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The Effects of Gap Areas on the Natural Forest Resurgence of the Oak (*Quercus castaneifoli*) in the Northern Khorasan Province, Iran

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Abstract

Natural resurgence is one of the most priorities of the forest management. In this study, in order to investigate regeneration success and determine the best gap area, the quantitative characteristics of the regeneration groups were evaluated at different gap area classes. Because of the dense natural forests, *Quercus castaneifolia* in northern Khorasan province of Iran, determination of the best gap area for the better resurgence was aimed 30 gaps were selected in three different areas. Some selected Parameters such as steep, direction, height and shape of the gap and percent of the canopy cover and the disturbing vegetation were determined. Quantitative characteristics such as light, resurgence, diameter at breast height and collar diameter of oak seedling (*Quercus castaneifolia)* with height over 1.30 m were measured in the different size gaps. The shape of the gaps was mostly oval-like and the regeneration in the gaps of 5 up to 8 R was better rather than the others. Percent of forest canopy cover decreased while the surface of the gap increased. Moreover, the percent of the disturbing vegetation cover, diameter at breast height (DBH) and collar diameter (CD) significantly correlated with the increase of gap area. It is concluded that the gaps should not be made in the area with 8 R or more unless the disturbing grass cover be removed.

Keywords

Iran, Gap area, Natural Forest, North Khorasan, *Quercus castaneifolia*, Regeneration

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1. Introduction

The crucial roles of forests in human life are in providing Biodiversity, timber and by-product production, oxygen releasing and water and soil conservation (Yakhkesi, 2003). Despite their ability to regenerate, Forests as dynamic resources to perform ecological balance through producing or adjusting ground andrunoff water as infrastructures of agriculture, providing wooden and cellulose industries, career opportunities and green spaces for human beings, hence they are considered as primary resources (Ashouri, 2004).Resurgence of managed forests is one of the foremost important objectives in Silviculture (MarviMohajer, 2006). Light, humidity, soil nutrients as physico-chemical parameters, living organisms, animal grazing and their interaction makes the stand to be appropriate habitat for regeneration or vice versa (Hojjati, 2008). Sustainable development of forests depends entirely on its regeneration rate (Delfan Abazari et al., 2004).The gap refers to a small space through the crown cover of trees with the surface of less than 0.1 ha (Yamamoto, 2000). Another definition proposed for a small growing or physical space, which is occurs due to the longevity of a tree, falling or breaking the trunk of trees. There are generally two types of gaps in forest. 1) Natural gap which are created as a result of wind fall or longevity of trees and 2) man-made gap which are made

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intentionally in variety of sizes (Abdollahi, 2007). Many widespread studies have been done on the openings of virgin European forests (i. e. Leibundgut 1993; Korpel 1995).The shape of these gaps is considered as an active part of forest cycle which provides conditions for short-term and long-term dynamics (Taheri, 2005).The number and quality of seedlings are highly dependent on the gap size. Johnson et al., (1989) found the success of natural resurgence of *Quercus* spp depends on the stand conditions and presence of competitor species. Kolb and Steiner (1990) reported that when the light intensity increases in the gap, the competition of vegetation and seedlings increases in the undercover but the growth of the Oak seedlings may reduce. Lorimer et al (1994) observed a high percent of mortality and lowgrowth in seedlings of *Quercus Rubra*, when either crown cover and undercover were located in the shade. *Quercus castaneifolia*is a tree species with the maximum height and diameter of 40 and 3 m, respectively. It has a broad crown, straight grayish-greenish young branches and shoots which gradually become lighter. As it grows, its bark gets cross and its color changes to brownish – black (Sabeti, 2002).A part of Norhern Khorasan forests in Iran is considered as parts of Hyrcanian forests. Therefore, conservation of these forest (Hyrcanian forests) is very crucial.

The objective of our research was to evaluate the effect of various surfaces of the gaps (figure 1) on the quantitative indices of the northern Khorasan forest resurgence in Iran. Moreover, the correlation among the surface of the gaps, the number and quality of the resurgence and the number of the growth of oak stands was aimed.

Fig. 1. View of gap of regeneration in the area.

2. Materials and Methods

2.1. Study Site

The forests of Jouzak- Darkesh, situated in 65 km in the west Bojnourd city in Northern Khorasan province, Iran (56° 58′ E, 37° 26′ N) was determined as our research area which was approximately 22500 ha (figure 2). The study field was a part of Hyrcanian forests of Northern Khorasan Province. The minimum and maximum altitudes of the forests were 1000 and 2455 m above the sea level, respectively. The region climate was determined to be semi- dry and cold based on the available statistics in a 20-year period and climatic classification using Emberger index. The average of annual rainfall and temperature is 434.50 ml and 10.20˚C, respectively (Choopani et al., 2008).

