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ASSESSMENT OF NATURAL REGENERATION IN CROPS FROM THE APUSENI MOUNTAINS

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Abstract

The choice of the areas for analysis was made according to a series of relevant principles such as the presence of the seedbed and its nature, the age of the stand to be above the lower limit of 50 years, the consistency of the stand below the value of 0.7. From the analyzes carried out, it was possible to identify the main forest types of influence of major seasonal factors (climatic, geomorphological, pedological) on the establishment and evolution of natural regeneration. It was considered, the synthesis of the way in which these factors imposed a certain distribution of the seed and the importance of this aspect for the structure of the arboretum.
From the point of view of the influence of seasonal factors on the settlement, the conducted study indicates good regeneration conditions for the majority resort type 2322 (spruce mountain) correlated with a location on slopes with slight or moderate slopes, sunny exposures at high altitudes and soils with volume middle edaphic.

Key words*: functional group; resort type; forest type; geomorphological form; litter type.*

INTRODUCTION

The forest is a community of plants and animals that live in interdependence and has an essential role in people's lives, providing products such as wood, food, oils, resin, but also creating environmental conditions for different ecosystems (Pecingină, 2019). Thus, the forest provides raw materials necessary for the development of numerous industrial branches in both developed and less developed states (Cseke et al., 2006; Ferguson, 1996; Hassan et al., 2005; Kozlowski, 2002; Negulescu et al., 1973; Vlad et al., 1997). However, the forest is subject to numerous biotic and abiotic risks (Achard et al., 2006; Bryant et al., 1997; Kozlowski, 2000). Providing numerous benefits for the environment and population, ensuring forest restoration is becoming increasingly important. Thus the sustainability of forests is achieved through adequate and timely regeneration of forests (Chazdon & Guariguata, 2016; Dey, 2014; Dey et al., 2019; Schelhas et al., 2021).
Natural regeneration is defined as the renewal of an arboretum by seeding or sprouting and is a slow and unpredictable process determined by the interaction of seeds with site factors (Duncan, 1954). Very important in high-altitude forests is the pattern of regeneration through spatial and temporal dynamics (Carrer et al., 2013; Spracklen et al., 2013). Regeneration can occur in 3 cases: where arboretum density has not been altered for a long time, where areas have been threatened by biotic or abiotic stress, and following regeneration cuts (Pardos et al., 2005; Serrada, 2003). As for the natural regeneration, it is different depending on the species, so in the case of the white spruce the best conditions are with 4-5 old seedling spruces per hectare in the cut areas or dense crops on the edges of the cuts, and the most favorable soil is the mineral one (Gärtner et al., 2011). In the forests of the northwest of the Transylvanian Plain, a natural regeneration of around 70% was achieved (Holonec et al., 2008). Natural regeneration is different depending on abiotic and biotic factors. Differences in natural regeneration have been found in the tropics depending on rainfall and environmental factors (Khaine et al., 2018).

Historical events have affected the genetic structure of forest plants and especially their distribution. Thus, in addition to forest species, other plant species were also affected, especially in the mountainous area (Höhn, 1998; Tóth et al., 2017). An area of Europe considered with diversity is the Mediterranean area, the southern peninsulas, including the Balkans, which have preserved genera and species of trees from ancient times, being considered the main area of post-glacial recolonization (Cowling et al., 2015; Gömöry et al., 2020). The diversity of forest species is influenced by many factors such as the geological substratum (for example species diversity in the karst area (Csergo et al., 2014), soil (Miles, 1985), altitude, climate change, etc. (Cowling et al., 2015; Liang & Wei, 2020; Pauli et al., 2012; Casiana Mihuț & Niță L., 2018). Climatic changes implying an increase in temperature, a change in precipitation, a decrease in the thickness of the snow cover cause a change in the types of vegetation and even a change in the methods of forest regeneration (Díaz et al., 2021; Gaál et al., 2012; Hajnalka et al., 2018; Hufnagel, 2017; Kiedrzyńska et al., 2021; Sipkay et al., 2010).

