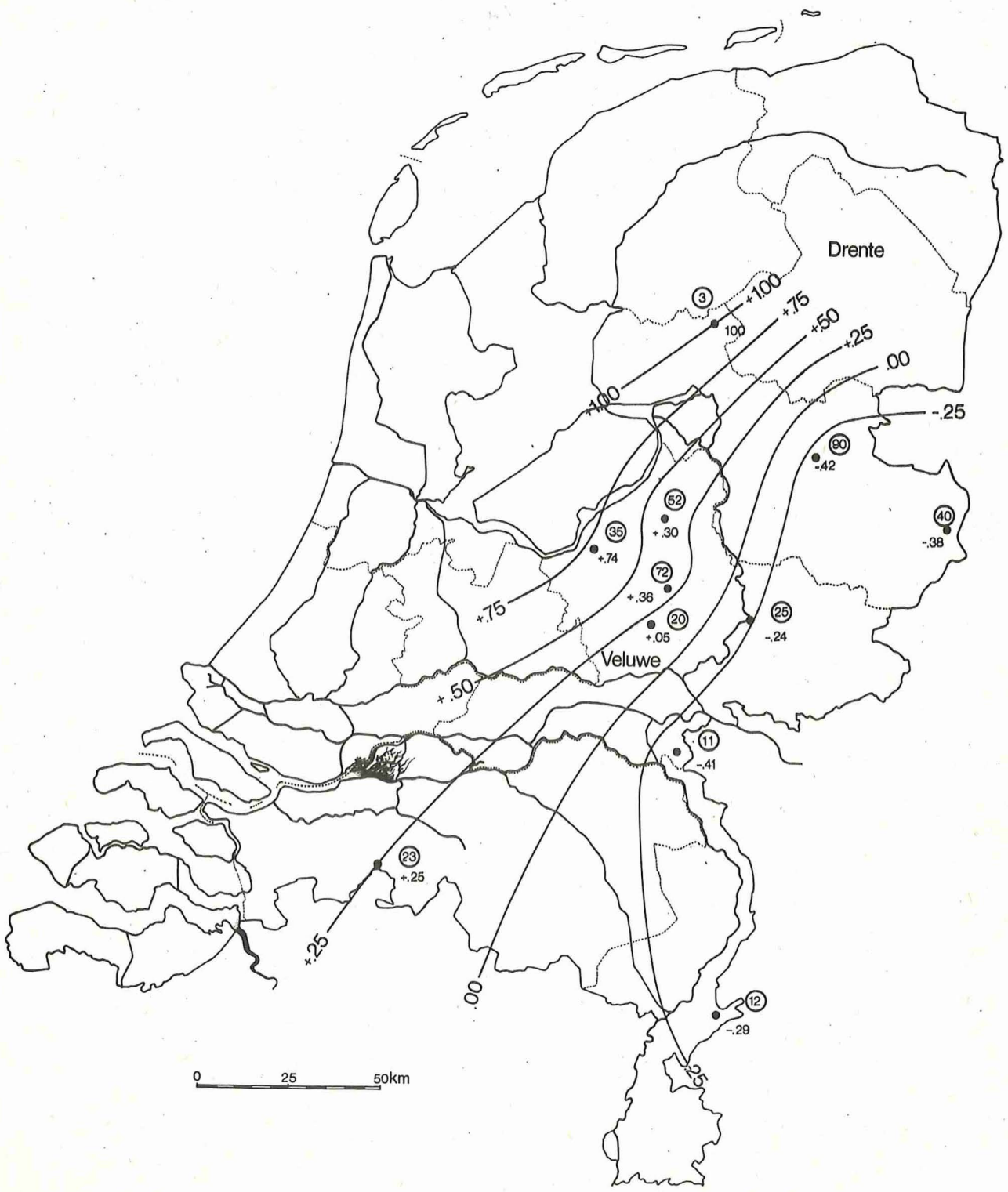
