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Potential for genetic conversion of Norway spruce *Picea abies* (L.) Karst. stands and methods for preserving gene resources of Istebna race in Silesian Beskid Mts

Abstract: The forests of the Silesian Beskid Mts have a specific composition with a marked dominance of Norway spruce. Although spruce stands are seriously threatened, some of them, such as those of Istebna race, show excellent genetic value. The work stresses the need for the conversion of spruce stands in the Silesian Beskid range on the basis of population genetics and describes the principles of such conversion.

Additional key words: genetic value, silvicultural value, species composition, regeneration, forest site type

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Introduction

The species composition of forests in the Silesian Beskid Mts and the Beskid Żywiecki and Beskid Mały Mts, covering mountain areas of the Bielsko, Ustroń, Węgierska Górka, Wisła, Andrychów and Jeleśnia Forest Districts, exhibits a great dominance of Norway spruce *Picea abies* (L.) Karst. The proportion of this species is often much higher than the percentage recommended for the mountain forest and mixed mountain forest sites. For example, it is 39.9% in the Bielsko Forest District, 48.4% in the Ustroń F.D., 89.8% in the Węgierska Górka F.D. and 96.9% in the Wisła F.D. (98.6% in the Istebna Forest Management Unit). Norway spruce is thus the dominant tree species in the Forest Promotion Complex of Silesian Beskid where it covers 24 400 ha (66.9%). The proportions of other tree species in this area are: European beech *Fagus sylvatica* L. – 14.1%, Scots pine *Pinus sylvestris* L. – 4.6%, European white birch *Betula pendula* Roth – 3.5%, pedunculate oak *Quercus robur* L. – 3.1%, European larch *Larix decidua* Mill. – 2.5%,

black alder *Alnus glutinosa* (L.) Gaertn. – 1.6%, and European silver fir *Abies alba* Mill. – 1.3%.

In many forest districts, spruce stands are in poor health condition due to the harmful effect of SO₂ and NO_x, and to other factors such as the ruthless exploitation of fir and beech in the past, plantation of non-indigenous spruce, and lack of stability in forest ecosystems, which results in a poor growth and high mortality of trees and a lack of regeneration. On the other hand, the investigations that have been carried out hitherto show an excellent genetic value of many partial populations of Norway spruce in the Silesian Beskid and Beskid Żywiecki Mts. For example, the IUFRO 1964/68 provenance experiments have proved the high genetic value of provenances from Ujsoły and Rycerka (1st and 2nd position, respectively, in the ranking of 93 Polish populations), as well as those from Węgierska Górka, Istebna and Wisła. Spruce trees of these provenances growing under different site conditions exhibit excellent adaptation and growth, reaching the height corresponding to the first class of stand quality. They constitute a se-

lection elite of this species in Poland and abroad, and are of particular interest to forestry scientists and practitioners. Stands of the Wisła F.D. make an important selection base for mountain spruce in Poland. According to the 1993 data, the Istebna and Wisła Forest Management Units have 324.4 ha of approved seed stands, several hundred hectares of other seed stands, and some so-called Swedish selection populations.

There are plans to convert the Silesian Beskid spruce stands for the following reasons:

- common occurrence of Norway spruce in stands growing on fertile mountain forest sites which constitute as much as 90% of the forest area in the region (mountain forest – 32%, mixed mountain forest – 42%, fresh deciduous forest – 11%, moist deciduous forest – 5%);
- low resistance of Norway spruce to biotic and abiotic damage, making it necessary to remove stands by clear cutting;
- dominating industrial damage (2nd degree);
- high acidity of soil.

However, the genetic data from many provenance tests, as well as the high production capacity, high technical quality of wood, and excellent plasticity of the progeny of Beskid spruce, suggest that it is necessary to retain a considerable proportion of this tree species in the stands of the Beskid Mts.

In the Forest Promotion Complex, the optimal proportion is assumed to be 45–50%. Pure spruce stands with some admixture of biocoenotic tree species are to be retained in the upper mountain belt, while the proportion of European silver fir should be increased to 20%. Also the proportions of European beech, sycamore maple and other admixture species should be increased.

Methods of stand conversion

At present, it is proposed using the natural regeneration of Norway spruce and European silver fir, regulating the regeneration of European beech, and artificially introducing sycamore maple *Acer pseudo-platanus* L., European ash *Fraxinus excelsior* L., wych elm *Ulmus glabra* Huds., small-leaved lime *Tilia cordata* Mill. and alder (*Alnus* sp.). Basically, stepwise cutting systems (especially III d) are recommended, and occasionally selection and shelterwood systems (Grzebinoga 2002).

