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Characterization, Propagation, Conservation status of Wild Pistacia of Zarghoon State Forest Ecosystem Quetta, Balochistan-Pakistan

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Abstract

The aim of this study was to observe the distribution, propagation, delivery and preservation status of wild Pistacia from Zarghoon State Forest Quetta, Balochistan, Pakistan. Different standardized techniques such as; frequency, relative frequency, density, relative density, relative dominance, Importance value index, Species richness, index of dominance and basal area covered by plant species were used. The data showed that *Pistacia atlantica* had the largest frequency, followed by *Pistacia khinjuk* with other ground flora in the study area. The total density of both species were; 20.02 plants/m^2. *Pistacia atlantica* was recorded as the dominant specie with an IVI value of 181.57 % followed by *Pistacia khinjuk* as a co dominant specie with an IVI value of 118.43 % and the total basal area covered by both species was noted 225.144 m^2. Seedlings of *Pistacia atlantica* showed highest regeneration with an IVI value of 192.59 % which followed by *Pistacia khinjuk* with IVI value of 107.41 %. The percentage of Male and female *Pistacia* species was found 30.83 and 69.17% by the ratio of 44.58% respectively. The physical condition of all the trees of *Pistacia khinjuk* was found healthy. Not found any tree of *Pistacia khinjuk* unhealthy, over mature, disturbed and cut stumps in the area while the *Pistacia atlantica* was found healthy with IVI value of 89.9 %, unhealthy 23.2 %, over mature 43.2 %, disturbed 48.5 %. Along *Pistacia* species other associated ground flora was noted and total ground flora was recorded 45.54 plants/m^2.

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Introduction

Pistacia trees belongs to Kingdom (Plantae) Order (Sapindales), Family (Anacardiaceae) and Genus (Pistacia), it is a flowering plants in the cashew family. *Pistacia khinjuk* Tocks, and *Pistacia atlantica* Desf, are very commons species grown widely in Pakistan. It grows from 8 to 10 m tall and different parts of this plant have been investigated for various pharmacological activities. *P. lentiscus* is also known as mastic. In addition to their therapeutic effects, Pistacia species are used in food industry, for example, consumption of pistachio (*P. vera*) nut as food additive (Marderosian and Beutler, 2010), *P. terebinthus* fruits as snack food or in making coffee-like drink. (Durmaz and Gokmen, 2011; Gogus *et al.,* 2011) and the anthocyanin composition of *P. lentiscus* fruit as food colorants (Longo *et al.,* 2007). Chemical studies on *Pistacia* genus have led to discovering diverse secondary metabolites in addition to high level of vitamins and minerals. These plants are widespread across temperate and tropical region of Asia and its population is suspected to be stable. In Iran it is wide ranging, occurring through the Makran Zone, Zagros Mountains and the Sanandaj-Sirjan Zone, however subpopulations are also noted to be disjunctive, which suggests that current populations are the remnants of a former, more widely distributed, continuous population; the species is almost absent from the Alborz Mountains (Ghaemmaghami *et al.,* 2009). In Syria this species in the Kalamoun Mountains in the northeast, specifically on the Abdel-Aziz Mountain (Padulosi and Hadj-Hassan, 2001). In Turkey this is widely distributed across the region of south-eastern Anatolia, In Egypt this grows in mountainous areas of Gabal Elba in the south of the Country (Padulosi and Hadj-Hassan, 2001), and in Iraq this is widely distributed in the Kurdistan region (Al-Jaff and Qaradaghi, 2003). Pistacia are native to Africa and Eurasia from the Canary Islands, all of Africa, and southern Europe, warm and semi desert areas across Asia, and North America from Mexico to warm and semi desert of United States, such as Texas or California. In Iran three species occurs naturally which are *Pistacia khinjuk* Tocks., *P. vera* and *P. atlantica* Desf., Patlantic including three subspecies *kuardica, cabulica* and *mutica*. (Bozorgi *et al.,* 2013). It is evergreen or deciduous resin-bearing shrubs and trees which are characterized as xerophytic trees (Ghaemmagami *et al.,* 2009). In Pakistan it is commonly found in Balochistan, Khyber, Chitral, Gilgit and in the Indus river gorge from Kohistan district to Skardu valley (Padulosi and Hadj-Hassan, 2001). Its populations in Pakistan have previously suffered decline from high rates of deforestation in the north, and so are now limited to high places that are inaccessible to humans and goats. So, the main objective of the present investigations is to characterization, propagation, distribution and conservation status of wild Pistacia from Quetta, Balochistan Pakistan.

