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The effect of polyethylene covers on the flowering of Norway spruce (*Picea abies* (L.) Karst.) grafts*

INTRODUCTION

Most of the studies conducted so far on the effect of climatic factors on flowering in Norway spruce concern the initiation of female flowers and the cone production and a significant role in these processes is ascribed to temperature (Tiren, 1935; Eklund, 1957; Uskov, 1962; Brøndbo, 1970; Chałupka, 1975). The artificial modification of environmental conditions by the provision of polyethylene covers onto spruce grafts has resulted in the intensification of production of both female (Remröd, 1972) and male flowers (Brøndbo, 1969, 1970; Remröd, 1972). As a result of using such covers a great increase in temperature relative to the surroundings is attained, of the order of 15 - 16°C (Brøndbo, 1969, 1970).

MATERIALS AND METHODS

In 1975 on a Norway spruce seed orchard growing in Kórnik 20 clones of the species were selected for the investigation. From each clone 12 grafts were used for the study, 6 of which were given polyethylene covers, 3 for the period from June the 3rd to July the 5th and 3 for the same period plus another two weeks till July the 17th, while the remaining 6 grafts were left as controls. The design was randomized. The covers were placed over the top part of the graft, enclosing it in a polyethylene sleeve, leaving the top and bottom open (Fig. 1). The polyethylene was constrained around the spruce grafts with clothes pegs.

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Fot. K. Jakusz

Fig. 1. A Norway spruce graft with a polyethylene cover placed over its upper part

In 1976 flowering was observed on the studied grafts and the results were subjected to a variance analysis.

RESULTS

The favourable weather conditions of 1975 stimulated a good cone crop for Norway spruce in 1976 in the vicinity of Kórnik. This was also manifest on the seed orchard of the Institute of Dendrology, on which several grafts have produced cones and several dosens have produced male flowers. This is the first substantial flowering score on that seed orchard (Fig. 2). The use of the polyethylene covers has had no effect on the number of female flowers. Of the covered grafts only 2% have had

female flowers which is about the same as for the rest of the seed orchard. The effect of the treatment on male flowering was however very much more significant (Table 1).

The significant differences between clones were caused primarily by



Fot. W. Chalupka

Fig. 2. The intensity of male flowering on part of the graft that was covered in polyethylene during induction time

the abundant flowering of clone 01-16 (Table 2) while others had much less, some even none, irrespective of treatment.

There was a distinct differentiation of the clones related to their origin which can be seen in Table 2. Clones originating from northeastern Poland, represented in the study by Forest District Zwierzyniec have yielded flowers much more abundantly than clones from southern Poland (Forest Districts Istebna, Rycerka and Stronie Śląskie).

The treatments have not affected significantly the percentage of flo-

Table 1

Variance analyses of male flowering on Norway spruce grafts used in the study. The analysis of the % of flowering grafts was performed on data after angular transformation

Source of variation	Numbers of flowers		% of flowering grafts	
	degree of freedom	F	degree of freedom	F
Clones	19	5.716**	19	2.797
Treatments	3	3.621*	2	1.392
Clones × treatments	57	2.775**		
Replicates	2	2.775		
Residual	158		38	
Total	239		59	

Table 2

The male flowering of Norway spruce clones in the seed orchard

Clone no.	For. Distr.	% of grafts with ♂ fl.	Mean no. of fl. per	
			graft	fl. graft
K-01-04	Zwierzyniec	16.7	1.2	7.5
K-01-16		58.3	40.4	69.3
K-01-24		0	0	0
K-01-26		25.0	5.7	22.7
K-03-06	Istebna	0	0	0
K-03-09		8.3	0.1	1.0
K-03-14		8.3	0.7	8.0
K-03-34		8.3	0.2	2.0
K-03-35		16.7	3.7	22.5
K-03-38		16.7	0.7	4.0
K-03-44		8.3	0.5	6.0
K-03-49		0	0	0
K-03-52		0	0	0
K-04-25		Rycerka	0	0
K-04-26	16.7		0.2	1.0
K-04-28	16.7		0.2	1.5
K-04-40	8.3		0.8	10.0
K-15-21	Stronie Śl.	0	0	0
K-15-33		0	0	0
K-15-34		8.3	1.5	18.0