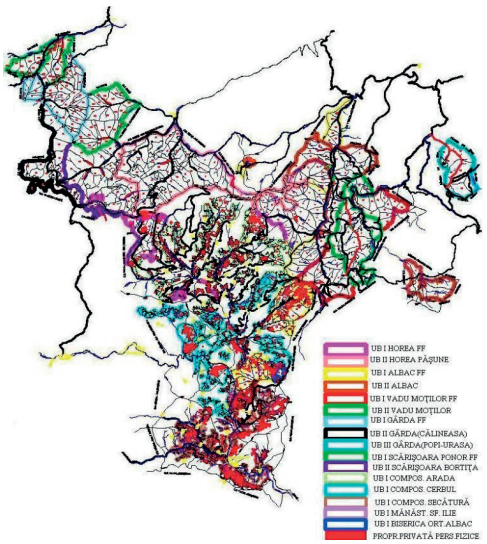

Figure 1. The map of Horea Forest District, Apuseni (scale 1:20000)

Very important in the conditions of climate change is the urgent implementation of policies for sustainable development, as well as measures to support biological diversity (Ferris & Humpherey, 1999; Lindenmayer et al., 2000; Mihuț Casiana et al., 2022; Zalewski, 2015; Zanchi et al., 2007).

Study area. The Horea Forest District in the Apuseni Mountains is located in the Biharia-Muntele Mare-Muntele Vlădeasa massifs, in the basins with affluent valleys of Ariesul Mare, the middle part and the upper parts of Someșul Rece and Someșul Cald. Administratively, the forest district carries out its activity within the counties: Alba - 4233 ha, Bihor - 180 ha and Cluj - 11374 ha, having a total area of 15787 ha (Figure 1).

MATERIALS AND METHODS

In order to be able to analyze the role that seasonal factors play in the evolution of natural regeneration, we considered the P.U. I Scărișoara-Ponor, from the Horea Forest District.

The selection of surfaces for analysis was made according to a series of relevant principles, namely: the presence of usable seedlings regardless of its age and nature, the age of the arboretum must fall above the lower limit of 50 years, an arboretum consistency below 0.7. In addition, only those surfaces were selected which, based on the works carried out, were affected in the recent past by disturbing elements such as: wind blows, snow, pest attacks, drying, thus decisively influencing the evolution of the settlement.

Of the total surface of P.U. I Scărișoara-Ponor which is 1553.3 ha (52 parcels and 216 subparcels), a total of 187.9 ha (2 parcels and 17 subparcels) fit the criteria, but due to the fact that the seedlings are located only on certain plots in the administrative units, the effective area occupied with seedlings and subject to analysis is 56.5 ha, about 3.6% of the total area of P.U. I Scărișoara-Ponor.

The quantification and analysis of the data was done in relation to the most important seasonal factors that can influence the development of natural regeneration, namely: functional group; type of resort; type of forest; soil type; geomorphological form; the exposure; the litter; the age of the seedling and the treatments carried out (applied). The two directions followed are represented by the distribution of

the area with seedlings in relation to the stational factor as well as the distribution of the seedlings per each seasonal factor.

RESULTS AND DISCUSSIONS

Analyzing the distribution of the naturally regenerated area from P.U. I Scărișoara-Ponor (Figure 2), we may observe the presence of only one type of functional group, namely 1-5 L (forests from national parks). This aspect is normal because the functional group in question occupies the largest area at the level of the studied production unit, which is actually included in the Apuseni Natural Park.

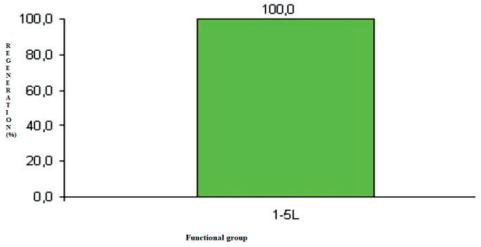

Figure 2. The distribution of the naturally regenerated surface in relation to the functional group from P.U. I Scărișoara-Ponor

Regarding the distribution of the seedlings by functional groups, we distinguish a certain balance in the case of P.U. I Scărișoara-Ponor between the mixed type (50.6%) and the intimate one (41.9%). A relatively low percentage is recorded in the case of the distribution type in groups, of 7.4% (Figure 3).

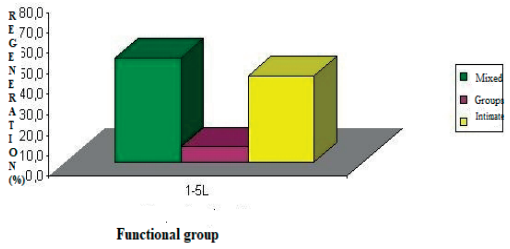

Figure 3. The distribution of seedlings by functional groups in P.U. I Scărișoara-Ponor

The general perspective of the P.U. I Scărișoara-Ponor indicates a balance between the combined spread of the seedlings and the uniform spread over the entire surface of a single functional group.

