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PHYTOSOCIOLOGY, STRUCTURE AND PHYSIOCHEMICAL ANALYSIS OF SOIL IN *QUERCUS BALOOT* GRIFF, FOREST DISTRICT CHITRAL, PAKISTAN

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Abstract

Phytosociology, structure and soil characteristics were investigated in *Quercus* forests of Chitral Hidukush range of Pakistan. Eight stands were sampled at four different valleys i.e., Gol National Park (GNP), Bumburate Kalash (BK), Rambor Kalash (RV), and Birir Kalash (BK) ranging from 1770 −2370m.asl. *Quercus baloot* formed pure vegetation in 5 stands, while at 3 locations *Quercus dilatata* Lindle. ex Royle, was co-dominant in high altitude with high soil moisture and maximum water holding capacity. The soil pH of oak forest was acidic ranging from 5.5±0.20 to 6.6±0.26. Maximum water holding capacity and soil moisture ranged between 47±2.4% to 62±4.6% and 28±0.57% to 57±0.49% respectively and both were significantly ($p<0.001$ and $p<0.01$) correlated with altitude. Among the species *Quercus baloot* was dominant on all sites. The total density and basal area ranged between 166.42 ha^{-1} to 351.55 and 12.11 to 30.13 m^2ha^{-1} respectively. The low density ha^{-1} and basal area m^2ha^{-1} was obseverd from stands on lower elevation. Circular plot were used to assess the vegetation on the forest floor. A total 60 species including *Quercus* seedlings were recorded from forest floor. It was also obseverd that in the study area large sized trees of *Quercus baloot* and *Quercus dilatata* were at the risk of elimination due to anthropogenic factors.

Introduction

Chitral is an integral part of Hidukush range of Pakistan and embodies a variety of forest types that are distributed at various altitude, geological formations and soil types (Champion *et al*., 1965). The dry temperate area support an extensive oak forest distributed between 1200m to 2000m elevation in the zone above agricultural fields and below dry temperate deodar forests. These forests are found either pure from lower areas or mixed with coniferous forests at high altitude. According to Alamgir (2004) the estimated area of oak forests covers approximately 16,700 hectares or 41,500 acres. Oak is the most preferred tree species in the study area, it is mainly used for fodder, fuel, small timber, fencing around cultivated fields, agricultural implements, charcoal wood, tannin extraction, and used as a roof thatching materials.

A lot of quantitative phytosociological work has been published from various parts of Pakistan. However, little attention is paid to include single tree species (Ahmed *et al*., 2010). Phytosociological characters differ among aspects and position, even in the same vegetation type. The literature on quantitative vegetation analysis on broad leaved single tree species in Pakistan is fragmentary. Beside some work of Cheema & Qadir (1973) on *Acacia Senegal*, Beg & Khan (1984) on dry oak forests of Swat, Ahmed *et al*., (2006) on the vegetation structure of Himalaya, Ahmed *et al*., (2010) on *Olea ferruginea* forest of District Dir Lower, and recently Khan *et al*., (2010a) on *Monotheca buxifolia* of subtropical dry temperate region of Pakistan have been reported. No studies were carried out in Pakistan on *Quercus baloot*. The present study is therefore been undertaken to assess the phytosociological analysis and to find out structural attributes in relation to the physiochemical properties of soil in *Quercus baloot* forests stand in four valley of Chitral viz, Gol National Park, Bumburate, Rambor and Birir. The analysis included: (1) Physiochemical properties of soil samples because soil influences the composition of the forest stand and ground cover, rate of tree growth and other silvicultural important factors; (2) Phytosociological attributes namely frequency, density, basal area and importance value index (3) Structure (density ha^{-1} and basal area m^2ha^{-1}) and (4). Understorey species distributed in different stands.

The stands were selected in order to represent the whole layout of major Oak forest variations of the area. This study will be helpful in understanding the floristic composition, present and future status of Oak forest in the study area.