wering grafts (Table 1). On the other hand significant effects were observed on the number of male flowers per graft and it was the period from June the 3rd to July the 5th that proved most effective in stimulating male flowering (Fig. 3). This concerns however primarily the clones from northeastern Poland, which was manifest by a significant interaction between clones and treatments (Table 1). It appears that for the clones from southern Poland the longer covering of the grafts (June 3rd — July 17th) with polyethylene proved more effective in stimulating male flowering (Fig. 3).

In order to extend the interpretation of the results obtained in the interaction between clones and period of covering with polyethylene the production of flowers on all the remaining grafts on the seed orchard was also estimated. Out of 687 grafts male flowers appeared on 59 and female on 12. The northeastern part of the country is represen-

ted by clones from Forest Districts Białowieża, Zwierzyniec and Przerwanki. Flowering grafts originate from all these three Forest Districts. The southern part of the country is represented by Forest Districts Istebna, Ustroń, Rycerka, Witów, Stronie Śląskie and Kopaliny. None of the grafts from Ustroń flowered. Table 3 gives the results of flowering of grafts from both the spruce regions in Poland.

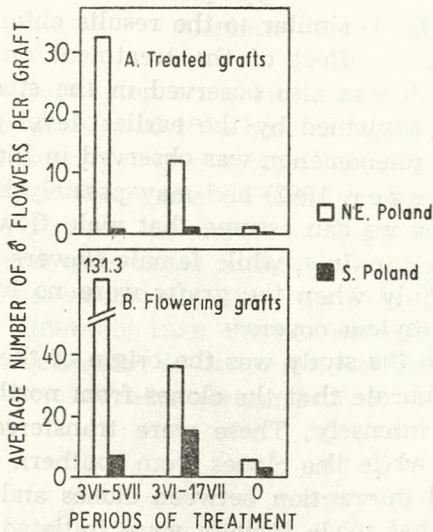


Fig. 3. The influence of clones origin and periods of treatment on male flowering

Table 3
The flowering of Norway spruce grafts depending on origin

Region	Percentage of grafts with flowers	
	male	female
Northeastern Poland	19.8	4.1
Southern Poland	6.2	1.2
Mean for the seed orchard	8.6	1.7

Generally no flowers were observed, irrespective of the treatments on the part of the seed orchard which for a certain time during the day is in the shade of adjacent pine stands. This concerns primarily one of the replicates and it is presumably for this reason that the differences between replicates are almost significant (Table 1).

DISCUSSION

The results obtained concern only one treatment made in 1975, in a year during which the climatic conditions have favoured the initiation of flowers in Norway spruce. (The cone crop in the vicinity of Kórnik can be judged as medium in 1976). In the experiment it was shown that

the placing of a polyethylene cover over the graft tops will not increase the number of grafts that will flower — this appears to be determined by various factors of graft development, shade, clone etc. On the other hand the treatment has increased the number of male flowers per graft.

The obtained effect was presumably caused by a high temperature under the polyethylene and an appropriate time during which the treatment was applied. This is similar to the results obtained by Brøndbo (1969, 1970). A lack of effect of the treatment on the production of female flowers, which was also observed in the studies of Brøndbo (1969, 1970) can be explained by the earlier development of male flowers on grafts. This phenomenon was observed in *Picea glauca* (Moench) Voss in Canada (Fraser, 1962) and may possibly be also applicable to Norway spruce. Thus we can assume that male flowers have developed at the end of June or in July, while female flowers may have been initiated around mid July when the grafts were no longer under the influence of the polyethylene covers.

Another factor in the study was the origin of the clones. The figures shown in Table 3 indicate that the clones from northeastern Poland flowered much more intensely. These were transferred southward when brought to Kórnik, while the clones from southern Poland were moved north. The obtained interaction between clones and treatments (Fig. 3) may also indicate that male flowers were initiated later in the clones from southern Poland.

