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Factors affecting success in natural regeneration works of cedar (*Cedrus libani* A. Rich.) In Kas region of Antalya

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Abstract

Plants are living things that form the basis of food pyramid, provide numerous products and are considered as the source of life. Many professions such as agriculture, forestry and landscaping work on plant growing. The fast growth of plants is of prime importance since it provides advantage in light and root competition in the areas where plants are grown. For this reason, it is highly important to identify the factors affecting plant development and to change these factors in favour of the target species. In order to achieve this, first of all, the factors affecting the development of the target species in the study area should be known.

In this study, which was carried out in the natural regeneration areas of Taurus Cedar (*Cedrus libani* A. Rich) found in the Kasaba Forest Sub-District Directorate in Kas region of Antalya, and was prepared as a term project, 3-year-old young cedars naturally grown in different stands were compared in terms of their root collar diameters, seedling length and number of seedlings, and the factors affecting the natural regeneration success were tried to be identified by factor analysis. As a result of the study, it was found that the average root collar diameter was between 2.5 and 4.7 mm, the average seedling length was between 4.5 and 11.3 cm, and the average number of young cedars per square meter was between 6 and 47. When the factors affecting the natural regeneration success were examined, it was found that the factors such as soil moisture, precipitation, amount of organic matter, light intensity and number of healthy seeds were the most important factors that played a role in this success, and that those factors explained 78.32% of the total variance.

Keywords: Taurus cedar; *Cedrus libani*; Natural regeneration; Growth; regeneration success

1. Introduction

Plants are the most important living groups in the world with vital importance for many other living groups, and they are considered as the source of life. In fact, all living life in the world is largely depend on plants, either directly or indirectly [1]. As well as producing the necessary nutrients for other living things through photosynthesis, plants also function in many other ways such as reducing all kinds of air pollution in their environment [2-4], reducing noise [5,6], preventing erosion, balancing the climate and promoting positive effects on people psychologically [7-10]. In addition to these, they are an important economic resource [11,12]. Particularly forests are extremely critical natural resources for many countries including our country.

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Forests are highly effective on community life in terms of versatile use of the products and services they provide. It is obvious that forests are the most important natural resources in preventing global climate change and managing renewable energy resources. Maintaining the continuity of this critical natural resource and preserving the original stand formats are of great importance for the sustainability of the ecological balance. Within this scope, it is necessary to successfully regenerate the pure and mixed forest formats consisting of species, in particular. In natural regeneration works to be carried out for this purpose, the factors affecting success should be well identified on the basis of species, and juvenile dynamics should be introduced from the first years [13].

Our country has highly valuable pure and mixed stand organizations depending on the impacts of different habitat conditions [14]. The Taurus Cedar (*Cedrus libani* A. Rich.) is the main species forming these organizations. In this study, the juvenile dynamics and the factors affecting the regeneration success in the natural regeneration works of cedar carried out in 3 sections in the Kasaba Forest Sub-District Directorate affiliated to the Kas Forestry Operation Directorate of Antalya were examined.

2. Material and methods

2.1. Material

Prepared as a term project, this study was conducted in 3 sections located in the natural regeneration areas, which had been selected 3 years ago because of mast seed year, in the Kasaba Forest Sub-District Directorate affiliated to the Kas Forestry Operation Directorate of Antalya (Figure 1). When the physiographic factors of the natural regeneration areas are examined, it is seen that the altitude varies between 1250 and 1400m. The stand view is south and southeast. The soil conditions are generally well-drained karstic fields, and the soil has alkaline and neutral conditions. The soil depth is highly variable depending on fissured bedrock conditions, and the organic matter content is insufficient in places. Considering the climatic conditions, the relative air humidity ranges between 70% and 85%, the average temperature is 21.5 ° C, and the average precipitation is 653 mm [15].



