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Quantitative and Qualitative Characteristics of Hazelnut (*Corylus avellana*) in Arasbaran Forests (Case study: Fandoghlu forest, Namin county, Ardabil)

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Abstract: Identification of the future vegetative condition and the natural evolution of forest depends on analyzing its present and previous situation as well as predicting its future vegetative. Fandoghlu forest is the genetic and vegetative center and origin of hazelnut with a total area of 207.94 km² (20794 hectares) within the boundaries of Ardabil province. In this research, the vegetative characteristics of hazelnut trees and other species – e.g., hornbeam, oak, beech and common hawthorn – which mainly consist of wooden species in Fandoghlu of Namin region, were recorded including diameter at breast height, basal area, freshness, reproduction based on systematic random (SR) sampling. Sampling intensity was 3.3% (since the forest is homogeneous) and sampling plots designed within a 150 × 200 m grid. The above gridding was initially implemented on a 1:10000 map from the region and it was performed in the region after its definitive determination in nature. A total of 33 plots each with an area of 1000 m² was sampled in the desired region, which the plots covers over 3.3 hectares of the area. Each plot was circularly sampled within a radius of 17.84 cm. The sampling was performed by recording data for trees with >7.5 cm in diameter among various species at the end of the form as number, diameter, height, cross-sectional area, and volume; and the number of vegetative and reproductive sprouts was also recorded in the attached tables for trees with < 7.5 cm in diameter in two diameter classes of 0-2.5 cm and 2.5-7.5 cm. Characteristics of control trees for sample plots, which include the nearest trees to the plot center and the thickest tree in the plot, were measured and recorded. The required data were provided to prepare the curve for diameter, height, cross-sectional area, volume, regeneration for available species including hazelnut and other woody species. T-test was used in this study. Comparing the results of test showed that there is a significant difference between the volume, cross-sectional area, and the height of hazelnut and other species. All conditions for the conservation of hazelnut are provided, but for other species given that the hazelnut-oak type is one of the dominant types for the studied region, it is required to provide forest with marking more beech and hornbeam toward above dominance.

Keywords: Systematic random sampling, Control trees, Hazelnut-oak type

INTRODUCTION

Nowadays, floristic studies as well as the identification of the vegetation habitats and communities of each country are considered as one of the most fundamental principles of management and correct

and accurate efficiency of renewable natural resources based on the principles of sustainable development. Since the best management in the field of natural resources and especially forest areas as the most complex terrestrial ecosystems are derived from their natural laws and mechanisms (Marvimohajer, 2000), therefore, obtaining sufficient information from the habitats of a region will be effective in the selection of appropriate method of management based on the principles of sustainable development.

- The results of a study by Ghasemi (2002) on Ardabil Fandoghlu forest showed that it is recommended to conduct cultivating operations in shorter cycle (5-10 years) in relation to forestry issues in these forests. Quantitative and qualitative survey of forestry activities in the region showed that *Picea* species is superior in terms of diameter, height, and maturity in comparison to two species of hazelnut and Turkish black pine. This indicates the adaptation of this species to region conditions. The results of viability test of seeds of indigenous species of the region (hazelnut, beech, *Quercus macranthera*, *Quercus castaneifolia*, field maple, hornbeam) also indicated that it was higher in hazelnut species, which this issue can be used in forests of this species with seed.
- In the case of qualitative and quantitative characteristics, we can say that Fandoghlu forest has a very high potential for establishing forest stands, and the existence of forest elements similar to Hyrcanian forests is another reason for the potential of this forest to create climax forests of beech and oak. In terms of structure, this forest has 99% coppice stands and only 1% seedling stand, which is similar to Arasbaran forest in this regard as composed of coppice and seedling stands with abundance of coppices (Amirghasemi et al., 2001).
- The results of a study by Yousefpour et al. (2003) showed that the beech species plays an important role both in the evolving and natural regenerating forest stands of Fandoghlu forest, and does not prove the previous perceptions that this forest is exclusively a habitat for hazelnut. It also revealed that the increase in the presence and abundance of the most precious and original species such as beech, chestnut-leaved oak, hornbeam, wild service tree and hedge maple indicate the middle and final stages of the sequence and reduction of the presence and frequency of pioneer species such as hazelnut, asparagus, and common hawthorn indicates the initial stages of the sequence, suggesting the passage of existing stands in Fandoghlu forest from the initial stage of the sequence (pioneer and middle). In general, according to the results of this study, it can be admitted that the forest stands of Fandoghlu in terms of the natural sequence are progressing towards climax forest communities (uneven-aged and mixed seedling forests of beech or oak).

