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Flowering of *Picea abies* (L.) Karst. clones of Istebna origin in the Kórnik seed orchard

Abstract: The flowering and graft mortality of Norway spruce clones of Istebna origin was only slightly different from clones of other origin in the same seed orchard. The negative effect of moving Istebna clones from the south to the north of their origin was probably compensated by moving them from a higher altitude to lowland. There is a danger that the complete loss of several clones, observed in the seed orchard with time, may really decrease the expected level of genetic variation in the progeny. It is recommended that the mortality of grafts and the reduction in the number of clones in the seed orchard should be under permanent observation.

Additional key words: Norway spruce, grafts, mortality, genetic variation

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Introduction

First-generation seed orchards of different forest tree species are mostly established from clones of local origin to enhance the production of genetically improved seeds. Some of the orchards are also set up with clones of very distant origin to serve the purposes of various investigations, e.g. research into flowering and seed production as affected by moving clones to different latitudes. Such a seed orchard composed of Polish clones of *Picea abies* was established by the Institute of Dendrology in Kórnik. The results of observations of female and male flowering in that orchard were published in earlier studies (Chałupka 1988; Chałupka and Rożkowski 1995). This paper provides a comparative analysis of the flowering and mortality of Istebna clones and clones of other origins.

Material and methods

The scions for grafting were collected from phenotypically selected plus-trees distributed in different regions of the natural range of Norway spruce in Poland, mostly from northeastern Poland, the Beskid Mts and the Sudeten Mts. First grafts were planted in 1968. The seed orchard, completed in 1973, had 783 grafts of 118 clones planted in 12 blocs. A systematic layout was used for the distribution of clones and grafts (Giertych 1965). Among the 118 clones, 47 represented the famous Istebna population from the Silesian Beskid Mts.

Observations of female and male flowering were carried out every year in the period 1976–1985. An individual graft was considered to be flowering even if only one strobilus was found on it. The exact number of female strobili was counted on grafts, and male strobili were assessed according to the following scale: 0 – no male strobili; 1 – one to several strobili on one–two branches, 2 – scarcely distributed strobili on several branches, 3 – scarcely distributed strobili in the whole crown, 4 – densely distributed strobili in the whole crown.

Additional observation was made in 1993 when clones flowered very abundantly. Female flowering was estimated according to a five-point scale: 0 – no

strobili, 1 – 1 to 10 strobili per graft, 2 – 11 to 50 strobili per graft, 3 – 51 to 100 strobili per graft, 4 – more than 100 strobili per graft. In the case of male flowering only the presence (1) or lack (0) of strobili were recorded.

In the period 1973–1993, also mortality of grafts was observed for all clones.

Results

Female flowering

Both in the period 1976–1985 and the year 1993, the average percentage of the female flowering clones of Istebna origin was higher than that of the remaining clones (Table 1 A). However, this was not the case with the percentage of flowering grafts which for Istebna clones was slightly smaller during 1976–1985 and larger in 1993, as compared to other clones (Table 1 B). The productivity of Istebna grafts was lower than that of the grafts of other clones (Table 1 C).

At the early age of the seed orchard (1976–1985), Istebna grafts contributed much less to the total number of strobili produced than to their proportion in the grafts of the seed orchard (27.4% and 43.6%, respectively). At the age of 20 (in 1993), the contributions of Istebna grafts to the total strobili production and to the seed orchard composition were almost equal (40.0% and 41.4%; Table 1 D).

Male flowering

More clones flowered male in the group of Istebna origin than in the group of the remaining clones (100.0% vs. 91.5% during the period 1976–1985, and 80.0% vs. 77.9% in 1993). The situation at graft level was slightly different: the percentage of the flowering grafts of Istebna origin in the period 1976–1985 was a little lower (59.6%) than among the grafts of other clones (62.9%). In 1993, when flowering was very abundant, 97.8% of Istebna grafts flowered male compared with only 88.9% of the grafts of other clones (Table 2). It was not possible to evaluate the male productivity of grafts because no detailed count of male strobili was done on individual grafts.

Graft mortality

Table 3 contains basic data on the dynamics of graft mortality in the Norway spruce clone archive at Kórnik. During 20 years of observations, five clones disappeared completely and two of them were of Istebna origin (Table 3 A). Many clones lost various numbers of grafts; among a total of 228 such grafts there were 96 grafts (43.0%) of Istebna clones. In the years 1973–1993, Istebna clones lost 29.4% of grafts – the percentage nearly the same as for other clones (28.9%) (Table 3 B).

Table 1. Female flowering of Norway spruce clones of Istebna origin in a seed orchard at Kórnik

		1976–1985			1993*		
		whole seed orchard	Istebna clones	other clones	whole seed orchard	Istebna clones	other clones
				A			
Total number of clones in 1976		118	47	71	113	45	68
Flowering female	No	83	35	48	109	44	65
	%	70.3	74.5	67.6	96.5	97.8	95.6
				B			
Total number of grafts in 1976		673	287	386	555	230	325
Flowering female	No	154	63	91	470	200	270
	%	22.9	21.9	23.6	84.7	86.9	83.1
				C			
Average number of female strobili per flowering graft		12.0	10.1	12.9	40.0	37.6	43.4
				D			
Percentage of Istebna grafts:							
in total cone production			27.4			40.0	
in seed orchard composition			43.6			41.4	

* year of abundant flowering

Table 2. Male flowering of Norway spruce clones of Istebna origin in a seed orchard at Kórnik

		1976–1985			1993*		
		whole seed orchard	Istebna clones	other clones	whole seed orchard	Istebna clones	other clones
				A			
Total number of clones in 1976		118	47	71	113	45	68
Flowering male	No	112	47	65	89	36	53
	%	94.9	100.0	91.5	78.8	80.0	77.9
				B			
Total number of grafts in 1976		673	287	386	555	230	325
Flowering male	No	414	171	243	514	225	289
	%	61.5	59.6	62.9	92.6	97.8	88.9

* year of abundant flowering

Table 3. Mortality of Norway spruce clones and grafts in a seed orchard at Kórnik in the period 1973–1993 as dependent on origin

	Whole seed orchard	Istebna clones	Other clones
	A		
Total number of clones			
1973	118	47	71
1993	113	45	68
Lost clones			
No	5	2	3
%	4.2	4.2	4.4
	B		
Total number of grafts			
1973	783	326	457
1993	555	230	325
Lost grafts			
No	228	96	132
%	29.1	29.4	28.9

Discussion

A less intensive female flowering in the grafts of Istebna clones, as compared to other clones, may indicate that moving Istebna clones 350 km north of their origin had an adverse influence on flowering. An opposite effect is well known when moving clones south (Werner 1975; Schmidtling 1984). The negative effect on female flowering, however, was not so great. This can probably be attributed to the fact that moving the clones from mountains to lowland (ca 500–600 m altitude difference) brought about an improvement in environmental factors which promoted flowering.

The mortality of the grafts of Istebna clones was similar to other clones growing in the Kórnik seed orchard. However, the total loss of some clones excluded them from possible crossings, thus decreasing genetic variability in the progeny. This means that a number of potential parental combinations became impossible and as a result some genes will not be transferred to the progeny of the seed orchard. This creates a danger that the expected level of genetic variation in this progeny may lower with age. It is therefore important to observe permanently the progress of the reduction in grafts and clones in the seed orchard.

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