Material and methods

Study area

Study area Zarghoon state forests consists on Quetta and Harnai district but its major portion is in Quetta district in the North East Zarghoon Mountains and the total area of this forests is 17160 acres (Fig. 1*)*. Administratively it is controlled by Quetta forests division. The major dominant tree species of the forests are Juniper and Pistacia and other associated ground flora are also part of this region (Table 5). The altitude of Zarghoon mountain range starts from 5000ft to 11739ft (Loy Sar Naikaan) peak which is the highest mountain peak of Balochistan. The area is in the form of a horse shoe.

The convex portion of this forest is formed by the water-shed and the back part of the steep cliff above Urak valley. This is the chief catchment area for the water supplied to Quetta. This forests mainly includes zarghoon north forest and central Zarghoon forests. In addition to that the north forests bed of stream from chashma baze towards sara khula. While central zarghoon forest starts from main north ridge forming northern watershed of the range. Moreover, from east the main ridge from north most angle to the Zarghoon hill and from the south the water shed extending in N, E, S, W direction for about three miles.

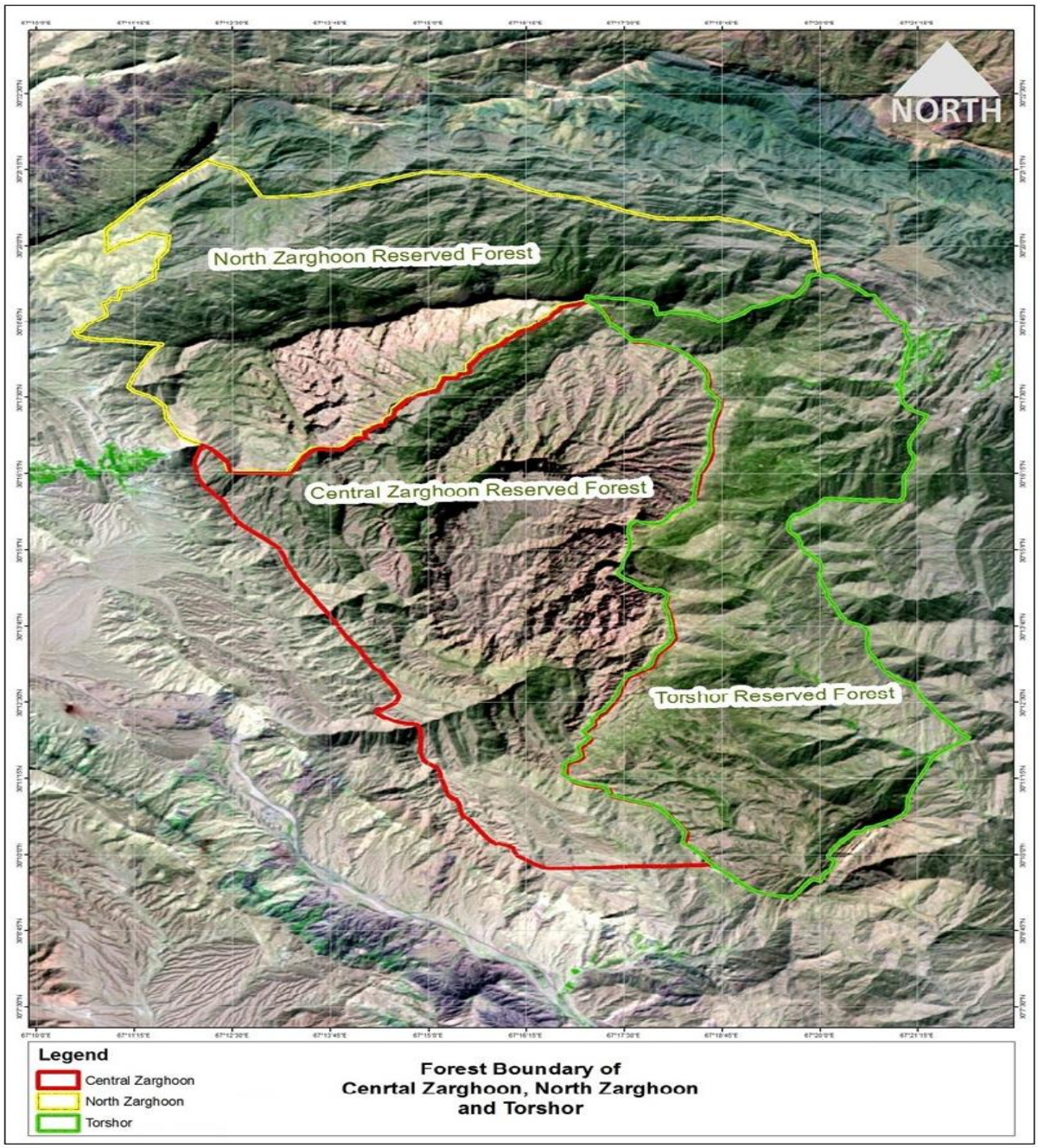

Fig. 1. Map of study area.

Climatic condition and soil characteristics of the study area

Climate of the study area may be defined as being of a continental semi-arid Mediterranean type. The long term average annual total precipitation is about 240 mm, most of which falls in winter. The area has high air temperature in summer (> 38 ^{o}C) and has very cold winters in which the severity of the cold is exacerbated by elevation and wind speed. The average relative humidity is about 30-40% and in summer about 20-30%.