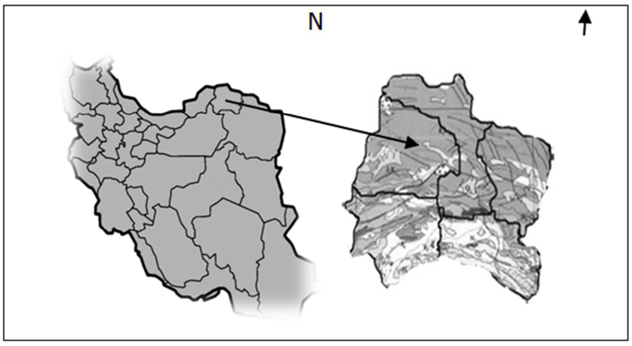

Fig. 2. The study area in Northern Khorasan (North-east of Iran).

2.2. Sampling Method

Thirty gaps were selected in the field of study. These gaps were divided into three categories in size: 2-5 R (small - size), 5-8R (medium - size) and larger than 8R (large - size) and ten replications were dedicated for each class (Mousavi et al., 2003). The gaps in each class were elliptical in shape (Shahnavazi etal., 2005). The approximate area was measured by recording the small and large diameters of the gaps and calculating the ratio of the large diameters to the small ones, which includes two classes (Hakimpour, 2000) as class 1-2/64, and class 2/64-4/28, gaps with a slight and a medium elongations, respectively. In each gap, general characteristics such as slope, direction, height, percent of crown cover and percent of disturbing vegetation were recorded.

In fact we tried to work on the gaps with similar conditions to make a better comparison among them. Natural resurgence was completely counted in gaps and light with a light meter recorded. Light meters a device that shows the exact amount of light inside the gap.

The collar diameter (CD) (cm) and Diameter at breath height (DBH) (cm) of the seedlings with the height over 1.3 m was measured with a Diameter caliper.

2.3. Statistical Analysis

All the analyses were conducted at a significance of p= 0.05 confidence level using SPSS 16.0.

Differences between the quantitative characteristics area classes of the gaps were tested using analysis of variance (one-way ANOVA) and Tukey multiple comparison tests.

3. Result

Selected Gaps in steep, altitude and direction were in a similar situation. Seventy percent of those were oval in shape (average elongation) and the others were circle-like ones (low elongation) (tab. 1).

Table 1. The quantitative characteristics of the gaps in different area classes.

	Mean Square	Df	F	P value
Crown Cover	5185.83	2	4.53	0.02**
DGC	6990.83	2	39.25	0.000**
Light	2021280.30	2	63.22	0.000**
Resurgence	6440967.10	2	11.67	0.000**
CD	2.04	2	9.49	0.000**
DBH	0.78	2	4.98	0.011**

** significant (α= 1%)

3.1. Crown Cover

Table 1 and Figure 3 show a significant difference (p= 0.02) among the mean percent of the crown covers in different area classes of the gaps. The mean values were significantly different (p< 0.05) for each pair of the percent. The maximum and minimum percent of crown covers in different area gaps were seen in 2-5R and ≥8R, respectively (fig. 3).

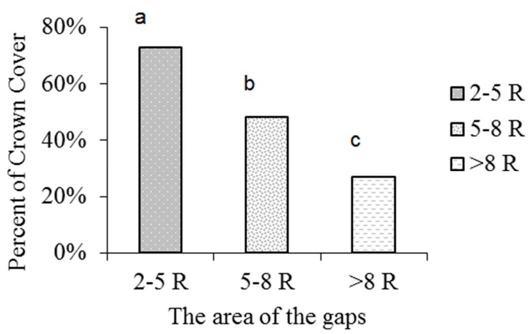

Fig. 3. The percent of the crown cover in different area classes of the gaps.

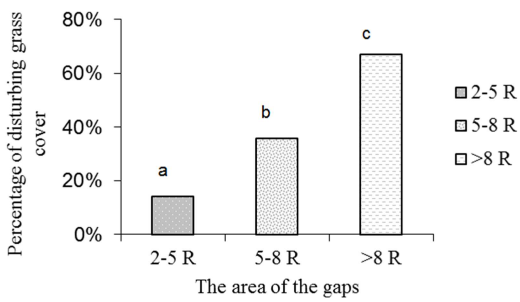

Fig. 4. The percent of disturbing grass covers in different areas of the gaps.

3.2. Disturbing Grass Cover

Table 1 and figure 4 present a significant difference (p= 0.000) among the percent of disturbing grass covers in area classes of the gaps. The mean values were significantly different (p< 0.05) for each pair of the percent. Figure 4 shows the maximum and minimum values of the disturbing grass covers were located in 8R and in 2-5 R, respectively (fig. 4).