Recommendations

1. In the conversion of spruce stands in the Silesian Beskid Mts we suggest using a method of stand appraisal according to the species diversity index (Fabijanowski and Rutkowski 1974). This concept is based on the assumption that the present species composition of forests and the size of forest re-

sources reflect the influence of site conditions and past forest management practices. The index describes objectively the species differentiation of Carpathian forests according to two criteria – species diversity and presence of spruce – in four categories of stands: with dominant pine and larch, with dominant fir, with dominant deciduous trees, and with dominant spruce. The detailed method of this appraisal is presented in an earlier paper (Sabor 2002).

2. The conversion of Norway spruce stands, besides fulfilling the requirements of sustainable multi-functional forest management, must at all stages take into account the laws of population genetics of forest trees. The ecological, technical, spatial and time-related elements of the cutting system should be adapted to the spatial structures of partial populations which depend on the size of so-called neighbouring groups affecting the effective size of populations, mating system and gene flow.
3. At its first stage, the conversion of Istebna spruce stands should include only those stands which in progeny tests did not show the ability to transfer adaptation and resistance characters. The stands of unquestionable genetic value and plasticity must be preserved. This category comprises Istebna spruce stands in compartments 15h, 24f, 45d, 78b, 88b, 91h, 95g, 108f, 115g and 149h. The elite stands should be described with regard to genetic polymorphism and possible occurrence of rare alleles by using isoenzymatic and terpene markers. Such studies have already been initiated.
4. During artificial regeneration, the rule of vertical regionalisation must be applied. It allows transfer of the planting stock only within one climatic zone as defined by Hess. Because in mountains the selection stress is about 800 times greater than in lowlands, also the consequences of improperly established plantations would be much more serious.
5. In the appraisal of the value and quality of Norway spruce from the Silesian Beskid Mts and Beskid Żywiecki Mts it is necessary to utilise the results of research on related issues, such as water, climate, increment, resistance, silviculture and genetics, carried out at the Faculty of Forestry, Agricultural University of Kraków, and at other scientific centres in Poland and abroad.
6. The determination of the role played by the main forest tree species growing on mountain sites, i.e. European silver fir and European beech, as well as by admixture species (European ash, sycamore maple, wych elm), valuable species (European larch), desirable species (stone pine *Pinus cembra* L., common yew *Taxus baccata* L., small-leaved lime, bird cherry *Padus avium* Mill.) and nurse species (European hornbeam *Carpinus betulus* L., European white birch, alder, aspen *Populus tremula* L. and

other) is an important task in the conversion of Norway spruce stands in the Beskids. Apart from suggesting the proportions, it is also necessary to formulate the potential aims of silvicultural and selection management of these species (Sabor 2002).

7. The restitution of European silver fir should be based on the existing, although scarce, local resources and on artificially introduced populations verified by progeny tests, representing fir stands from the Beskid Sądecki Mts, Gorce Mts, Beskid Niski Mts and Roztocze (experiments conducted by the Department of Forest Trees Breeding, Agricultural University of Kraków). The results of adaptation studies carried out by the Katowice Branch of the Forest Research Institute could also be taken into consideration.
8. The investigations conducted so far indicate a significant ecotypic (local) variation in the genetic and silvicultural value of the partial populations of European beech in the Carpathian Mts. For this reason it is suggested that local beech stands, especially the progeny of beeches from the Bielsko region, mainly from Bielsko-Jaworze, Biła and Grodziec, tested in the plots-archives of zones I and II of the Regional Bank of Beech Genes at the Katowice Regional Forests Directorate, should be used in the conversion of Beskid spruce stands (according to the expert opinions given by the Department of Forest Trees Breeding, Agricultural University of Kraków). The progeny tests initiated in 1995 on ten experimental plots situated in the Bielsko, Rudziniec, Pszczyna, Złoty Potok, Kłobuck, Prudnik, Prószków, Opole, Olesno and

Brzeg Forest Districts clearly indicate that the beech stands of the Bielsko region show a positive genetic and adaptation reactivity. Therefore, it seems that these stands may become the main source of the beech planting stock in the Silesian Beskid Mts (Sabor 1999, Sabor et al. 2000).

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