Soil of the area is invariably calcareous and on the steep, 3 mountain slopes are skeletal to existent. However where do they occur on colluvial slopes or in rock areas mostly dominated by shales. The piedmont fans and aprons at the base of mountains are generally gravely or sandy loams, somewhat excessively drained. The soils are brown to dark brown, shallow to moderately deep underlain by consolidated conglomerate beds, calcareous, pH 8.1-8.5, porous, highly permeable but having low water holding capacity.

Ground floristic investigation

For floristic investigation a survey of the study area was conducted during 2018. Each locality was repeatedly sampled from April to October and to ensure that the overall landscape of that area is represented and data was collected from various localities of the study area.

Measurement of importance value index (IVI) of wild Pistacia forests

Predominant natural forests cover by wild Pistacia was studied. For data collection from study area (zarghoon state forest ecosystem) twenty stands (20) were laid out for the purpose of distribution, occurrence of Pistacia species and their ground vegetation. In order to study the above mentioned attributes the parameters such as frequency, relative frequency, density, relative density and relative dominance was determined through the following formulas proposed by Oosting, (1957); Chul and Moody, (1983).

$$\text{Frequency} = \frac{\text{Total No of quadrats in which the species occurred}}{\text{Total No of quadrats studied}} \times 100 \quad \text{(Eq. 1)}$$

$$\text{Relative frequency} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100 \quad \text{(Eq. 2)}$$

$$\text{Density} = \frac{\text{Total No of individuals of a specie}}{\text{Total No of quadrats studied}} \quad \text{(Eq. 3)}$$

$$\text{Relative Density} = \frac{\text{Density of a given species}}{\text{Total densities of all the species}} \times 100 \quad \text{(Eq. 4)}$$

$$\text{Relative dominance} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all the specie}} \times 100 \quad \text{(Eq. 5)}$$

To identify the dominance of the Pistacia species through Importance Value Index (IVI) was calculated by using formula given by Mishra, (1968); Curtis and McIntosh, (1951).