Figure 1 General view of the study area

2.2. Method

In the study, in order to identify the growth dynamics of natural young cedars at the end of the third year, the root collar diameters and lengths of the young cedars were measured in 3 sections (56, 123 and 148) constituting the study area, and the number of young cedar per square meter was determined. In all three sections, the measurements were carried out according to random sampling method, in a way to best represent the physiographic differences in the sections, with 5 replicates in the testing plots with the size of 25x40m. The measurements were performed with the help of a digital caliper gauge and a length meter with a millimetre precision. Variance analysis and Duncan test were used to evaluate the data obtained from the research. Moreover, factor analysis was used to identify the factors affecting the natural regeneration success. SPSS package program was used for all statistical applications.

3. Findings

The following results were obtained as a result of the measurements carried out in the testing plots selected from the natural regeneration areas of cedar, of which work was carried out in 3 sections of the Kasaba Forest Sub-District Directorate, located in the Kas region of Antalya. Table 1 shows the results of variance analysis and Duncan test applied to the measurements of root collar diameter, seedling length and average number of young cedars taken from the testing plots selected from the 3 sections forming the study area.

Table 1 Variance analysis and Duncan test results on seedling characters

Section No	Root Collar Diameter (mm)	Length (cm)	Number of Young Cedars (piece/m ²)
56	2.5 a	4.5 a	6 a
123	3.1 b	8.9 b	34 b
148	4.7 c	11.3 c	47 c
Sig.	P<0.05	P<0.05	P<0.05

When the table values are examined, it is seen that the root collar diameter varies between 2.5 mm and 4.7 mm in the study area. While the lowest root collar diameter was obtained in section no. 56, the highest root collar diameter was obtained in section no. 148. A similar picture can also be observed in terms of length values. The average seedling length is observed to be 4.5 cm in the section no. 56, while it is 8.9 cm in the section no. 123 and 11.3 cm in the section no. 148. As for the average number of young cedars, while there is an average of 6 seedlings per m² in section no. 56, there is an average of 34 seedlings in section no. 123, and an average of 47 seedlings in section no. 148. When the table values are examined, it is seen that there is a significant difference at minimum of 95% confidence level ($p < 0.05$) between the data in terms of all three characters, and as a result of Duncan test, each value forms a separate homogeneous group.

The main aim of the study is to identify the factors affecting the regeneration success in the natural regeneration works of cedar. Accordingly, physiographic, edaphic and climatic factors as well as the parameters related to the main stand were identified, and the factors were analysed with the help of SPSS program. Among a total of 32 variables, 5 important factors were derived as a result of the factor analysis. These 5 important factors of soil moisture, precipitation, organic matter content, light intensity and number of healthy seeds explained 78.32% of the total variation in natural regeneration success.

4. Results and discussion

There exist highly valuable studies conducted on different fields related to Taurus Cedar, which is one of the most important main forest tree species of our country. First of all, many studies were conducted in order to determine the distribution range of the species under the ecological conditions of our country [16,17,18]. In this study, 3 different homogeneous groups were identified in terms of diameter development in the natural regeneration areas of cedar selected from 3 sections of the Kasaba Forest Sub-District Directorate located in the Kas region of Antalya. Accordingly, while the lowest root collar diameter was measured as 2.5 mm, the highest root collar diameter was measured as 4.7 mm (Table 1). In another study conducted on pure cedar stands in Antalya region, it was found that the average root collar diameter development of 3-year-old natural young cedars varied between 3.8 and 5.8 mm [19].

Comparing these data, it can be stated that the root collar diameter developments of the natural young cedars in the study area are at a sufficient level. 3 different homogeneous groups were identified in terms of average length growth in the natural regeneration areas of cedar selected from 3 sections of the Kasaba Forest Sub-District Directorate located in the Kas region of Antalya. Accordingly, while the lowest average length growth was found to be 4.5 cm, the highest average length growth was found to be 11.3 cm (Table 1). In a study carried out in the Manavgat region with similar habitat conditions with the study area, it was reported that the average length growth of 3-year-old natural young cedars varied between 5.6 and 14.8 cm [19]. According to these comparative data, it is possible to say that there is a good growth trend in the study area, despite the occurrence of length growth losses starting from the age 3 due to low bonitet class of the study area.