Following the analysis of the distribution of the naturally regenerated surface in relation to the type of station in P.U. I Scărișoara-Ponor, we may observe that most of the natural regeneration has developed within the station type 2322 (spruce-type montanous Bm), namely 57.5%, and within the station type 3332 (mix-type montanous Bm), of 28.2% (Figure 4).

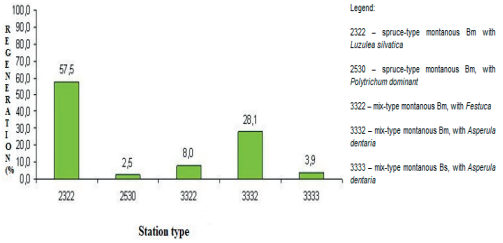

Figure 4. The distribution of the naturally regenerated surface in relation to the station type in P.U. I Scărișoara-Ponor

From the point of view of how the seedlings are distributed by station type, the natural regeneration from P.U. I Scărișoara-Ponor may be remarked due to the predominance of the mixed and intimate mode of distribution (Figure 5). The most important proportions are found on the two types of majority stations: 2322 (mixed 22.7%; intimate 29.2%) and 3332 (mixed 20.2%; intimate 6.2%). The way of distribution into groups of the seedlings presents a lower percentage, having present the station type 2322 (5.7%), respectively 3332 (1.7%).

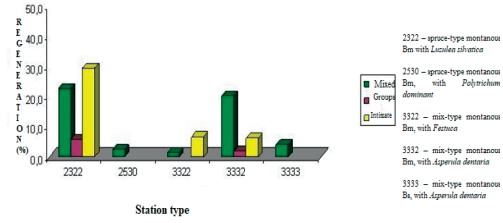

Figure 5. The distribution of seedlingst by station types in P.U. I Scărișoara-Ponor

The natural regeneration in P.U. I Scărișoara-Ponor developed on a high number of station types. Taking into account the fact that only the two stands affected by disturbing elements were taken into account in the analysis, we may support the idea that the high percentages of

seedlings are a relevant indicator of the station's exposure to these elements. In this sense, resort types 3322 and 3332 have the highest degree of exposure. The way of distribution of the seedling has a balanced arrangement between the majority mixed and intimate types.

Forest type is another stational factor that plays an important role in the development of natural regeneration. In P.U. I Scărișoara-Ponor, the seedlings grow exponentially in relation to the type of forest 1141 (spruce-type with *Luzula silvatica*), of about 65.5%. A high percentage is also located within the forest type 1341 (mixture of coniferous and beech, on skeletal soils), of about 20.2%. The other types of complementary forest are characterized by a rather weak representation (Figure 6).

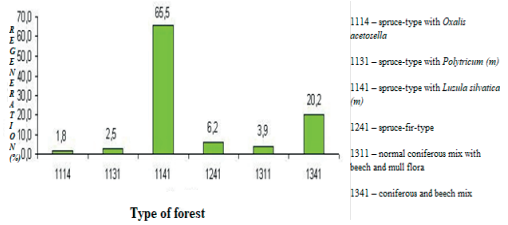

Figure 6. The distribution of the naturally regenerated surface in relation to the type of forest in P.U. I Scărișoara-Ponor

The distribution of seedlings in P.U. I Scărișoara-Ponor per types of forest highlights a high distribution on the intimate grouping mode from F.T. 1141, of 35.8%. The mixed grouping mode is present on the forest type 1141 (24.1%), 1341 (20.2%) and less on the forest type 1311 (normal coniferous mix with beech, with mull flora), of 3.9% (Figure 7).

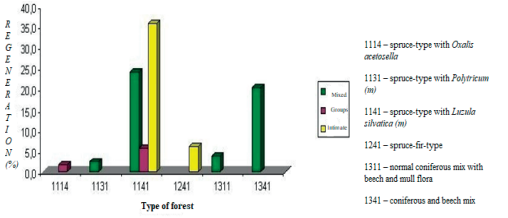

Figure 7. The distribution of the seedling by forest types in P.U. I Scărișoara-Ponor

Based on the analyzed data, we may conclude that the forest type that offers good conditions for the development of natural regeneration is the forest type 1141. In the studied perimeter, the seedlings are located on each type of forest, both individually, through a single way of distribution, and through two, or more isolated through three types, of its organization.