IVI = Relative frequency + Relative density + Relative dominance (Eq. 6)

Measurements of plant diameter and basal area

At breast height (1.37 m above ground level) the circumference of the tree species was measured to calculate the diameter of each tree species by measuring tape (cm) and the individuals with diameter less than 10 cm were recorded as saplings (Pande *et al.,* 1988). The basal area of examined Pistacia species was calculated by the formula as followed by Misra and Misra, (1981).

$$\text{Basal area (m2)} = \frac{\text{pi x (DBH)2}}{(4\text{x}10000)} \quad \text{(Eq. 7)}$$

Shannon's diversity index, Species richness, evenness index and index of dominance

The diversity, species richness, evenness index and index of dominance was calculated by using the Shannon-Wiener diversity index (Shannon and Weaver, 1963) through following formulas;

$$\text{Shannon} - \text{Wiener diversity index (H)} = -\Sigma \text{ Pilogn Pi} \quad \text{Eq. (8)}$$

$$\text{Pi} = \frac{\text{Number of individual of one species}}{\text{Total number of all individual}} \quad \text{(Eq. 9)}$$

$$\text{Species richness} = \frac{(S - 1)}{\text{Log N}} \quad \text{(Eq. 10)}$$

Where, S = total number of species and N= total number of individual of all species

$$\text{Evenness index} = \frac{H}{\text{Log N}} \quad \text{(Eq. 11)}$$

Where, H= Shannon-Wiener diversity index and S = total number of species

Index of dominance = Σ (Pi) ^{2} (Eq. 12)

All the calculation was done through Microsoft Excel program.

Propagation, nursery raising and field plantation

For propagation, nursery raising and field plantation the data was collected from forest and wildlife department of Balochistan in Quetta and Killa Saifullah districts through field visit.

Results

Data collected during the field survey two *Pistacia* species (*Pistacia khinjuk* and *Pistacia atlantica*) were recorded in both study sites. These two species were

located at an elevation of 5000ft to 7400ft in the study area. The data showed that *Pistacia atlantica* had the largest frequency of 100% followed by*Pistachiakhinjuk*88.89%. The total density of Pistacia species were 20.02 plants / m². Out of these species *Pistacia atlantica* showed the highest density (15.56 plants /m²) and *Pistacia khinjuk* showed the lowest (4.45 plants / m²) (Table 1).

Table 1. Importance value index and Basal area covered by Pistacia species in Zarghoon state forest ecosystem Quetta Balochistan.

Plant species	Frequency %	Density (plants /m²)	Relative dominance	Relative density	Relative frequency	IVI	Basal area (m²)
Pistacia khinjuk	88.89	4.45	49.13	22.24	47.06	118.43	110.62
Pistacia atlantica	100.0	15.56	50.87	77.76	52.94	181.57	114.53

Table 2. Dominance of a species (IVI) on the basis of physical condition of each species of Zarghoon State Forest.

Parameters	*Pistacia atlantica*					*Pistacia khinjuk*				
	H	UH	OM	DIS	CS	H	UH	OM	DIS	CS
Relative dominance	21.7	1.2	17.1	10.8	0.2	49.1	NF	NF	NF	NF
Relative density	46.6	6.4	6.90	16.0	1.4	22.8	NF	NF	NF	NF
Relative frequency	21.7	15.7	19.3	21.7	2.4	19.3	NF	NF	NF	NF
IVI%	89.9	23.2	43.2	48.5	3.9	91.2	NF	NF	NF	NF

Where, H; healthy, UH; unhealthy, NF: not found, OM; Over mature, DIS; disturbed and CS; Cut Stump.

The IVI of both Pistacia species were calculated on the bases of Relative dominance, Relative density and Relative frequency as shown in Table 1. *Pistacia atlantica* was recorded as the dominant specie with an IVI value of 181.5688 % followed by *Pistacia khinjuk* as a co dominant specie with an IVI value of 118.4312 % (Table 1). The basal area in study area (zarghoon state forest) covered by *Pistacia atlantica* was found 114.53 m² and *Pistacia khinjuk* was110.62m², so the total basal area covered by both species was noted 225.144 m² (Table 1).

