DET FORSTLIGE FORSØGSVÆSEN I DANMARK

THE DANISH FOREST EXPERIMENT STATION
STATION DE RECHERCHES FORESTIÈRES DE DANEMARK
DAS FORSTLICHE VERSUCHSWESEN IN DÄNEMARK

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REPORTS WITH SUMMARIES IN ENGLISH
RAPPORTS AVEC DES RÉSUMÉS EN FRANÇAIS
BERICHTE MIT DEUTSCHER ZUSAMMENFASSUNG

BIND XXIX

HÆFTE 2

INDHOLD

KØBENHAVN
TRYKT I KANDRUP & WUNSCH'S BOGTRYKKERI
1965

THE EFFECT OF THE ROOT-STOCK UPON THE HEIGHT GROWTH OF *PICEA ABIES* GRAFTS

GRUNDSTAMMENS INDFLYDELSE PÅ HØJDEVÆKSTEN HOS PODNINGER AF RØDGRAN

BY
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When assessing the qualities of grafts for instance in tree-shows (*Syrach Larsen,* 1956, p. 93) the observations will necessarily cover the mutual effect of the stock and the scion.

In the field of gardening and fruit-breeding the significance of the root-stock is well known and is often exploited in order to obtain a special effect. Also in breeding of forest trees it is useful to know — especially when the stocks are of varied genetic nature (a population) — if their influence is important or not in the estimation of the clones, which are grafted upon them.

In 1953 *Bent Søegaard* started an experiment at the arboretum in Hørsholm with the purpose of investigating height growth, form, and flowering habit of grafts of Picea abies when different clones and populations of Picea were used as stocks.

In the present report is published a preliminary result regarding the relation between the height growth of the scion and the stock material.

Material used for the experiment

Grafts of 2 clones of Picea abies applied to 5 different types of stocks were employed in the experiment.

The scions were:

1) P. abies, clone V. 48
2) „ , „ V. 49

They originate from selected trees in an old stand (planted 1764) at Blå Bomme, Jægersborg Dyrehave.

The stocks were:

1) P. abies, clone V. 1101
2) „ , „ V. 525
3) „ , population
4) P. orientalis, population
5) P. omorika, population

The two clones were propagated from cuttings in 1947 while the populations were propagated from seed in 1948.

The grafting took place in March 1953. It was carried out in the greenhouse as a side veneer upon potted stocks. Care was taken that the stocks were of uniform quality.

Cultivation

The grafts were planted in the nursery in May 1953. They were transplanted in 1955 and in the spring of 1961 they were moved to the experimental area where they were planted under a light shade of alder at a distance of 2.5 × 2.5 m.

The plantation of alder was established in 1958 with 2-year old plants of Alnus glutinosa, A. cordata, A. rubra, and A. glutinosa × incana. Of the nursery trees A. rubra in block IV has had a more rapid growth than the others. This appears to have had some effect upon the grafts in this block as will be seen from the analysis.

Hoeing around the plants has been carried out whenever necessary ensuring that no roots were allowed to form above the place of grafting.

Design of experiment

The experiment was layed out as randomised blocks the details of which are shown in fig. 1. There are 4 replications. Every block contains 10 plots thus including all possible combinations of scions and stocks. Each plot consists of a row of 7 equal grafts (with the exception of plot D_2 in block IV which from the start contained only 5 plants and plot D_2 in block II, where 1 plant has died).

Apart from what was mentioned about the A. rubra in block IV there is no important variation of growth factors within the experimental area.

Measurements

Heights were measured in August 1964. The measurements were taken vertically from the surface of the soil to the terminal bud. This distance does not differ greatly from the height above the place of grafting since this point is only few centimeters from the ground surface.