Materials and Methods

Fandoghlu forest of Ardabil is located at 25 km Northeast of Ardabil city toward Astara, and 10 km from Namin, between 38° 16' to 38° 32' N and 48° 32' to 48° 40' E (Figure 1).

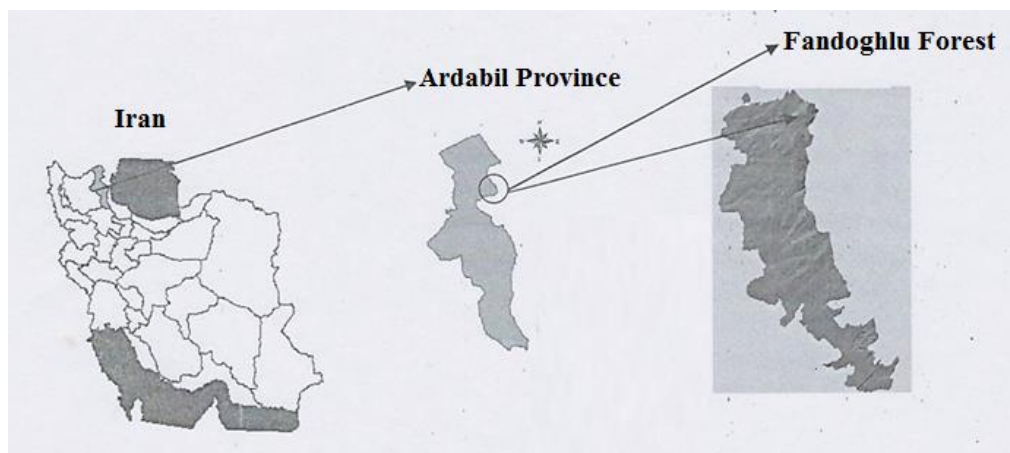


Figure 1: Geographical location map of Fandoghlu Forest

This forest region has a total area of 40378 ha, of which 913 ha are forests, 3233 ha are pasture land, and the rest of it is agricultural lands and legal exceptions of individuals and organizations (General Forestry of East Azarbaijan, 1984) which are managed and protected by General Natural Resources Department of Ardabil province.

Research Methodology

Systematic sampling was conducted with random origin. The sampling intensity was 3.3% (since the forest is homogeneous) and the sampling plots designed within a 150×200 m grid. The above gridding was first mapped as 1:10000 from the above mentioned region. It was then implemented in the region after its definitive determination in the nature, which a total of 33 plots each with a total area of 1000 m^2 were provided in the region. The total area of the plots consists of 3.3 ha of the region. Each plot was circular in a radius of 17.84 cm. Then, the vegetative characteristics of trees such as diameter at breast height with a diameter tape and the circumference at breast height of trees were measured after turning forest, and diameter at breast height of each tree was obtained by division of the number π , and also the height with the calipers and the diameter number and classes were obtained using the equation of cross-section area = $\frac{\pi d^2}{4}$, and hence the equation for the volume of each tree was obtained as $v = \frac{\pi}{4} d^2 * h * f$. The form factor (F) of 0.5 is used due to the lack of accurate research in this case (Namiranian, 2006). Data about the forest area with >2.5 cm trees in diameter were collected by species distinction ranking based on quality. At the end of the form, number, diameter, height, volume, cross-section area, viability, regeneration and type of control trees that are closest to the center of plot and the thickest tree in the plot were recorded. The vegetative and regenerative species number was recorded in the appendix table according to the species by recording data on the general condition of sample plot and data about the regeneration in sample plot and in diameter classes with <7.5 cm, 0.5-2.5 cm, and 2.5-7.5 cm. Data entered into a database in SPSS software after field operations and recording parameters and they were analyzed using t-test at the probability level of 95%. The specifications such as mean, variance, standard deviation, skewness, and kurtosis separately were obtained in hazelnut trees and other species and statistical analysis was conducted.

Results and Discussion

Height of trees per hectare: Diagram of diameter-height classes of hazelnut and other species in the study area shows that the maximum height number is for diameter class of 12.5-17.5 cm in hazelnut

and in other species. The results of t-test show that there is a significant difference between the height of hazelnut trees and other species at the 95% probability level (Figure 2).