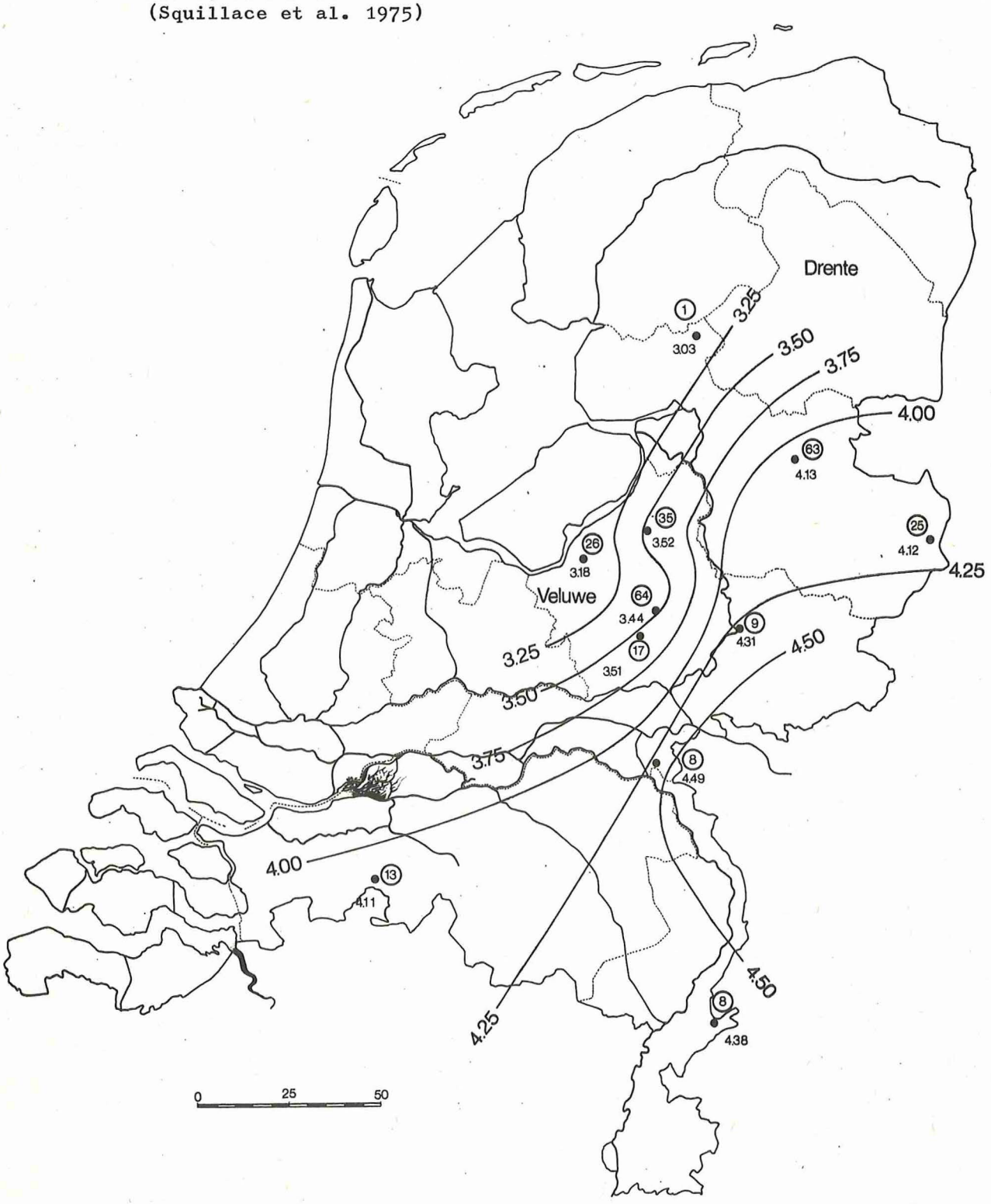


