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Structure and Regeneration Patterns of *Juniperus polycarpos C.Koch* in Alborz Mountains, Iran

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ABSTRACT

The absence of natural regeneration is the most important problem of Junipers forest. Regeneration in these forests is strongly inhabited by grazing pressure and human disturbance. The rate of natural regeneration in Iran is low, therefore in present research sample plots are carried out to analyze the structure and regeneration patterns of the *Juniperus polycarpos c.koch* in Alborz Mountains of Iran. In each sampling plot, the diameter at breast height, height of all trees and regeneration density and were measured. Statistical analysis showed that there was a positive correlation between regeneration density, mature trees density and basal area per hectare. All *Juniperus polycarpos c.koch* trees with height up to 1.5m were considered as seedling (regeneration plants) and were classified into tree groups: S seedling, P seedlings, and G seedlings. The results of regeneration in three groups showed that the regeneration of S seedlings was the most frequent and the regeneration of P seedlings was the least frequent.
KEYWORDS: Natural Regeneration, *Juniperus polycarpos c.koch*, Structure, Iran.

INTRODUCTION

The genus Juniper consists of approximately 67 species (Farjon, 2005; Adams, 2008), all native to the Northern hemisphere, although *J.procera Hochst.exend* grows southward along the Rift Mountains in East Africa into the Southern hemisphere (Adams, 2008). The *J.polycarpos c.koch* is one of the most important trees of Iran which is found on south slopes in high mountains of Elburz, Arassbaran, and Northern parts of Khorassan (Djavanshir, 1974). The natural forests of *J.polycarpos* occur as open woods of scattered trees. This specie is notable in soil conservation, also is a frost resistant plant and grows in areas where the minimum of temperature reaches to - 35^0C Among Conifers, Junipers are most adapted to arid conditions as their xylem is characterized by a small pore volume (Djavanshir, 1974). They replace other genera towards the drought-limit of trees and often constitute the only available source of timber and fuel wood in dry and mountain areas. Thus, Junipers are exceedingly important for human subsistence in semi-arid regions and stands are widely exploited, notably in Central Asia (Farjon, 2005). As a results of illegal cutting, the forest stands moderately have become open, over-mature and poor quality, as it is reported in Pakistan by Atta (2000), Regenerations in these forests are strongly inhabited by grazing pressure and human disturbance. The rate of natural regenerations in Iran is smaller than usual; even in some researches, it has been reported zero percent (Nematollahi, 1956). Regarding to the Iranian government command, harvesting of this genus is prohibited since 1989. An investigation on the ecology, ecosystem and distribution of genus *Juniperus* was conducted as a national plan (Korouri and Khosnevis, 2000). However, despite the increasing protection of Juniper habitats, population sizes have continued to decline, very often due to the absence of regeneration (Ward, 1982; Fiter and Jennings, 1975). The main purpose of this study was to analyze the structure and regeneration patterns of *Juniperus polycarpos c.koch* in the Alborz Mountains of Iran.

MATERIAL AND METHODS

Study area

This research was carried out in the Eshkar-sar of Roud-sar reserve zone which is located in Northern Iran. The area is located in 36°- 46' northern latitude and 50°-26' eastern longitudes almost 804 ha with an elevation ranging between 2130 and 3320 meter above see level. The mean annual precipitations is 498 mm and mean annual temperature is 5.5^0 C, mean temperature in July is 37^0 C

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and in January is -11 ^{0}C. The slope gradient of study area was 30 to 60 percent with a south-west aspect. Soil is generally shallow, with clay loam texture and regarding to the FAO classification, is called lithic lithosol. There are many small and scattered stands of J.polycarpos which are surrounded by other species stands or bare areas. Table 1 presents the important properties of soil in study area.

Table -1: Important properties of soil in study area

Soil depth (cm)	Organic carbon (%)	pH	Total N (%)	$\frac{C}{N}$	Soil texture	EC
0-5	2.81	6.7	0.25	13	Silt-clay	0.78
5-10	2.98	6.8	0.19	16	Silt-clay	1.14
10-50	1.99	6.9	0.14	15	Silt-clay	0.76

METHOD

The data was collected in summer 2006. The Random-Systematic method was carried out and 53 temporary sampling plots of each 0.5 hectare area were considered (Nooki et al, 2008). In each sampling plot, the diameter at breast height, height of all trees and regeneration density and qualitative condition were measured. All J.polycarpos trees with height up to 1.5 m were considered as seedling (regeneration plants) and were classified into three groups (Milios et al, 2007):

- **S** seedlings: seedlings under closed canopy (under a single or a group of *J.polycarpos* trees)
- **P** seedlings: seedlings under (or near) the edge of the canopy of a single or a group of *J.polycarpos* trees
- **G** seedlings: seedlings growing in a canopy gap (without any significant side shade).