3.3. Light

As shown in table 1 and figure 5 there was a significant difference (p= 0.000) in light mean values in different areas of the gaps. The mean values were significantly different (p< 0.05) for each pair of the light intensities. In the basis of the results, the maximum and minimum light intensities were observed in the gaps over 8R and gaps between 2-5 R, respectively (fig. 5).

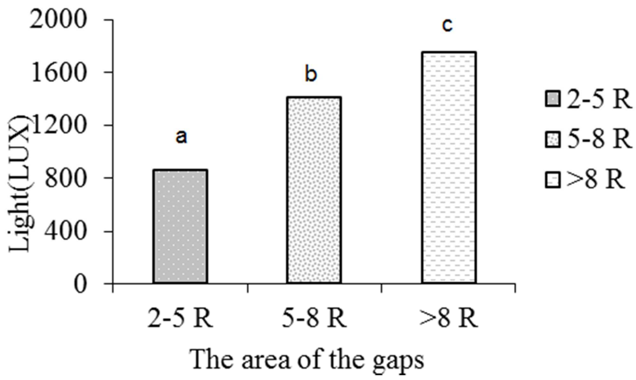

Fig. 5. The average of light intensity in different areas of the gaps.

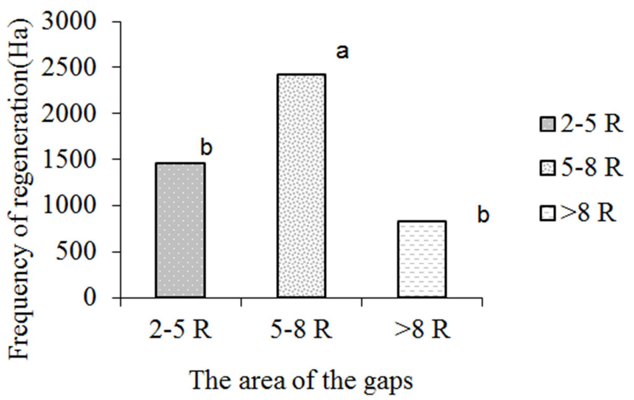

Fig. 6. The frequency *Quercus castaneifolia* resurgence in different areas of the gaps.

3.4. Resurgence

It can be seen from the data in table 1 and figure 6 that there was a significant difference (p= 0.000) in the average values of resurgence in the area classes of the gaps. The results showed, the maximum and minimum resurgence were observed in gaps over 8R and 5-8 R respectively, whereas 2-5 R gaps had a moderate range of resurgence.

The maximum and minimum the disturbing grass cover were seen in 8R and in 2-5 R, respectively. The mean values were significantly different (p< 0.05) for each pair of the resurgences in area classes of the gaps. There was significant differences (p<0.05) in the medium-size gaps when compared to the gaps with other sizes but no significant difference were seen between large and small gaps (p> 0.05) (fig. 6).

3.5. CD and DBH

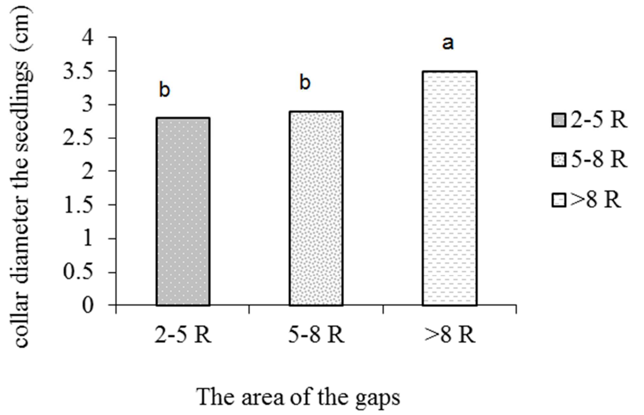

Fig. 7. The average of collar diameter of *Quercus castaneifolia* seedlings in different areas of the gaps.

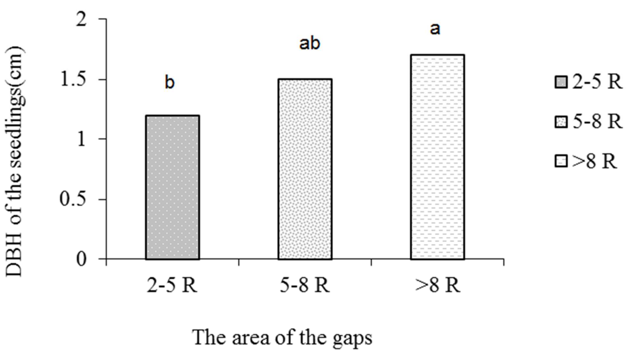

Fig. 8. The average of DBH in *Quercus castaneifolia* seedlings in different areas of the gaps.