FIG. 3. Average needle cast damage (1 = least damage, 7 = dead) of Scots pine families related to geographic origin of female parents in the Netherlands. Numbers in circles indicate numbers of families upon which the average rating is based.
(Squillace et al. 1975)



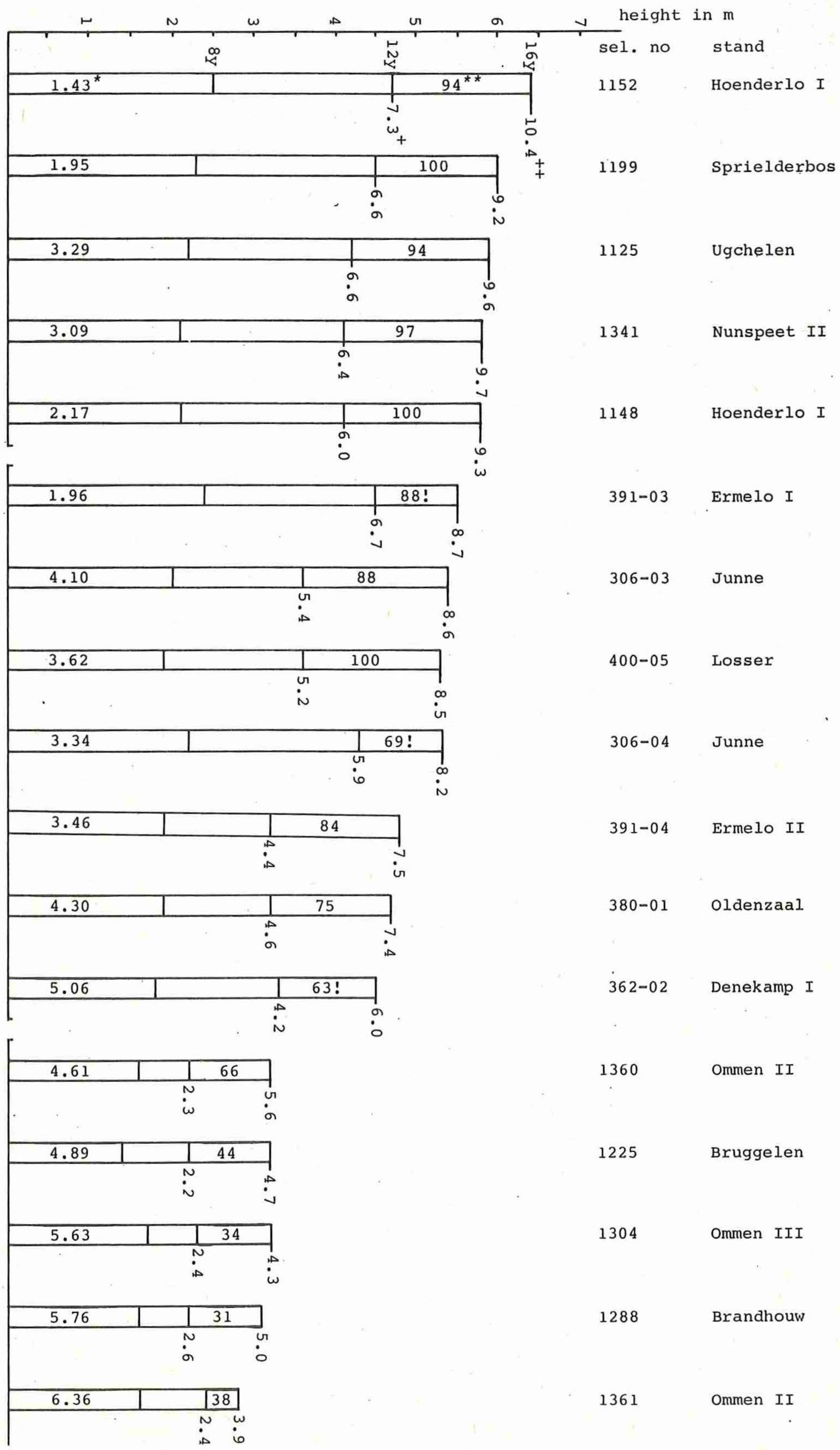


Figure 4 Growth of some of the best (left) intermediate (centre) and poorest (right) halfsib progenies in the Loobos trials up to ages 8, 12 and 16 years.