Study area and climate: Chitral is located in the extreme north-east of N.W.F.P., parallel to the pan handle shaped Wakhan corridor of Afghanistan. It is the largest district of the province with 14850 sq. km area, covering 20% of the provincial landscape. It lies between 35º15’06” to 36º 55’ 32” North and 71º 11’32” to 73º 51’ 34” East with a population of 3, 20,000 (Anon., 1998); (Haidar & Qaiser, 2009).

The area is bordered on the east by district Ghizer of Northern areas of Pakistan, on the south by district Dir and Swat. Nuristan province of Afghanistan lies across the border to the west and on the north-west by the Wakhan corridor, which separate Pakistan and Tajikistan (Fig. 1). Three distinct mountain ranges surround the Chitral region, to the north-west bordering Afghanistan in the Hindukush range, to the east-south is the Hindu Raj range and in between there is Shandur-Karakoram range.

High mountain topography is the characteristic feature of the area which is the only cause of its isolated nature. Entry into the area is limited by only Lowari and Shandur pass which are at an altitude of 3300m and 3800m respectively. But these passes are closed due to heavy snowfall for almost six months of the year and are totally inaccessible during winter (Ali & Qaiser, 2005; Haidar & Qaiser, 2009).

Elevation of the area varies from about 1070m in the extreme south in Arandu to 7,690m at the summit of Trich Mir in the Hindukush. High Mountain and rough topography of the area has given rise to lot of narrow side valleys. The present study was carried out in the four side valleys of the district viz, Gol National Park, Bumburate, Rambor, and Birir. Eight forest stand two in each valley were investigated.

Gol National Park (CGNP): This is one of the important national park of Pakistan and is located on 35º 56 N, and 71º 40 E beside the river Kunar at a distance of three kilometer. It has gorge running from some 18km before bordering into Afghanistan. The elevation of the site ranges between 1450 to 5000m.a.s.l. It has a total area of 77.5 square kilometer. This park is surrounded by high peaks. Infact it is a narrow valley, with relatively steep sharp defined slopes.

The national park is out of the reach of monsoon and receives 462mm mean annual precipitation mainly in winter and spring seasons. During the month of September it rains more on the spectacular peaks surrounding the park. However in the month of November rainfall is rises in the valleys and on the lower peaks, where as the temperature in the Park ranges between -12.2 to 43.3C (Zarif, 2004).