It is not exclusively the growth vigour which is expressed by the vertical heights: the reason for small height of one particular plant

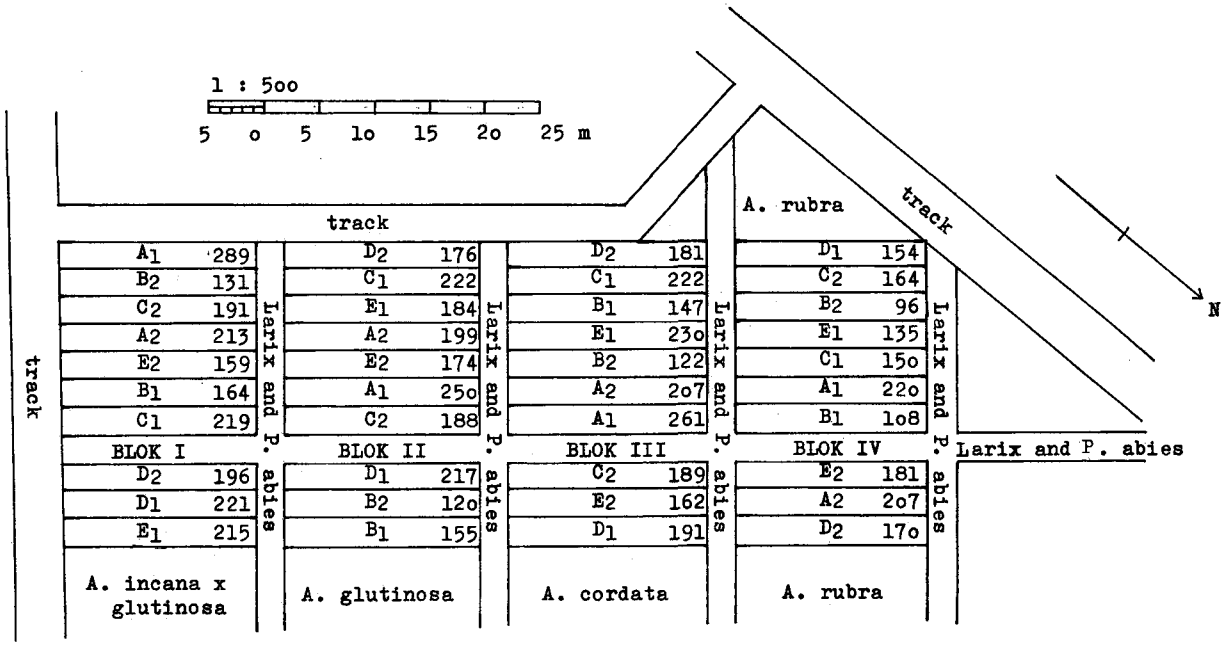

Figure 1. The experimental area. Majuscules in the plots signify type of rootstock: A = P. abies, clone V. 1101, B = P. omorika, population, C = P. abies, clone V. 525, D = P. orientalis, population, E = P. abies, population. Index indicates the scion: 1 = P. abies, V. 48, 2 = P. abies, V. 49. Figures show mean height of plot (cm).

may be that it is less vigorous than others, — on the other hand it is possible that it has a more horizontal growth because it has retained its branch character longer (see fig. 2).

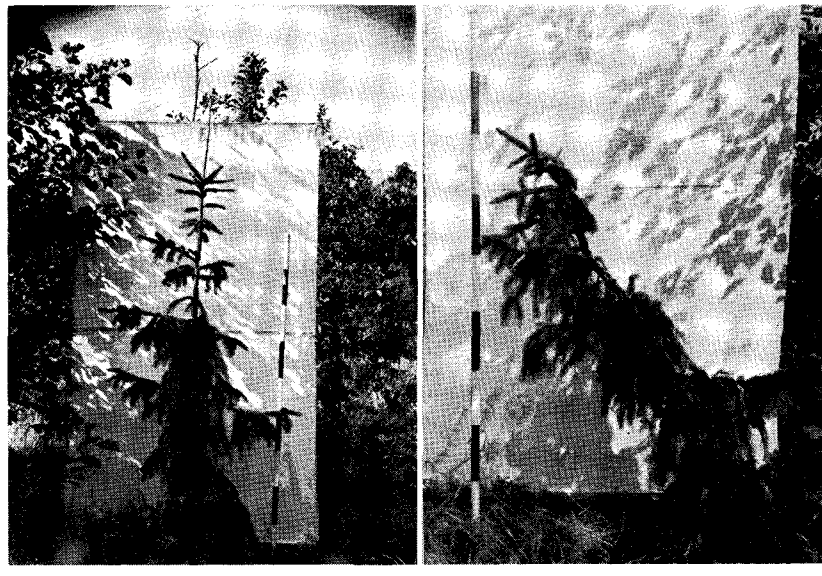

Figure 2. Picea abies (V. 48) grafted on two root-stocks of a P. abies population. Both grafts are from plot E_1 in block II.
Figur 2. Picea abies (V. 48) podet på to grundstammer af en P. abies population. Begge podninger er fra parcel E_1 i blok II.