N.B. Needle cast rating at age 9 years(*), survival at age 16 years(**), diameter at ages 12(+) and 16(++) years in cm; ! partly damaged by fire.

Table 1. Some results from the provenance trials of 1975 and 1976

provenance	name en type of the trial				
	Leende small	Leende large	Appelscha small	Appelscha large	Garderen
	Survival % at age 7 years from seed				
All	94	95	84	61	95
	mean height in m at age 7 years from seed*				
All	1.31 (25)	1.27 (25)	1.41 (24)	1.37 (23)	1.32 (37)
best Dutch halfsibs	1.42 (4)	1.36 (8)	1.64 (3)	1.64 (4)	-
best Dutch provenances	1.40 (7)	1.33 (5)	1.55 (6)	1.51 (5)	1.37 (21)
Speulderbos					1.35
Junne	1.43	1.26	1.57	1.66	1.39
poorest Dutch halfsibs	1.25 (2)	-	1.36 (3)	1.35 (1)	
poorest Dutch provenances	1.23 (2)	1.21 (3)	1.28 (2)	1.29 (2)	1.27 (9)
Poland	1.30 (4)	1.26 (3)	1.38 (4)	1.24 (3)	1.30 (1)
Windsor Park (G.B.)	1.32 (2)	1.31 (2)	1.23 (2)	1.29 (2)	1.23 (1)
Denmark, seed orchard FH227	1.23	1.02	1.60	-	1.23
Newton Treebank 69(4122)510	1.12	1.05	1.20	1.19	
Ledmore seed orchard (Altyre Estate clones)	1.16	1.02	1.23	1.42	
Ledmore seed orchard (Crathes Estade clones)	1.03	0.98	1.25	1.10	
Seed orchard 69(NT)II England					1.20
Seed or hard 69(NT 5) England					1.21
Seed orchard 69(NT 4) England					1.20
Niederdeutsches Tiefland-West					1.24
Largest difference between provenances	0.50	0.64	0.54	0.56	0.32
Least significant difference (T-test 5%)	0.13	0.14-0.28	0.19-0.34	0.23	0.10-0.21

* between brackets the number of halfsib families and/or provenances

Table 2. Results of some fullsib progenies at age 9 years from seed.
NB. 13* ranking number of the progeny

stand		Junne	Junne	Junne	Denekamp II	Denekamp I	Ermelo I	Ermelo II
stand	sel. no.	306-03	306-04	306-06	362-04	362-05	391-03	391-04
Junne	306-06	3.0 13*	2.9 15			3.0 11		
Denekamp I	362-02		3.1 8	3.2 3		3.1 4		
Oldenzaal	380-01						3.2 2	2.8 22
Ermelo I	391-01						3.1 7	2.8 21
Ermelo I	391-03			3.0 12		3.1 6		3.0 10
Ermelo II	391-04					3.0 14	2.8 20	
Losser	400-05	2.8 18	2.8 19	3.1 5	2.9 16	3.1 9	3.2 1	2.9 17

Photo 1. Provenance Austerlitz cpt 17e. So far one of the best provenances in the 1975 trials. The seed was collected in a 15-year-old stand, which had been established with material derived from a selected seed stand.

Photo 2. Halfsib progeny from Ommen with very good height growth in the 1975 trials.

Photo 3. Provenance Junne cpt 21c, with very good height growth in the 1975 trials.

Photo 4. Polish provenance with fairly good height growth in the 1975 trials.

Photo 5. Provenance Junne cpt 21c with very good height growth in the 1976 trial.

Photo 6. Provenance Speulderbos cpt 18g with very good height growth in the 1976 trial.

Photo 7. Provenance De Scherpenberg with very good height growth in the 1976 trial.

Photo 8. Provenance Junne cpt 21a with poor height growth. The stand Junne cpt 21a is not a seed stand.

Photo 9. Seed orchard FH 227, Denmark. Poor height growth in the 1976 trial.