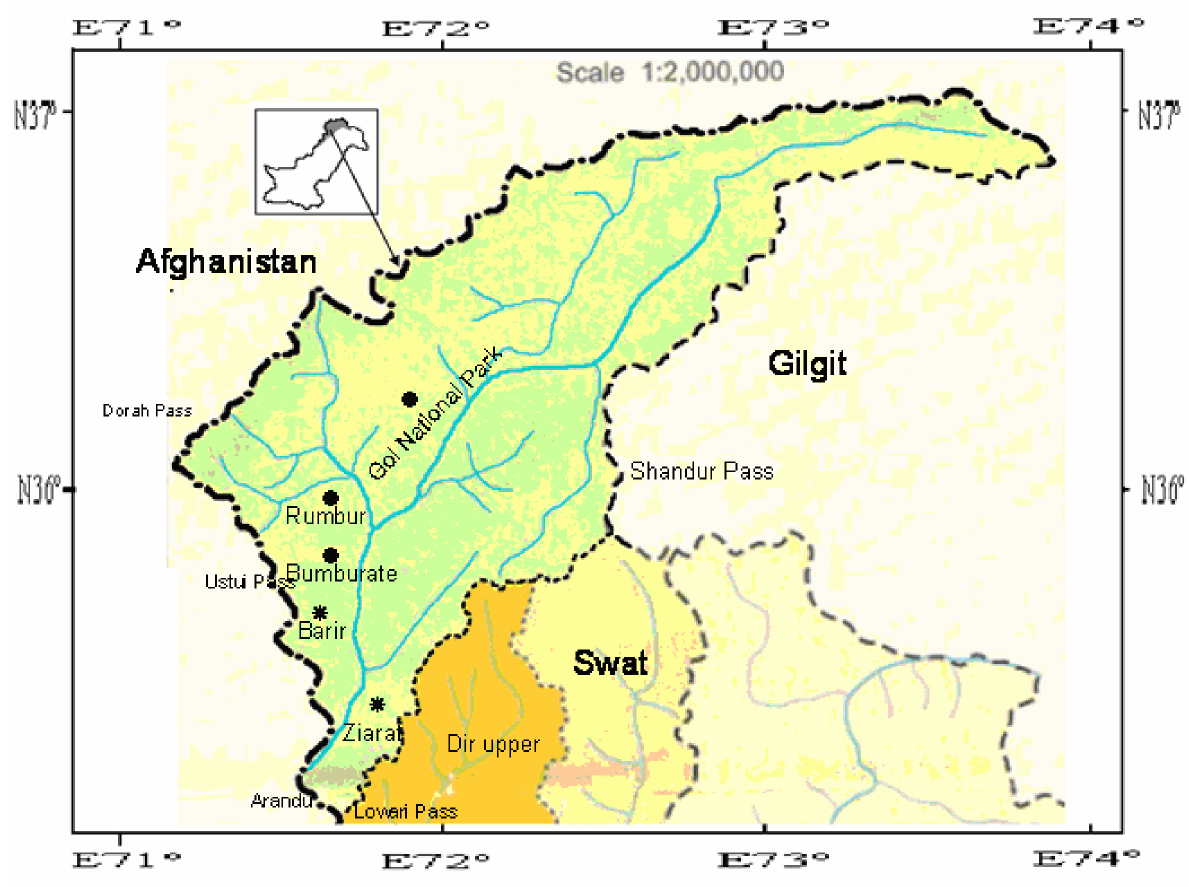

Fig. 1. Topographic maps of the studied areas of Chitral

Bumburate Kalash: The study site is located between 35º 41 N and 71º 38 E and is the largest valley of Kalash. It is 40km away from chitral and wider than other two valleys i.e. Rambur and Birir of Chitral. The area has rugged topography and steep slopes. Two stands were sampled at different aspects and altitudes.

Rambur Kalash: Rambur is located between 35 º 46 N, 71º 40 E and lies in the north of Bumburate. It is about 32km from chitral and about 8km from the adjacent valley. The two valleys join at 35º 44 N and 71º 77 E (1640m) joining Kunar at the village of Ayun at 1400m.a.s.l. both the valleys are connecting to Nuristan province of Afghanistan (Fig 1).

Birir Kalash: Birir valley lies in the southern-most tip of Chitral at a distance of 34km and is easily accessible viz Ayun. This is narrow valley as compared to other two valleys. The valley opens toward Gahirat (35º 40 N 71º 45 E) at 1360m elevation. Two stands compart 1 and comport 2 were investigated.

According to Ajaz, (2004) the climate of the above sites is typical of high elevation region without large bodies of water to regulate the temperature. The summers are mild and agreeable with average maximum temperature between 23ºC to 27ºC and minimum 1ºC to 2ºC. in winter the valleys are in grip of cold northerly wind and hazard. The extreme minimum temperature recorded in the valleys is -4.8 to -15ºC, in the month of January and February. Snowfall is quite frequent from December to March. These valleys receive an average rainfall between 700mm to 800mm.

Materials and Methods

The field investigation was carried out in August 2009. Stands were selected where Quercus was dominant tree species. A total of 8 forest stands in four major area of Chitral on different aspects and altitudes were investigated (Table 1). Forests where coniferous trees species were mixed in Oak forest were avoided for sampling.

PCQ method of Cottam & Curtis (1956) was used for tree species while a 1.5m circular plot was used for ground flora including saplings and seedlings of *Quercus* species.

Fifteen PCQ point were taken at each stand. In each PCQ the trees, saplings and seedlings were enumerated and measured for diameter at breast height (dbh) (1.3cm from ground level).