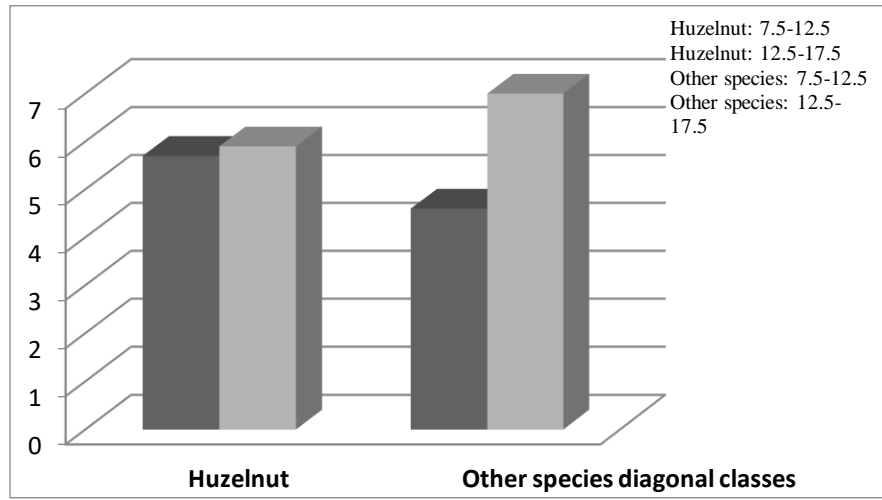


Figure 2: diameter-height classes of hazelnut and other species in the studied area

Table 1: T-Test for height of hazelnut and other species

Characteristics	df	Statistics	Significant level
Hazelnut height	32	13.01	0.001*
Other species height	32	9.07	0.002*

* Significant difference at 95% level

Cross-sectional area at breast height per hectare: The diameter diagram in the study area showed that it was the highest in hazelnut in the diameter class of 12.5-17.5 (7.93 m²) and the lowest in other species in the diameter class of 12.5-17.5 (0.7 m²) (Figure 3). The results of the T-test showed that there is a significant difference between the cross-sectional area at breast height per hectare of hazelnut and other species in the 95% probability level (Table 2).

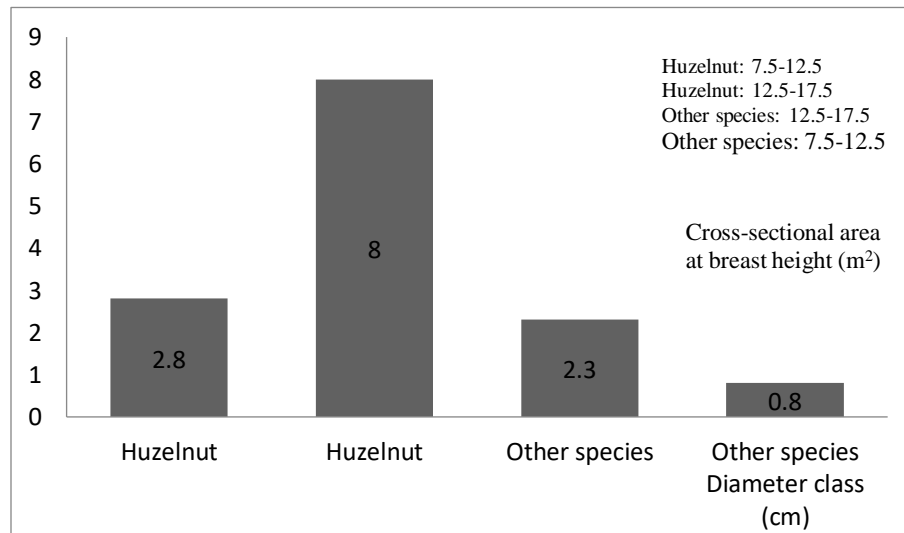


Figure 3: Diameter-cross-sectional area at breast height of hazelnut and other species in the studied area

Table 2: T-Test of cross-sectional area at breast height of hazelnut and other species

Characteristics	df	Statistics	Significant level
Hazelnut cross-sectional area	32	3.82	0.001*
Other species cross-sectional area	32	1.21	0.006*

* Significant difference at 95% level

The volume of trees per hectare: The volume diagram of diameter classes in the region shows the largest volumetric growth of hazelnut in the diameter class of 7.5-12.5 (8.9 m³) and the lowest of that was observed in other species with 1.32 m³ in the diameter class of 12.5-17.5 cm (Figure 4). The result of T-test also showed that there is a significant difference between the volume of hazelnut per hectare and other species at 95% level (Table 3).