RESULTS AND DISCUSSION

Stand structure

Density and basal area values for trees in the study area are summarized in table 2. The average density of Juniper tree was 37 stems/ha with a range of 0-136 stem/ha. Also, the average basal area of stand was 1.8 m^2 ha^{-1} with a range of 0-17.6 m^2 ha^{-1}. Table 2 presents Summary of stand characteristics in Eshkar-sar region.

Table – 2: Summary of stand characteristics in Eshkar-sar region

	Minimum	maximum	Mean		Std.
	statistic	statistic	statistic	Std.Error	statistic
Density(ha^{-1})	.00	136.00	36.52	4.759	34.65
Basal area(m^2ha^{-1})	.00	17.63	1.83	.436	3.18

The overall frequency distribution of diameter and height classes of Juniper trees are presented in Figures 1 and 2, respectively. The frequency of trees over diameter and height classes showed a reverse J shape.

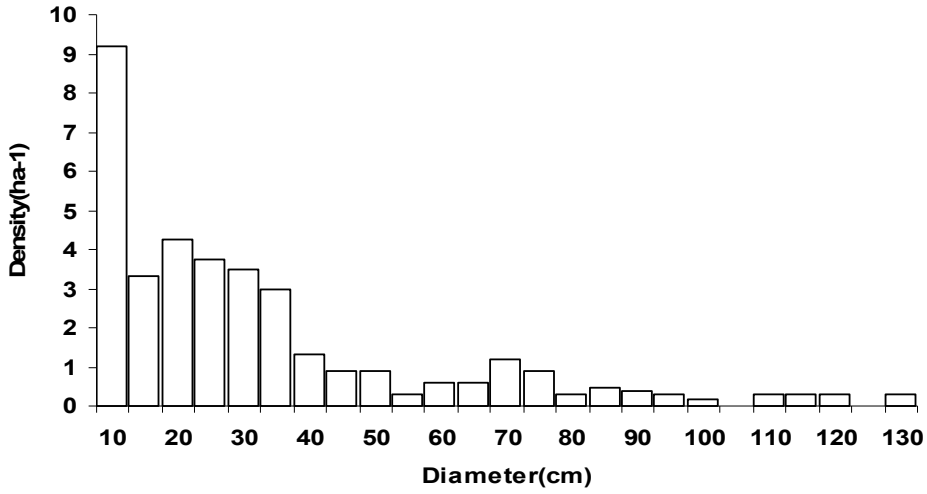

Fig.1: Frequency distribution of Juniper trees on diameter classes in the study area

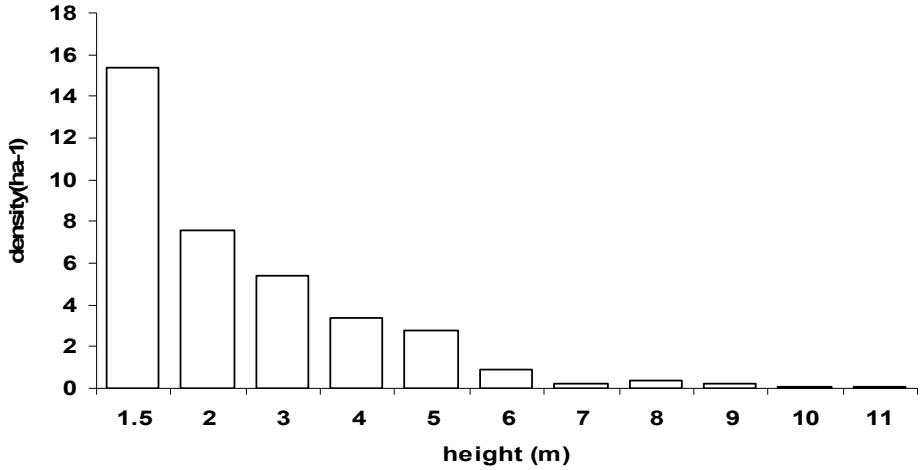

Fig. 2: Frequency distribution of Juniper trees on height classes in the study area

Stand regeneration

Generally, the average of seedling and sapling per hectare were recorded 17. Table 3 presents Summary of Regeneration characteristics in Eshkar-sar region.