Differences in the flowering of clones related to origin were also observed by Remröd (1972). He believes that seed orchards of clones from northern Sweden should be established in central or southern Sweden, where intensification of flowering may be expected. The results obtained in our study lead to the same conclusions in the conditions of Poland.

Correlations of flowering with insolation (Chałupka, 1975) concerned initiation of female flowers. The appearance in 1976 of both male and female flowers in the seed orchard suggests that the sunny summer of 1975 has favoured the initiation of flowers of both sexes. The effect of the polyethylene was however primarily a thermal effect and not a light effect since in the covers it was the temperature that was dramatically increased, together with humidity while the insolation was slightly lowered. A sort of greenhouse effect was obtained. Thus we can suspect that the initiation of male flowers is favoured by a high temperature and humidity and not by insolation.

The one-time result reported here does not entitle to formulate definite conclusions, it does appear however that covering grafts with polyethylene during flower induction time may prove to be a practical

method of stimulating the production of pollen in a seed orchard. In view of the fact that the shoots may get overheated it would be better to place the polyethylene on a light wooden construction around the grafts as Remröd is using so as to prevent the direct contact of polyethylene with the shoots which led to their occasional injuries.

SUMMARY

The covering of Norway spruce graft tops with polyethylene in June or June + 2 weeks of July of 1975 has led to an increase in the number of male 1976 flowers per graft though not in the number of flowering grafts. Clones from northeastern Poland produced male flowers most intensely when covered for the month of June alone while the clones from southern Poland were made to flower most abundantly when the period of covering was extended to July the 17th. The northeastern clones flowered more intensely than the southern ones suggesting that a southward (to Kórnik) transfer of clones favours flowering while a northward one does not. Grafts shaded for parts of day by the adjacent stands did not flower at all.

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WŁADYSŁAW CHAŁUPKA, MACIEJ GIERTYCH

*Wpływ osłon z folii polietylenowej na kwitnienie szczepów świerka
pospolitego (Picea abies (L.) Karst.)*

Streszczenie

Oslanianie wierzchołków szczepów świerka pospolitego w czerwcu lub w czerwcu i na początku lipca 1975 r., spowodowało w 1976 r. wzrost liczby kwiatów męskich w przeliczeniu na jeden szczepek, nie wpłynęło natomiast na liczbę kwitnących szczepów. Klony z północnowschodniej Polski kwitły obficie gdy były osłaniane w czerwcu. Do kwitnienia klonów z południa Polski korzystniejsze było natomiast przedłużenie osłaniania do połowy lipca. Klony północno-wschodnie kwitły intensywniej niż klony południowe, co sugeruje, że przesunięcie klonów na południe (do Kórnika) sprzyja kwitnieniu. Efektu tego nie obserwuje się natomiast przy przesunięciu klonów z południa na północ. Szczepy przebywające przez część dnia w cieniu sąsiedniego drzewostanu nie kwitły.

ВЛАДЫСЛАВ ХАЛУПКА, МАЦЕЙ ГЕРТЫХ

*Влияние прикрытия из полиэтиленовой фольги на цветение привоев
Picea abies (L.) Karst.*

Резюме

Прикрытие верхушек привоев ели обыкновенной в июне или в июне и начале июля 1975 года привело в 1976 году к увеличению числа мужских цветков в пересчете на один привой, и в то же время не повлияло на число зацветающих привоев. Клоны из северо-восточной Польши зацвели обильнее, если их прикрывали в июне. Для зацветания клонов с юга страны более благоприятным было продление прикрытия до половины июля. Северо-восточные клоны цвели интенсивнее, чем клоны южные, на основании чего можно предположить, что перемещение клонов на юг (в Курник) способствует зацветанию. Этот эффект не наблюдается при переносе их с юга на север. Привои, находившиеся часть дня в тени соседнего дрeвостоя, не цвели.