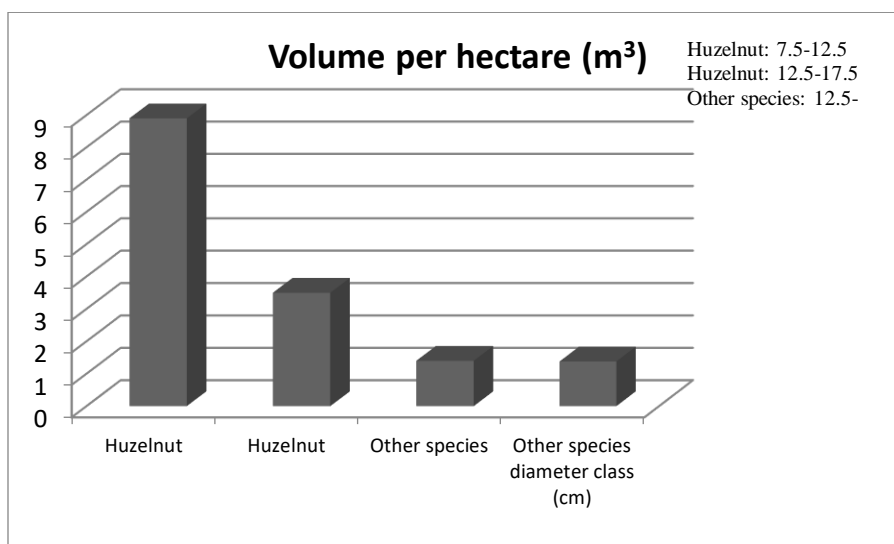


Figure 4: Diameter-volume classes per hectare for hazelnut and other species in the study area

Table 3: T-Test of volume per hectare for hazelnut and other species

Characteristics	df	Statistics	Significant level
Hazelnut volume	32	5.13	0.012*
Other species volume	32	1.19	0.002*

* Significant difference at 95% level

Regeneration per hectare of hazelnuts and other species: As Figure 5 shows, the share of hazelnut in the diameter class of 0-2.5 was the highest with 29413 sprouts, and the lowest share was related to other species in diameter class of 0-2.5 (389 sprouts). This shows that the maximum chances of survival and competition are related to hazelnut and in the diameter class of 0-2.5 cm. The T-test table also shows that there is a significant difference in regeneration between hazelnut and other species at 95% probability level (Table 4).

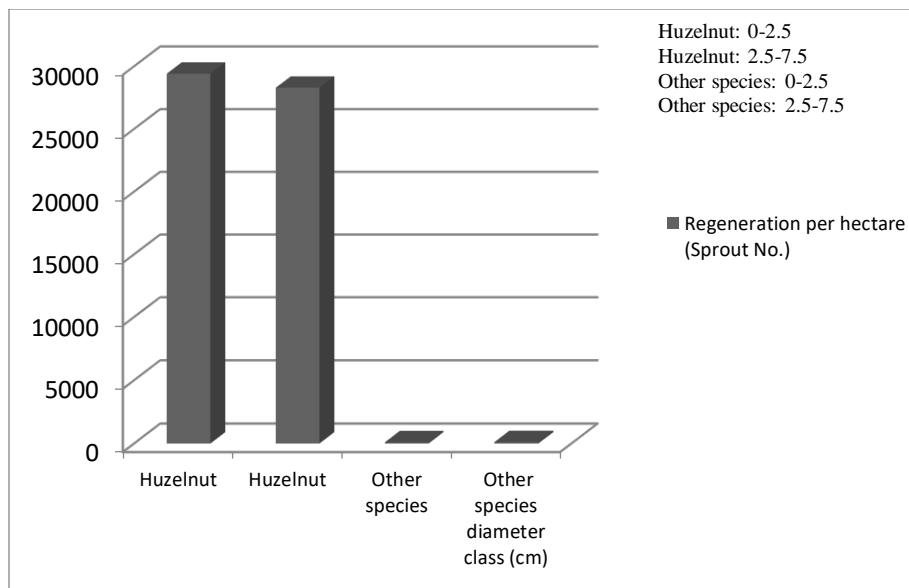


Figure 5: Diameter classes-regeneration of hazelnut and other species in the study area