Table – 3: Summary of Regeneration characteristics in Eshkarsar region

	Minimum	maximum	Mean		Std.
	statistic	statistic	statistic	Std.Error	statistic
Seedling Density(ha^{-1})	0	54	17 1.9	13.9	

Comparison of density between three categories of *J.polycarpos* seedlings were significantly different at $p<0.01$ level. Table 4 presents ANNOVA of Regeneration in three categories. In this stand, the S seedling category seems to demonstrate the highest density, with a significant difference, while there was no significant difference in density between P and G categories. Figure 3 presents comparison of means density between tree categories of *J. polycarpos* seedlings.

Table – 4: ANNOVA of Regeneration in three categories

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	545.86	2	272.93	27.46	.000
Within Groups	1550.53	156	9.94		
Total	2096.39	158			

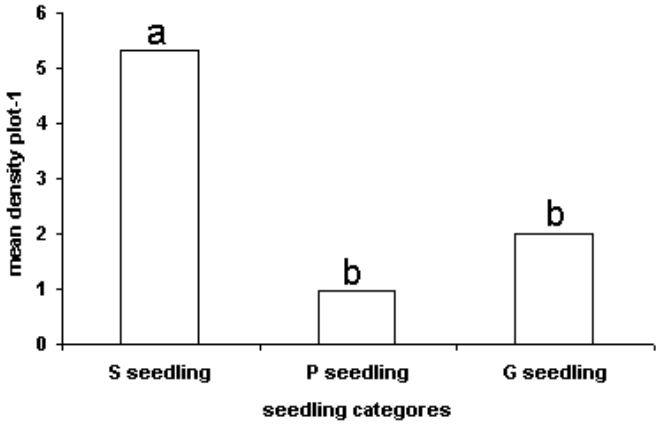

Fig. 3: Comparison of means density between tree categories of J. *polycarpos* seedlings

Also, significant correlations were found between seedling density and both tree density ($r=0.52$, $p<0.001$) and basal area ($r=0.39$, $p<0.01$) (Table 5).

Table – 5: Relationship between tree density and basal area with seedling's density in the study area. (Significant levels: **=p<0.01; ***=p<0.001)

variable	Regression equation	r	Sign.
Seedl.dens/stand density	Y=7.8+0.27x	0.52	***
Seedl.dens/stand basal area	Y=10.8+2.2x	0.39	**

The studied stand of *J.polycarpos* (Eshkar-sar) has the lowest tree density regarding to its lowest basal area and number per hectare in comparison with other sites of Iran, Pakistan and Oman (Korouri & Khoshnevis, 2000; Fisher & Gardner, 1995). In other hand, the density, basal area and regeneration of some parts in the studied stand where have been moderately grazed and harvested, considerably got improved. Obviously, ideal qualitative condition would be accessible when grazing and intensive cutting have been prevented. The results of regeneration in three groups (G, S and P) showed that the regeneration of S seedlings was the most frequent and the regeneration of P seedlings was the least frequent. The study of Milios et al (2007) in *J.excelsa* forests of Greece showed same results. In most of mature stands of juniper forests, grazing, human disturbances and soil erosion may be responsible for low seedling density per unit area (Atta, 2000) and may be the harsh ecological condition of Juniper habitats as well. The seedling and smaller juvenile juniper plants with their sharp acicular leaves would probably not be grazed, but they could be damaged or killed by animals' ponderous tread and trampling (Atta, 2000). Statistical analysis showed that there was positive correlation between regeneration density, mature trees density and basal area per hectare. The results of this study indicates that Juniper seedlings are shade tolerated in early stages of their establishment, also the results of Sheikh(1985) and Atta (2000) confirm this(Taheri 2007 not related to this study) . In conclusion, the juniperus forests of Alborz mountains of Iran are neither generally deteriorating, nor in an unstable state. Increased human disturbances will eventually threaten them and therefore proper management is absolutely necessary to save these forests.

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