Another seasonal factor that has a major impact on natural regeneration is the type of soil (Figure 8). It greatly influences the seedlings due to the fact that it is a stable component of the forest ecosystem, whose specific characteristics can change the evolution of certain species from one area to another. From the perspective of this aspect, the studied perimeter is characterized by a strong development of natural regeneration on the soil type 4201 (typical podzol), respectively 3301 (typical dystricambosol). The soil type 3306 (gleyed dystricambosol) is very poorly represented at the level of the studied perimeter, the proportion of its representation being approximately 2.5%.

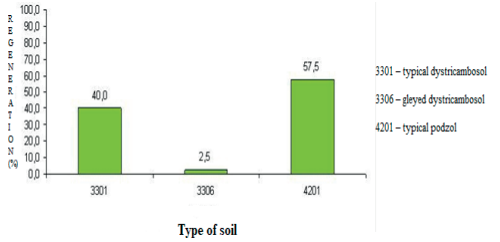

Figure 8. The distribution of the naturally regenerated surface in relation to the type of soil in P.U. I Scărișoara-Ponor

The organization of the seedlings in the studied perimeter is dominated by high percentage values for the intimate distribution mode on the type of soil 4201 (29.2%), respectively mixed within the type of soil 3301 (25.5%) (Figure 9).

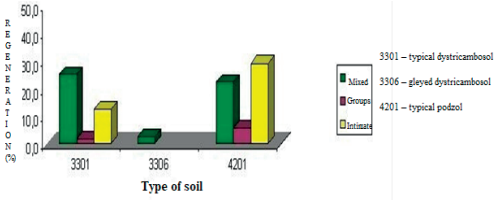

Figure 9. The distribution of seed by soil type in P.U. I Scărișoara-Ponor

The geomorphological shape of the slope (Figure 10) also represents an edifying factor

for the evolution of natural regeneration in the perimeter affected by disturbing element. The highest percentages of seedlings in the studied area are located on the middle wavy slopes (53.8%), respectively on the wavy ones (32%). As a particular element, the presence of regeneration can also be noted on the middle flat slopes.

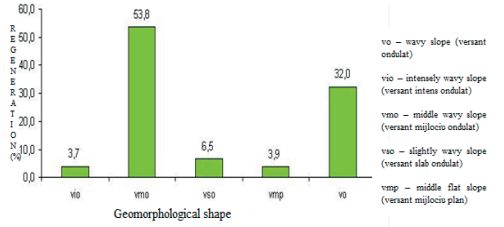

Figure 10. The distribution of the naturally regenerated surface in relation to the geomorphological shape in P.U. I Scărișoara-Ponor

Analyzing the way the seedlings are organized on geomorphological shapes in the studied area, the presence of a generally valid characteristic also found in the case of the other exemplified factors is noted here as well. The area under study is characterized in this sense by the presence, at the level of the dominant and middle wavy slopes, of all forms of seedling organization (intimate, in a proportion of 32%, mixed, 20% and per groups, 1.8%). High percentage values are also recorded in the case of mixed regeneration, on wavy slopes (26.7%) (Figure 11).

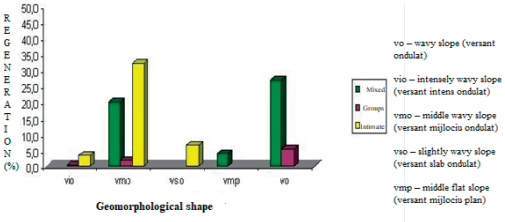

Figure 11. The distribution of the seedlings on geomorphological shapes in P.U. I Scărișoara-Ponor

The exposure of forest surfaces has a major impact on the establishment and evolution of natural regeneration, correlated with the light requirements of forest species. The best growing conditions are recorded on the southern slopes, which are warmer and sunnier, with a long vegetation season. On the other hand, on the northern slopes, the conditions are harsher, here developing species such as fir or beech. The perimeter under study is individualized by a strong regeneration on the southern slopes, of 35.6%. High percentage values are also recorded in the southeastern (17%) and southwestern exposures (14.9%). As for the northern exposures, they occupy 14.0% of the naturally regenerated surface and affected by disturbing elements, while the slopes with a northeast orientation 12.2%, and those on the northwest 5.5% (Figure 12).