Method of analysis

The heights which form the basis of the analysis are the means of the measurements in each plot (no values for the 3 missing plants have been calculated). These means appear in table 1.

An examination (Bartlett's test) has revealed that there is not a common variance within the plots. It is thought that this is partly due to a difference of variances between the two clones, V. 48 and V. 49, — partly to differences between plots grafted on clones and plots grafted on populations (see later).

No relation between mean heights and variances has been found so it is not possible to equalise the variances by a transformation of the data. It was therefore decided to divide the material into two parts: one containing the measurements of the scion V. 48 grafted on the five different types of stock, the

Table 1. Mean heights of plots (cm).
Tabel 1. Parcellernes middelhøjder (cm).

Plots	Blocks I	II	III	IV	Mean of all plots
Scion V. 48					
P. abies, clone V. 1101	289	250	261	220	255
„ , „ V. 525	219	222	222	150	203
„ , pop.	215	184	230	135	191
P. orientalis, pop.	221	217	191	154	196
P. omorika, pop.	164	155	147	108	144
Scion V. 49					
P. abies, clone V. 1101	213	199	207	207	207
„ , „ V. 525	191	188	189	164	183
„ , pop.	159	174	162	181	169
P. orientalis, pop.	196	176	181	170	181
P. omorika, pop.	131	120	122	96	117

other containing the V. 49 material. Each part has been subjected to analysis of variance although only the latter satisfies the Bartlett test. In judging the results it must be borne in mind that the formal demands for employing the method of analysis have not been fulfilled as far as the scion V. 48 is concerned.

The computed and the tabulated Chi-squares are shown in table 2.

Table 2. Chi-squares computed (Bartlett's test) and tabulated.
Tabel 2. Beregnede χ^2-værdier (Bartletts prøve) og tabelværdier.

	d. f.	Chi-square at 5 % level computed	tabulated
All data	39	96.79	54.56
Data containing V. 48	19	46.18	30.14
„ „ V. 49	19	28.30	30.14

Result

The analysis of variance is seen in table 3. It appears that there is in fact very significant differences between treatments (types of stock).

The confidence limit has been calculated to 30.6 and 23.5 cm at the 1 % probability level for the scions V. 48 and V. 49 respectively.

T a b l e 3. Analysis of variance. d. f. = degrees of freedom, F = mean square of blocks and plots divided by the mean square of error. ** = significance at 1 % level.

*T a b e l 3. Variansanalyse. d. f. = frihedsgrader, F = middelkvadratet for blokke og parceller divideret med middelkvadratet for fejl. ** = signifikans ved 1 % sandsynlighedsniveau.*

Source of variation	d. f.	Sum of squares	Mean square	F (computed)	F (tabulated)
Scion V. 48					
Blocks	3	13 762	4 587	22.71**	5.95
Treatments	4	25 202	6 300	31.19**	5.41
Error	12	2 428	202		
Total	19	41 392			
Scion V. 49					
Blocks	3	525	175	1.48	5.95
Treatments	4	17 568	4 392	37.22**	5.41
Error	12	1 419	118		
Total	19	19 512			

Discussion

The calculated values of F (treatments) are greater than the tabulated values in respect of both clones V. 48 and V. 49 meaning that there is in fact significant differences between the heights regardless of which scion is applied to the five types of stock.

It is further noted from the values of F (blocks) that in respect of V. 48 there is a significant difference between blocks. It is evident from table 1 that this is due to the comparatively small heights in block IV.

Such a difference does not occur in the case of V. 49 indicating that this clone has a greater ability to tolerate the fairly heavy shade in block IV.

A comparison of the confidence limits with differences of mean heights (table 1) shows that the clone V. 1101 has induced a significant better height growth than all other types of stock included in the experiment. The population P. omorika appears to be less valuable as a stock than any of the other clones and populations.

Although there are no significant differences between the stocks which rank between P. omorika and V. 1101 it is noteworthy that the succession is the same for the two clones of scions.