In this study, the number of young cedars per square meter was also determined as a result of the counts performed in 3 sections. Accordingly, while the lowest average number of young cedars was found to be 6/m², the highest average

number of young cedars was 47/m² (Table 1). In another study conducted on this subject, it was found that the number of natural young cedars varied between 18 and 115 pieces/m² at the end of the first 5 years [20]. In the light of these comparative data, it is not possible to say that the number of natural young cedars is at a sufficient level and is homogenous at the end of the 3rd year. It can be said that this situation is caused by insufficient germination of healthy seeds or insufficient moisture or organic matter content.

In the research, the most important factors affecting the success of natural regeneration works of cedar were identified as soil moisture, precipitation, organic matter content, light intensity and number of healthy seeds, and these factors explained 78.32% of the total variation in natural regeneration success. In other studies conducted on this subject, it is emphasized that soil moisture, soil temperature, and especially the organic matter content in extremely alkaline areas with calcareous bedrock characteristics are of great importance for natural young cedars to come and take root in the area [18].

Plant development occurs as a result of the mutual interaction of genetic structure and environmental conditions [22-23]. In natural regeneration works, genetic structure intervention remains limited, and thus the climatic and edaphic factors in the environment, in which the plant is grown, are determinative in plant development. The studies conducted reveal that in our country, plants grown in areas with different climate types have different levels of development depending on the type of that climate [24,25]. Many factors such as precipitation, temperature, stress factors, light, air pollution and soil structure affect the morphological characteristics and development of plants [26-29]. For this reason, identification of the factors affecting the development of each species at the highest level in natural regeneration works, and the arrangements to be made on these factors can contribute to the development of the target species, significantly.

Along with ecological conditions, some external factors also significantly affect plant development and morphological characteristics. The studies conducted reveal that factors such as pruning, hormone applications, spraying, shading, and fertilizing are also effective on plant morphological characteristics and development [30-33]. Therefore, the species can be supported by identifying the effects of also these factors on the species spreading over large areas, and by using these factors especially in sensitive areas, if necessary. For instance, by identifying the fertilizer types that can encourage the growth of cedar seedlings at the highest level, the fertilization applications can be carried out in sensitive areas.

5. Conclusion

As a result of the study, first of all, differences were determined between seedling developments in different stands up to several times. Studies to be conducted with the purpose of determining whether the development differences in these areas are due to genetic structure or environmental conditions can contribute to cedar regeneration and breeding practices, significantly.

In the light of the data obtained from the study area, the natural regeneration works of cedar should be carried out in mature stands, which have reached the thick woody stage, and in the correct seed year; the care of young cedars should be carried out in time and according to its technique so the root competition of cedar is decreased; care should be given to protection measures and the soil moisture, organic matter content, soil depth, light intensity and healthy seed number, which constitute the germination bed especially in the first years, should be checked periodically; and the light demand of young cedars should be well identified and met in time.

Identification of the factors affecting the development of main forest trees, especially cedar, individually and carrying out applications according to these factors in natural regeneration works will affect the success of regeneration significantly and will provide an advantage in light and root competition by contributing to the rapid growth of seedlings at a young age.

Identification of the factors affecting the seedling development as well as their effect levels can also contribute to nursery practices, significantly. The economic value of agricultural plants is directly proportional to their growth performances. While the fast growth of the plants reduces the growing process, and thus the cost, it increases the profit rate. For this reason, identification of the factors affecting seedling development and its use in practice are of great importance. It is recommended to diversify and continue the studies to be conducted on this subject for both natural regeneration works and nursery practices.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

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