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Short Communication

Model of Serbian spruce genetic diversity conservation applying MPBS method for adaptability improvement

Mirjana Šijačić-Nikolić[1*], Jelena Milovanović[2] and Ida Katičić-Trupčević[3]

[1]Faculty of Forestry University of Belgrade, Kneza Višeslava 1, 11030 Belgrade, Serbia.
[2]Faculty of Applied Ecology "Futura" University "Singidunum", Bulevar Mihajla Pupina 12a, 11070 Belgrade, Serbia.
[3]Faculty of Forestry University of Zagreb, Svetošimunska 25, p.p. 422, 10002 Zagreb, Croatia.

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Biodiversity loss causes are variable, interactive and rather anthropogenic. Genetic variability, between and within species, has multiple fundamental values. Forest ecosystem diversity has an important role in evolution, selection and improvement processes aiming at the satisfaction of human needs. Serbian spruce (*Picea omorika* Panč./Purkyne) is an endemic species of the Balkan Peninsula and a tertiary relic. The conservation of this endemic species is necessary not only its rarity and vulnerability, but also on the account of its valuable pioneer qualities. Taking into account qualities of Serbian spruce, the model of Serbian spruce genetic diversity conservation was designed by the application of multiple population breeding system (MPBS), conservation method in which the population with the function of genetic conservation was subdivided into subpopulations, each having an effective population size. The proposed model of conservation of the total Serbian spruce genetic diversity can become an adequate solution for the prevention of further narrowing and also of the extension of the narrow range of the species.

Key words: Serbian spruce, adaptability improvement, multiple population breeding system, genetic diversity conservation.

INTRODUCTION

Modern human and his activities change and destroy nature, which results in irreversible biological diversity loss through extinction of many organic species, or their population reduction to critical levels. Species extinction does not appear as planned and targeted human activity, but indirectly, through species habitat devastation. Bio-diversity loss causes are variable, interactive and rather anthropogenic. However, different groups of people have different approach to biodiversity. The new biological diversity conservation concept tries to make a balance between these 2 attitudes through the idea of sustainable use and conservation of the primeval genetic, species and ecosystem diversity. Forest ecosystems ensure life space for other organisms maintaining complex mechanisms of genetic diversity. Genetic variability, between and within species, has multiple fundamental values. As long-lived sedentary plants, forest trees are exposed to a sequence of different environmental conditions during their life span (Hattemer, 1995). Also, forest trees and shrubs successfully adapt to changed environmental conditions (Karhu et al., 1996), even if they are caused by negative influences of pests, diseases and climate changes. Forest ecosystem diversity has an important role in evolution, selection and improvement processes aiming at the satisfaction of human needs.

*Corresponding author. E-mail: sijacic68@nadlanu.com.

MATERIALS AND CONSERVATION METHODS

Serbian spruce (*Picea omorika* Panč./Purkyne) is an endemic species of the Balkan Peninsula and a tertiary relic. Its widespread populations from the tertiary have been reduced to the refugia in east Bosnia and west Serbia. Its current geographical distribution is between 43°21' and 44°08' north and 18°37' and 19°45' east, in the middle and the upper course of the Drina river catchment (Ballian et al., 2006, Nasri et al., 2008). Today, only about 20 small populations are registered in Serbia and according to the national forest inventure database (unpublished data), in the national park Tara in Serbia on the area of 60 ha, there are only about 1000 trees in mixed stands with spruce and beech. The conservation of this endemic species is necessary not only for its rarity and vulnerability (Djurdjevic et al., 2003), but also on the account of its valuable pioneer qualities.

Multiple population breeding system (MPBS) is a conservation method in which the population with the function of genetic conservation is subdivided into subpopulations, each having an effective population size of approximately 50 individuals (Namkoong, 1984). If the population consists of 20 subpopulations, the total number of trees is 1000. In this population size, only a few rare alleles can be spontaneously lost (Eriksson, 2004). Each population has a special breeding goal, which can include the monitoring and enhancement of one or more traits in different environmental conditions. From the aspect of genetic conservation, the aim of this method is the adaptation of different subpopulations to different environmental conditions. The subdivision of the population with the function of genetic conservation into several subpopulations enables the increase in the total additive variation of the population with neglectful losses in intra-subpopulation variability (Eriksson et al., 1993).

Several forest geneticists studied the option of species conservation by large MPBS subpopulations. Varela and Eriksson (1995) proposed the system of several MPBS subpopulations in a forest site of several hectares, like at the cork oak (*Quercus suber* L.). As many species have specific site requirements, one large subpopulation should cover the greatest possible scope of site variability (Berg et al., 1994). However, the reason of applying the MPBS of large subpopulations can be the most representative inclusion of the very variable and specific genetic structure of endemic and relic species. The application of different intensities of a multiple population breeding system is considered the most appropriate mode of conserving genetic resources in vulnerable and endangered species (Eriksson, 2001; Myking, 2002).