Total Density (plants /m²) and Total Basal area (m²) in study area covered by both tree species (*P. atlantica* and *P. khinjuk*) was found 20.01 plants /m² and 225.14 m² respectively (Fig.2).

Table 3. Regeneration Patron of the Pistacia Species in Examined Area (Zarghoon area forest).

Parameters	*Pistacia khinjuk*	*Pistacia atlantica*
Relative dominance	26.84	73.16
Relative density	37.09	62.91
Relative frequency	43.48	56.52
IVI%	107.41	192.59

Dominance of Pistacia species on the basis of physical condition

All the Pistacia species of Zarghoon state forest was examined on the basis of the physical condition of each species through different attributes such as healthy (H), unhealthy (UH), over mature (OM), disturbed (DIS) and cut stump (CS). The results revealed that all the trees of *Pistacia khinjuk* was healthy with an IVI value of 91.2393 %. Not found any tree of *Pistacia khinjuk* unhealthy, over mature, disturbed and cut stumps in the area (Table 2). On the bases of physical condition the tree of *Pistacia atlantica* was found healthy with IVI value of 89.9 %, unhealthy 23.2 %, over mature 43.2 %, disturbed 48.5 %. A few cut stumps was recorded in *Pistacia atlantica* having an IVI of 3.9%.

Regeneration patron of the Pistacia species and Sex distribution in the examined area

In study area the regeneration of Pistacia species were being done through two patron; first one was by natural regeneration and second was done through nursery rising (Fig. 3A-3E). The overall regeneration patron of the *Pistacia khinjuk* and *Pistacia atlantica* in study area was examined through the calculation of IVI value of the seedlings. Seedlings of *Pistacia atlantica* showed highest regeneration with an IVI value of 192.59 % which followed by *Pistacia khinjuk* with IVI value of 107.41 % (Table 3). Data regarding sex distribution are shown in Table 5.

Results indicated that the percentage of male and female Pistacia species was found 30.83 and 69.17% by the ratio of 44.58% (Table 4).

Table 4. Sex distribution of Pistacia species in the study area.

Characters	Number	% age	Ratio (Male/Female)
Male	111	30.83	44.58
Female	249	69.17	
Bi-Sexual	0	0	
Total	360	100	

Associated ground flora of the Zarghoon state sorest

Associated ground flora of the Zarghoon state forest examined and their IVI value were calculated and display in Table 5.A total of 16 species were recorded across all the stands in the current study. The density of the total ground flora was recorded 45.54 plants/m². The highest density observed was of *Tulipa spp* which was 10.22 plants/m² followed by *Artimisia maritima*, *Peganum hermala* and *Sophora mollis* that were 7.28, 5.78 and 4.61 plants/m² respectively. The least density was showed by *Ephedra nebrudensis* (0.22 plants/m²).

Based on the relative frequency values *Ferula opoda* and *Pervoskia spp* was found as dominant species having relative frequency 9.29 % (Table 5).

Table 5. Associated ground flora of the Zarghoon State Forest and their importance value Index.

Plant Name	Frequency	Relative frequency	Density	Relative density	IVI
Artimisia maritima	83.34	8.2	7.28	15.98	38.08
Peganum *hermala*	77.78	7.65	5.78	12.69	32.17
Sophora mollis	72.22	7.1	4.61	10.12	27.39
Tulipa spp	88.89	8.74	10.22	22.44	49.49
Ferula opoda	94.44	9.29	4.33	9.51	26.11
Ephedra procera	83.33	8.2	1.61	3.54	14.84
Ferula costoda	77.78	7.65	2.06	4.52	16.37
Pervoskia spp	94.44	9.29	2.00	4.4	17.06
Seriphedium spp	66.67	6.56	2.06	4.52	15.98
Ephedra nebrudensis	22.22	2.18	0.22	0.5	4.27
Nonia spp	55.56	5.46	0.76	1.67	9.36
Amagdulus spp	38.89	3.82	1.17	2.57	11.17
Limonium spp	22.22	2.18	0.72	1.58	8.93
Cymbopogon shoenainthus	55.56	5.46	1.28	2.8	11.92
Pennis etumorientale	44.44	4.4	0.83	1.82	9.2
Perotis latifolia	38.89	3.82	0.61	1.34	7.66