Summing up one has learned from the experiment that *the root-stock may have a significant influence on the height growth of the scion.*

If this fact will effect the evaluation of clones in tree-shows when the root-stock material is a population depends on the variation within this population.

One can get an impression of how much this variation amounts to by calculating the standard deviations of the individual heights. The figures applying to the present experiment are seen in table 4.

T a b l e 4. Standard deviations of individual heights. The figures are means of the 4 blocks.
T a b e l 4. Middelfejl på de enkelte højder. Tallene er middeltal for de 4 blokke.

Plots	Standard deviation	
	cm	% of height
Scion V. 48		
P. abies, clone V. 1101	38.0	14.9
„ , „ V. 525	29.7	14.6
„ , pop.	57.4	30.1
P. orientalis, pop.	41.0	20.9
P. omorika, pop.	27.6	19.2
Scion V. 49		
P. abies, clone V. 1101	23.8	11.5
„ , „ V. 525	18.4	10.1
„ , pop.	33.1	19.6
P. orientalis, pop.	22.4	12.4
P. omorika, pop.	28.3	24.2

It appears that *standard deviations expressed in percentages of mean heights are greater when populations are used as stocks than when the stocks are clones.*

Judging from this observation it can be assumed that when one intends to compare different clones in tree-shows it is possible to ascertain finer nuances (see *Syrach Larsen,* 1956, p. 98) if a genetically uniform material is used for stocks. Moreover an adequate basis for the comparison can be found in a smaller number of individuals.

SUMMARY

An experiment which is being carried out at the Arboretum in Hørsholm is intended to investigate how the root-stock of Picea abies grafts influences the plants in respect of height growth, form, and flowering habit. In the present report are presented the preliminary results concerning the height growth.

The grafting was done in 1953 and the grafts were planted on the experimental area in 1961, the design of which is seen in fig. 1. 10 different grafts were employed. 2 clones of P. abies, V. 48 and V. 49, both selected trees from an old stand (planted 1764) at Blå Bomme, Jægersborg Dyrehave, were grafted on 5 types of stock:

1) P. abies, clone V. 1101
2) „ , „ V. 525
3) „ , population
4) P. orientalis, population
5) P. omorika, population

The heights were measured in August 1964 and the data has been subjected to analysis of variance (table 1 and 3). It appears that differences between heights are due to the fact that different types of stock have been used: the clone V. 1101 has induced a significant better height growth than the clone V. 525 and the three populations. The population P. omorika is a poorer stock than any of the others.

Standard deviations of the individual heights (table 4) show that the variation of plants grafted on populations is greater than where the plants have been grafted on clones.

ACKNOWLEDGEMENT

The author is indebted to Mr. *H. C. Olsen,* statistician at Det forstlige Forsøgsvæsen (The Danish Forest Experiment Station) for advice and assistance.

RESUMÉ

På arboretet i Hørsholm løber for tiden et forsøg med det formål at undersøge, hvorledes grundstammen påvirker rødgranpodninger med hensyn til højdevækst, form og blomstring. Nærværende rapport er en foreløbig opgørelse, som kun omhandler højdevæksten.

Podningerne udførtes i 1953 og plantedes på blivestedet i 1961. Forsøgsanlægget ses af fig. 1. Der er anvendt 10 forskellige podninger,

idet 2 kloner af rødgran, nemlig kviste fra to udvalgte træer V. 48 og V. 49 (planteår 1764) i Blå Bomme, Jægersborg Dyrehave, er podet på 5 typer af grundstammer:

1) P. abies, klon V. 1101
2) „ , „ V. 525
3) „ , population
4) P. orientalis, population
5) P. omorika, population

Efter højdemålinger i august 1964 og en behandling af materialet ved variansanalyse (tabel 1 og 3) har man fundet, at der er forskelle mellem højderne, som må tilskrives, at der er anvendt forskellige grundstammer: klonen V. 1101 har som grundstamme bevirket en signifikant bedre højdevækst end både klonen V. 525 og de tre populationer, og populationen P. omorika har medført en ringere højdevækst end alle de øvrige typer af grundstammer.

En beregning af middelfejl på de enkelte højder (tabel 4) viser, at der er større variation på de planter, som er podet på populationer, end på de podninger, hvor grundstammerne er kloner.

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