Individuals were defined as Tree (Dbh ≥10cm, Sapling ≥ 6 and established Seedlings <6cm). To determine the maturity of the forest trees individuals were classified in a series of dbh size classes at the intervals of 10cm dbh in different stands. Data was saved in Excel spread sheet and graphs were designed.

The vegetation was quantitatively analysed for frequency, density, basal area following Curtis & McIntosh (1950) and Hussain (1989). The relative values of Frequency, Density and Basal area were summed to determine Importance Value Index (IVI) in a particular stand (Curtis 1959). Every species was ranked according to their importance values and the species with the highest importance value in the stand was considered as the dominant species.

For soil analysis, the samples were collected from each stand. The litter from the surface was removed and soil was dug out from 0-30cm randomly from each stand. About 500g of each sample was placed in polyethylene bags and sample was mixed well individually before use. Then samples were air dried at 20 to 25ºC, and passed through a 2 mm sieve and analysed for different physiochemical characteristics. Soil pH was measured with the help of dynamic digital pH meter. Similarly soil moisture (%) of every stand was calculated using difference of wet and dry weights divided by the gross soil weight:

$$\text{Soil moisture (\%)} = \frac{\text{Wet weight of dry soil (g)}}{\text{Wet weight (g)}} \times 100$$

Maximum water holding capacity was determined following Keen (1931) using the following formula;

$$\text{MWHC} = \times 100 \quad \frac{\text{Loss of weight of soil sample}}{\text{Weight of oven dried soil}} \times 100$$

Total nitrogen was determined according to Bremner (1965), using the Kjeldhal method and total Phosphorus was estimated by the Bingham (1949) method. Total potassium (K), Magnesium (Mg) and Sodium (Na) was determined by using the flame Photometer, following the method outlined by Pratt (1965), and Peech & English (1944).

Table 1. Locations and Ecological characteristics of sampling sites of forest area.

Location	Latitude	Longitude	Altitude	Slope	Canopy	Aspect
Gol National Park	35.40	71.46	1770	15	Open	E
Gol National Park	35.38	71.46	1920	17	Open	E
Bumburate Site 1	35.41	71.41	2073	24	Open	E
Bumburate Site 2	35.41	71.38	2283	34	Open	W
Rambor Site 1	35.41	71.40	2370	19	Open	N
Rambor Site 2	35.46	71.41	2206	26	Open	NE
Birir Site 1	35.40	71.45	2022	10	Open	N
Birir Site 2	35.38	71.45	2125	22	Open	S

Table 2. Phytosociological summary of the stands.

Location	Spcies	Frequency %	Density %	Basal area %	IVI %	Density/ha^{-1}	Basal area m2/ha^{-1}
Gol National Park	*Quercus baloot*	100	100	100	100	256.26	13.21
Gol National Park	*Quercus baloot*	100	100	100	100	204	12.51
Bumburate Site 1	*Quercus baloot*	100	100	100	100	311.41	24.89
Bumburate Site 2	*Quercus baloot*	61	73.34	78.46	70.93	257.83	23.67
	Quercus dilatata	39	26.66	21.54	29.07	93.72	6.49
Rambor Site 1	*Quercus baloot*	100	100	100	100	206	19.11
Rambor Site 2	*Quercus baloot*	57.69	70	75.36	67.68	212.94	17.98
	Quercus dilatata	42.31	30	24.64	32.32	91.26	5.87
Birir Site 1	*Quercus baloot*	100	100	100	100	275.78	24.88
Birir Site 2	*Qurecus baloot*	72	75	82.27	76.33	124.86	11.02
	Quercus dilatata	28	25	17.73	23.77	4 1.62	2.37