Diversity index of Zarghoon State Forest (Shannon-wiener diversity index, Species richness, evenness index and index of dominance)

Results revealed that the highest value of shannon-wiener index and species richness indicated more diversity. In present studies the Zarghoon state forest showed the highest Shannon-wiener diversity index which was (0.52), Species richness of the study area was 0.39. Evenness index of Zarghoon state forest was 1.74. The higher value of evenness index represented uniform distribution of species. Zarghoon state forest showed high value of index of dominance which was 0.66.

Table 6. Diversity index of Zarghoon state forest (Shannon-wiener diversity index, Species richness, evenness index and index of dominance).

Parameter	Index Values
Shannon-wiener diversity index	0.52
Species richness	0.39
Evenness Index	1.74
Index of dominance	0.66

Discussion

According to Brown and Curtis (1952) Importance value indexes of any plant species gives more information about the species than any other single attribute alone and reflects the realistic ecological importance of the species in a stand. Therefore, the relative values of Frequency, Density and Basal area were summed up to determine Importance value index (IVI). Our study is similar to Brown and Curtis, (1952) as the IVI explicitly reflects the dominance of wild Pistacia that is *Pistacia atlantica* and *Pistacia khinjuk* as a co dominant species among prevalent Pistacia species in the study areas. In study area (Zarghoon state forest) *Pistacia atlantica* was recorded as the dominant specie with an IVI values of 181.57 %.

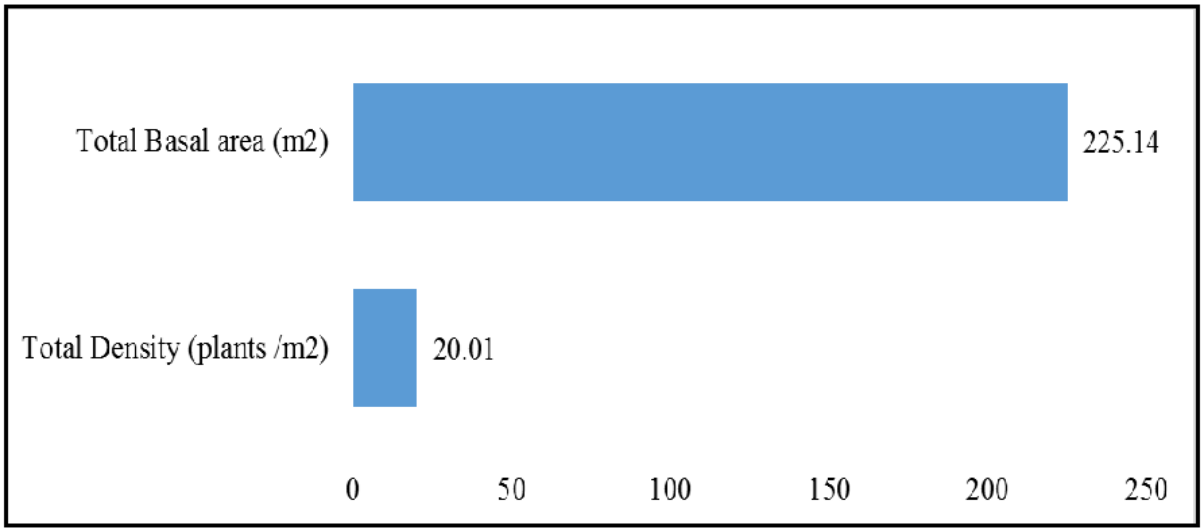

Fig. 2. Total Density (plants /m²) and Total Basal area (m²) covered by both species (*P. atlantica* and *P. khinjuk*) in study area.