Table 4: T-Test for hazelnut nutrition and other species

Characteristics	df	Statistics	Significant level
Hazelnut regeneration	32	24212	0.001*
Other species regeneration	32	452	0.004*

* Significant difference at 95% level

Table 5: Mean, standard deviation, variance, skewness, and kurtosis of hazelnut

Characteristics	Hazelnut volume (m ³)	Hazelnut cross-sectional area (m ³)	Hazelnut height (m)
Mean	0.804657	0/189654	236.941143
Standard deviation	0.4037367	0.0805784	95.4112167
Variance	0.1630033	0.0064929	9103.3002751
Skewness	-0.113	-1.172	-1.368
Skewness standard deviation	0.873	0.390	0.698
Kurtosis	0.698	0.390	0.873
Kurtosis standard deviation	0.778	0.778	0.778
Total	33	33	33

According to Table 5 among 33 sample plots, the mean of hazelnut volume in the sample plot was 0.804657, the mean of cross-sectional area in sample plot was 0.189654, the mean of hazelnut height in the sample plot was 236.941143, standard deviation of hazelnut volume was 0.4037367, hazelnut cross-sectional area and height were 0.0805784 and 95.4112167, respectively, the variance of hazelnut volume was 0.1630033 and hazelnut cross-sectional area and height were 0.0064929 and 9103.3002751, respectively. As skewness is normal at zero, in the table above, the skewness value is also negative by the asymmetric distribution with kurtosis towards the values smaller, which indicates the asymmetry between volume, cross-sectional area and height of hazelnut.

Table 6: Mean, standard deviation, variance, skewness, kurtosis of other species

Characteristics	Other species volume (m ³)	Other species cross-sectional area (m ³)	Other species height (m)
Mean	0.195552	0/051273	21.436337
Standard deviation	0.1802180	0.0559512	8.9846003
Variance	0.0324785	0.0031305	80.7230432
Skewness	4.739	6.972	-0.062
Skewness standard deviation	0.185	0.185	0.185
Kurtosis	34.225	68.183	-1.051
Kurtosis standard deviation	0.368	0.368	0.368
Total	33	33	33

According to Table 6, among 33 plots, the mean volume of other species, the mean cross-sectional area, and the mean height were 0.195552, 0.51273, and 21.436337, respectively. The standard deviation of other species, cross-sectional area, and height were 0.1802180, 0.0559512, and 8.9846003, respectively. The variance of other species, the cross-sectional area and the height were 0.0324785, 0.00313305, and 80.7230432, respectively. Considering the table above, skewness value is also positive and negative by the symmetric distribution with the kurtosis toward smaller values, suggesting the volume and cross-section area asymmetry of other species.

Conclusions and suggestions

In the case of qualitative and quantitative characteristics, it can be stated that Fandoghlu forest has a very high vegetation potential for the establishment of forest stands. The presence of forest elements similar to Hyrcanian forests is another reason for the potential of this forest to create climax forests of beech and oak. This forest in terms of structure has 99% coppice stands and only 1% seedling stand, which is similar to Arasbaran forest in this regard as composed of coppice and seedling stands with priority in coppices (Amirghasemi et al., 2001). Therefore, the following fundamental recommendations are suggested in order to achieve the objective of the continuity of the natural sequence in Fandoghlu forest:

1. Accelerating the ecological sequence through: (a) Transformation of forest structure from coppice and seedling stands and its continuation towards multistoried and mixed uneven-aged seedling forests of beech or oak naturally and without human intervention that requires a long time. (b) Performing silviculture operation required to direct existing stands toward the ideal stands and climax of the region (Section a) and accelerate the natural sequence process.
2. Planning for the establishment of indigenous forest species in low-tree and without tree areas of the region plan with full respect for all principles of silviculture close to nature (using indigenous species and creating mixed populations).
3. Maintaining the unique hazelnut genetic reserves in this forest.
4. It is also recommended to study other forest areas due to the lack of studies on quantitative and qualitative characteristics of hazelnut in forests of other regions in Iran, especially about Hyrcanian forests.

Acknowledgments

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