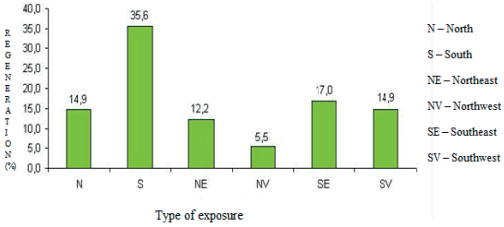

Figure 12. The distribution of the naturally regenerated surface in relation to the type of exposure in P.U. I Scărișoara-Ponor

The studied area is characterized by a balance in terms of the mixed distribution of the seedlings on the types of exposures in which it is present (Figure 13). The highest percentages are recorded on the south-oriented (11.9%) and north-oriented slopes (9.6%). The intimate organization of natural regeneration is well developed on the southern slopes (23.7%), but also on the southwestern ones (14.9%). The last type of organization, per groups, appears sporadically on the northern and northwestern slopes.

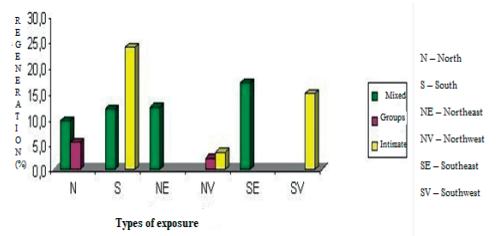

Figure 13. The distribution of seedlings by types of exposure in P.U. I Scărișoara-Ponor

The high percentages for southern, sunny exposures are absolutely normal, it being known that the seedlings develop best in the presence of favorable conditions of light and heat.

The installation of natural regeneration is not possible without an appropriate structure of the vegetation cover at ground level. The seedlings in the studied production unit is structured in an overwhelming majority on a normal-continuous litter type, in proportion of approximately 92.2%. The other type of litter, thin-continuous litter type, is present in a rather low proportion (Figure 14).

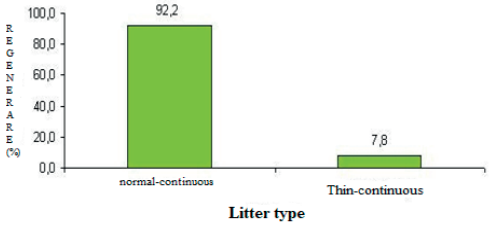

Figure 14. The distribution of the naturally regenerated surface in relation to the litter type in P.U. I Scărișoara-Ponor

The 3 forms of seed distribution fall within the general rule indicated so far. The dominant litter type is indicated by all types of seedling organization (mixed in proportion 45%, by groups 5.3% and intimate 41.9%). The type of complementary litter in this perimeter is individualized by the mixed-group duality.

The age of the seedling is largely dependent on the age of the developed mature arboretum. The disturbing elements that affected the area studied and the treatments carried out also left their mark on the age of the seedlings. The areas studied have a superior development in terms of the seedlings that is around 10 years old (approximately 86.5%). Younger natural regeneration (5 years) is limited in spread (Figure 15).

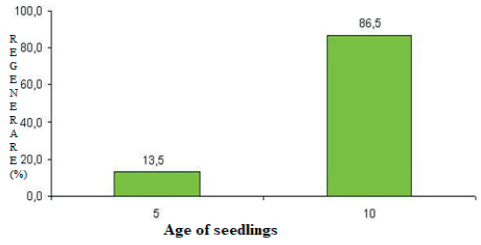

Figure 15. The distribution of the naturally regenerated surface in relation to the age of the seedlings in P.U. I Scărișoara-Ponor

The mixed organization of the seedlings in the studied area (Figure 16) is better distributed among the 10-year age group (40.5%), compared with the seedlings polarized around age 5 (10.1%). The intimate distribution mode is also strongly developed for the 10-year-old seedlings (38.6%) and limited to the 5-year level (10.1%). The weakest form of distribution, that by groups, is only identified in the 10-year-old seedlings (7.4%).

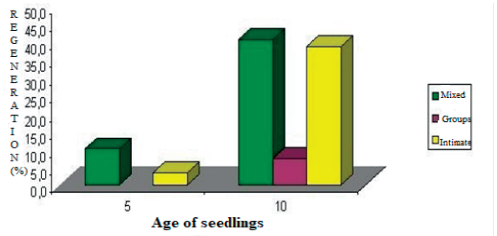

Figure 16. The distribution of regeneration by age categories of the seedlings in P.U. I Scărișoara-Ponor

From the interpretation of the data as a whole, we may conclude that the polarized natural regeneration around the age of 10 years is best represented, in correlation with the combined spread of the seedlings and the uniformity of this at the level of the analyzed surface.