The *Pistacia khinjuk* was reported as co dominant specie with an IVI value of 118.43 %. Since importance value index shows the relative ecological importance, conspicuousness or dominance of each species in a stand therefore, it is a good index for summarizing vegetation characteristics, ranking species for the purpose of management and conservation practices.

Fig. 3A. A bunch of seeds and leaves collected during study.

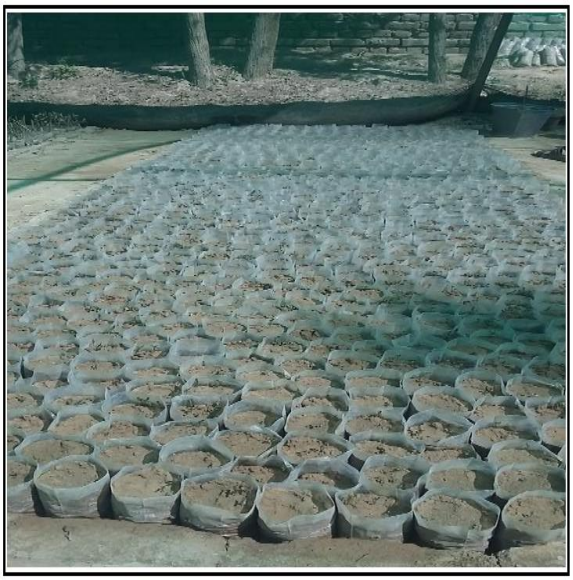

Fig. 3B. Polythene Bag filled and seeded with *Pistacia khinjuk*.

It reflects the degree of relative dominance and abundance of a given species in relation to other species in the area (Kent and Coker, 1992). In case of the current study the IVI values on the basis of physical condition such as healthy, unhealthy, over mature, disturbed and cut stumps as well as the dominance of the seedlings of Pistacia represented clear picture of both the Pistacia species. IVI values of the area *Pistacia khinjuk* showed that all the species was healthy with an IVI value of 91.24% but *Pistacia khinjuk* was less in number as compared to *Pistacia atlantica*. *Pistacia atlantica* present in Zarghoon state forest when examined on the basis of IVI value clearly showed different IVI values of healthy, unhealthy, over mature, disturbed and cut stumped.

Fig. 3C. Artificial Regeneration of *Pistacia khinjuk* in Nursery plantation.

The healthy trees were dominant with an IVI value of 89.95% and that of unhealthy was 23.24 %, over mature 43.18 %, disturbed 48.45 %. Regeneration status of a species is essential from conservation point of view. Natural regeneration of both the species is vital for preservation and maintenance of this natural resource. Seedlings found in both the study sites showed that the regeneration of *Pistacia atlantica* was high with an IVI value of 192.59% as compared to *Pistacia khinjuk* which was 107.41 %.

Fig. 3D. Natural regeneration of *Pistacia atlantica* inside study areas.

Vegetation covering an area has a definite structure

and composition developed as a result of long term interaction with biotic and abiotic factors, and any change in the status of these factors disturbs the floristic composition of the forest (Mekonnen, 2006). Pausas and Austin, (2001) also suggested that over any large region the distribution of species richness is likely to be governed by two or more environmental factors (Elevation, rainfall and drought) and not by a single factor.

Fig. 3E. Natural regeneration of *Pistacia atlantica* inside study areas.

The Shannon diversity index, species richness, Evenness Index (equitability) and species dominance were computed to see the variation in Zarghoon state forest and the variation were found as 0.52, 0.39, 1.74 and 0.66 respectively. The higher value reflects that one specie is dominating more than other species.

Conclusion

It can be concluded that all the vegetation types under study registered comparatively poor floristic composition related to the total area of the study. This valuable resource needs to be conserved, protected and managed sustainably.

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