According to the table 1 and figures 7 and 8 there were significant differences (p= 0.000 and p= 0.011) for the mean values of CD and DBH of seedlings in area classes of the gaps, respectively. Generally, CD values in the seedlings increased with increasing area of the gaps. The maximum and minimum mean value of collar diameters were observed in the gaps over 8R and 2-5 R, respectively (fig. 7).

Diameter at breath height of seedlings increased with increasing area of the gaps. The results showed, the maximum and minimum values of DB were observed in gaps over 8R and 2-5 R, respectively (fig. 8).

4. Discussion

Natural resurgence is one of the most priorities of the forest management. Our results implied that the gaps were homogenous in steep, direction and height. The shapes of the gaps were mostly oval - like. This result was accordant with the finding of Shahnaviand et al (2005) that reported, the shape of the regeneration gaps is more oval- like.

Our results showed that the mean percent of crown covers is higher in small gaps in comparison to the big gaps, which their results were reverse. Due to the higher density of the trees at the smaller gaps, crowns were closer to each other and this result confirmed this suggestion that why there was a meaningful difference among the gaps. Talebi et al (2006) reported that the crown cover in *Quercus persica* ranges from 12.43-15.73 percent. The average of the percent of the disturbing grass cover was higher in larger gaps and vice versa. Therefore, the percent of the disturbing grass covers in the gaps were dissimilar together. In the gaps larger than 8R, there was a better opportunity for the disturbing grass cover to establish and to grow. It couldbedeu of thegreateramount of light in the gaps larger than 8R. In the 2-5 R gaps because more shade weeds grow less. The 5-8R gaps were moderate in light penetration and disturbing grass cover growth. Similar result was reported Dave and Karen (2000) the highly correlation of the surface with the frequency of the vegetation cover on the soil. They observed that the vegetation cover increased while the surface of the gap increased. However, it was reversely correlated to the regeneration of the seeds. The average of the transmitted light intensity was higher in the larger gaps in comparison to the others and vice versa. It could be due to condensed trees at the small gaps, which make the crowns denser. Therefore, less light penetrated in to them.

Saghebtalebi et al. (2001) reported that the amount of relative light fluctuates between 23.4% in the gaps, smaller than 2R to 40% in the gaps larger than 2R. This result is similar to Hakimpour (2010) that observed the amount of the transmitted light in to the gaps increase with increasing the surface of the gap. The maximum and minimum of the *Quercus castaneifolia* regeneration was observed at the 5-8R gaps and gaps over 8R, respectively. At the 2-5 R gaps, adverse correlation was observed between the abundance of the vegetation cover and existence of shade. The establishment and growth of the oak seedlings of which were reported to be light tolerant. In addition, Goudarzi (1996) reported that the number of seedlings is low at plots with a low crown cover (between 10-30 %). The number of seedlings increased with increasing of crown cover up to 60% but subsequently decreased as the crown cover exceedance over 60%. Shahnavazi et al (2005) observed that the frequency of the beech seedlings decreases while the size of the gaps increases but simultaneously, the number of the light-tolerant seedlings gradually increases. Mirzaei et al. (2007) reported the intense sunlight, unavailability of water and competition of the weeds negatively affect the growth and establishment of the seedlings on oak seedlings (*Quercus castaneifolia*). This finding was agreed with the data obtained from the large gaps of our study and seems to be consistent with the observations of Jonhson (1993) reported that the most Oak species are shade-intolerant and grow poorly in a high shade, but they grow well in a low – moderate shade. Like to the former findings, Humphery (1997) proposed, although the seedlings of *Quercus castaneifolia* are light-tolerant but primary seedlings require shade and are vulnerable to sunlight.

So, they do not grow well at the large gaps due to the presence of vegetation cover and intense sun light. The highest and the lowest CD and DBH were observed at gaps larger than 8R and 2-5 R, respectively. Collar diameter and DBH of Oak seedlings in the larger gaps increased due to the intense light.

These results were agreed with Arab et al. (2005) that concluded the thickest and the thinnest Oak seedlings located in an open and semi- closed crown cover, respectively. Based on the obtained results, the optimal size of the gaps for the resurgence of *Quercus castaneifolia* seedlings ranges from 5-8 R (or 50 percent of the crown cover).It is concluded that in northern Khorasan forest in northeast of Iran, the gaps should not be made in the area with 8 R or more unless the disturbing grass cover be removed.

Overall, it can be concluded that medium sized gaps 5-8 R (500-800 m^2) are the most suitable for resurgence of *Quercus castaneifolia*.

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