The method of application of the treatment by harvesting exploitable crops has a major impact on the development of the seedlings, both by creating favorable conditions and by protecting them. In the studied perimeter, natural regeneration has developed best on the surfaces with no treatment during the last decade (43.9%), respectively on the surfaces covered with hygiene cuts (35%) (Figure 17).

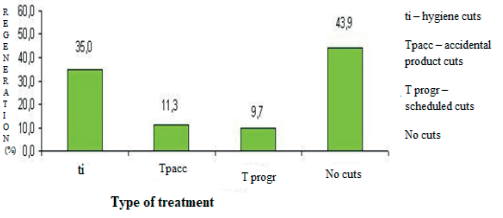

Figure 17. The distribution of the naturally regenerated surface in relation to the type of treatment in P.U. I Scărișoara-Ponor

The surfaces with no treatments in the studied area are characterized by a balance of the three

types of seedling organization (mixed 20.7%, per groups 7.1% and intimate 14.9%) (Figure 18).

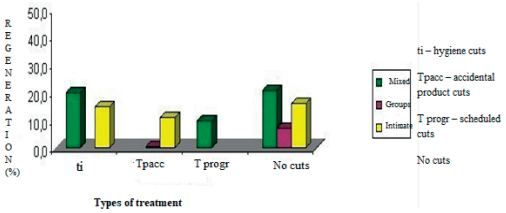

Figure 18. The distribution of the seedlings by types of treatment in P.U. I Scărișoara-Ponor

The overall picture regarding the influence of the treatment on the natural regeneration in the studied area indicates a development of the seedlings in general on the surfaces strongly affected by wind and snow falls (treatment of accidental cuts), in combined forms of spread and those submitted in the last decade to hygiene cuts.

CONCLUSIONS

Due to regional stational peculiarities, the coniferous crops in the Apuseni Mountains are generally characterized by a strong natural regeneration, but the local specificity of each type of station can lead to a series of impediments in terms of the development of the natural seedlings in good conditions.

From the analyzes carried out on the forest areas taken in the study, we had the possibility to identify the main forest types of influence of the major seasonal factors (climatic, geomorphological, pedological) on the establishment and evolution of natural regeneration.

The synthesis of how these factors imposed a certain seedling distribution and the importance of this aspect for the structure of the arboretum was also pursued.

Taking into account the requirements of the main forest species presented (spruce and fir), there are no important limiting factors with negative effects on the development of forest vegetation. On the background of the zonal climate and under the influence of the local relief, we may differentiate characteristic topoclimates, that of a sunny slope and that of a shady slope, which overlap the physiological needs of the species. At the same time, the movement of moist air masses from the southwest and northwest, with intense and frequent frontal activity, leads to a high vulnerability to falls caused by winds.

The higher percentage values of the particularities within the stational and arboreal factors quantified in the present paper are a faithful indicator of the favorability of natural regeneration.

From the point of view of the influence of stational factors on the seedlings, the conducted study indicates good regeneration conditions for the majority type of station 2322 (spruce-type mountanous Bn), correlated with a location on slight or moderate slopes, sunny exposures at high altitudes and deep medium soils with medium edaphic volume.

The studied area is favorable for the natural regeneration of the spruce, being characterized by a medium rating in terms of this species.

The treatments performed in the last decade in the studied area had a minimal influence on the installation of natural regeneration, the seed developing rather as a result of the already existing favorable conditions of heat and light.

Spruce seeding is largely facilitated by the fact that the seed spreads over long distances, but great importance must be given to preventing damage to seedlings from heat and drought, especially on southern slopes, by applying appropriate treatments.

At higher altitudes, a faster release of the seedling from the maternal shelter is indicated, approximately 3-5 years after the seedling is established.

The area under study shows a natural regeneration identifiable only for the spruce, but the creation of stable crops from a silvicultural point of view cannot be obtained without a corresponding natural regeneration for the fir and beech crops, also present in a smaller proportion. Therefore, in order to achieve this objective, the natural regeneration of the fir tree, which takes place under shelter, can be supported by the application of progressive cuts, progressive cuts at the edge of the massif or combinations thereof, with a maximum utilization of the pre-existing seedlings.

In the mixtures of spruce and beech in the studied area, it is necessary to apply progressive treatments, by opening large meshes around the old spruces, in the year of their

abundant fruiting, with the aim of favoring the establishment of the spruce and ensuring its advance in growth.

For the regeneration of the beech, the pre-existing seedling is used, which is gradually exposed to light and later, a few meshes will be opened around the groups of old beech trees, allowing the beech seedling to be installed between the spruce meshes.

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