The cost of running a MPBS programme is not expected to differ much from the costs of running a breeding programme by the establishment of one large breeding population.

RESULTS AND DISCUSSION

Natural regeneration of Serbian spruce is, almost exclusively, limited to open sites, such as forest openings and the areas of disturbed vegetation (Čolić, 1957, 1966). This fact points to a potential factor that jeopardizes its intensive reproduction: lack of light in mixed populations. In contrast to Norway spruce, Serbian spruce does not tolerate full shade, especially by broadleaf species, on nitrogen rich soils (Tucic and Stojkovic, 2001). In such conditions, Serbian spruce shows a considerable reduction in increment, primarily diameter increment and later on also height increment (Tucic and Stojkovic, 2001). The level of additive genetic variation of adaptation to shade is very low (Tucic et al., 2005, 2006). The studies of Serbian spruce ecological traits indicate that Serbian spruce natural stands should be included in the process of intensive management.

Taking into account the above traits of Serbian spruce, the model of Serbian spruce genetic diversity conservation was designed by the application of MPBS.

Model of conservation of Serbian spruce genetic diversity

Initial material for the establishment of MPBS

Subpopulations: The seeds for the establishment of MPBS subpopulations should be collected from:

- Natural populations from the territory of Serba and Bosnia and Hercegovina.
- The seed orchard at Godovik in Serbia (Tucović and Isajev, 1986) with 50 half-sib families incorporated (with 120 plants per family).
- The sources outside the natural range (seed orchards in the Czech Republic, Finland, etc. established for the allocation of reproduction material, thanks to its high horticultural value).

The seed of such mixed origin ensures the planting material of higher additive variation (genetic diversity). The external sources are very important because it is possible that some genotypes, extinguished within the range, are conserved in the site conditions of external sources. The planting material produced in this way is distributed to plantations at different sites, to enable natural selection in local natural conditions. The plantations at different sites make it possible to conserve the adaptable potential of the species, necessary for the survival in the processes of continuous environmental changes.

The sampling should include the greatest possible number of the available natural populations (there are about 30, according to the world conservation monitoring centre), all the 50 half-sib lines in the seedling seed orchard at Godovik and the majority of the external sources. The sample size depends on the size of the concrete population.

Location and structure of MPBS subpopulations: MPBS of conservation of total Serbian spruce variability and adaptability includes the establishment of 3 subpopulations at 3 different altitudes within the Serbian spruce natural range, at approximately 500, 1000 and 1500 m (considering the vertical distribution of Serbian spruce in natural conditions).

The subpopulations (plantations) have completely randomized block design, that is, the groups of 4 seedlings of one family are randomly distributed throughout the area of the selected site and each family is represented by 25 groups. The distance between seedlings should be small (e.g. 1 x 1 m), to achieve a more intensive process of natural selection. The area of individual subplantations is 5 ha. The maximal number of families is 500, with 100 individuals each, which creates the conditions for the minimal inbreeding.

Management of subpopulations: The implementation of the adequate management practice in the newly established subpopulations is highly desirable. It is especially necessary to perform non-systematic thinnings of the adequate intensity, aiming at providing more light to the plants in the early phases of development. Of course, thinning should take into account the concepts of conservation of species diversity.

Expected results: The MPBS of large subpopulations enables the conservation of Serbian spruce adaptability at the majority of site types within its natural range. By

exposing the genotypes, which represent almost the entire Serbian spruce genetic diversity, to different environmental conditions, it is possible to investigate the nature of the interaction genotype – environment and to identify the degree of genetic control of Serbian spruce phenotype expression. The realization of management practice of the defined intensity will improve the conditions of the survival of juvenile plants, which are, in natural populations, rather endangered by the lack of light and by the competitive species.

Later on, during the period of maturity of the established subpopulations, it will be possible to produce a satisfactory quantity of generative reproductive material of high adaptability, which will be the base of the widening of the narrow natural range of the species. It will be clearly differentiated which seed material is suitable for a given site.

Conclusion

MPBS is a dynamic method of conservation, which enables the adaptation by natural selection or breeding. MPBS of large subpopulations is efficacious for the most representative coverage of the highly variable and specific genetic structure of endemic and relic species, such as Serbian spruce and its adaptation to a wide range of environmental conditions. If the financial means are provided, the proposed model of conservation of the total Serbian spruce genetic diversity by MPBS can become an adequate solution for the prevention of further narrowing and also of the extension of the narrow range of the species.

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