Results and Discussion

Phytosociological study: Details of the sampling sites were computed into Table 1 while the quantitative information of oak forest are shown in Table 2. It is obvious that *Quercus baloot* is distributed from 1770m to 2770m elevation predominantly on East and North Slope while rarely occur on South slope. Angle of Slopes ranged between 10 to 34 degree. Due to anthropogenic disturbances, canopy was open. On the basis of Frequency, Density, Basal area and Importance Value *Quercus baloot* was found to be the dominant species in all stands (Table 2). Using same criteria *Quercus dilatata* was co-dominant species at three locations. At five stands the dominant species was obtained with 100% Importance Values. In these locations *Quercus baloot* is distributed in pure form, while in rest three stands it is associated with *Quercus dilatata* with the range of 67% to 70% of Importance Value respectively. In PCQ analysis the *Quercus dilatata* exhibited a very low Relative frequency, Density and Basal area but comparative high value of Density and Basal area was obtained from Rambor site-2 due to relatively few large sized trees.

Quercus dilatata was reported from high altitudes in Bumburate site-2, Rambor site-2 and Birir site-2 on Southern Aspects. According to Champion *et al*., (1965) *Quercus dilatata* Lindle.ex Royle found in higher and relatively narrow altitudinal belts between 1828m 2286m on southern aspects and like colder belt. Moreover he viewed it as one of the natural climax subtypes of moist temperate forest that has almost been eliminated by anthropogenic agencies.

Ahmed *et al*., (2006) reported this species as a co-dominant with *Quercus incana* in Mankial town a few miles from Bahrain (Swat) at about 2000 to 2100 meter elevation.

The study describes *Quercus baloot* as a pure stand; however it is also associated with *Pinus gerardiana* and *Cedrus deodara* under lower pine forests at Gol National Park Chitral and Drosh Champion *et al*., (1965), Beg (1974), Khan (1978), Rehman (2004) and Zarif (2004). While Khan *et al*., (2010) reported this species as a co-dominant (35% IVI) with *Monotheca buxifolia* from District Dir Lower at 1380m elevation. These forests are highly disturbed due to the removal of other broad leaved trees like *Olea ferruginea* and *Monotheca buxifolia* for fuel and fodder. Most of the forest occurs in the form of scrub probably due to the elimination of the coniferous trees and because of chopping of large trees for building purposes, lopping for fuel and burning for charcoal. Due to deforestation and overgrazing at many places soil has been washed out and rock were exposed (Alamgir, 2004). It is suggested that with proper care and management these Quercus forest could be saved.

Understorey species including herbs, shrubs and grasses associated with *Quercus baloot* are listed in Table 4. A total of 51 species were recorded from all stands. However at many locations ground flora was poor and consisted only a few species. *Quercus baloot* was distributed in all stands with 6.5% to 100% frequency while co-dominant *Quercus dilatata* was recorded from three stands with frequency range from 12.4 to 31.2. Among the dominant species *Impatient brachycentra, Rumex hastatu, Tulipa stellata*, and *Impatiens balsamina* were recorded from six stands with frequency range from 3.4% to 52% while *Oxalis corniculata*, *Ormopterum tubersum*, *Silene vulgaris, Artemisia brevifolia, Urtica dioica* and *Plantago lanceolata* were found in five stands with 3.7 to 56% relative frequency. Two gymnospermic species *Cedrus deodara* and *Pinus gerardiana* were also recorded on the forest floor with 6.4% to 45% frequency. Maximum numbers of 21 species were recorded from Bumburate, while 12 to 17 species was obtained from Rambor and Birir. Many species were common in the above three valleys except Gol National Park because of similarity in soil properties. Maximum Water Holding capacity and Soil Moisture were also recorded from these areas. Gol National Park ground flora was very poor and consisted of a few species may be due to soil erosion, difference in disturbances, grazing, topography, soil moisture or chemical nature of the soil. Out of 51 species 19 species were found in only one or two stands with low Relative Frequency. In these species *Lonicera quinquelocularis, Rosa webbiana, Daphne mucronata, Artemisia maritima, Astragulus anisacanthus, Viola rupestris, Artemisia parviflora, Convolvulus arvensis, Verbascum thapsus, Impatients bicolor* and *Pedicularis chitralensis* were locally abundant and found 3.5 to 45% in circular plots. *Impatiens brachycentra, Ephedra gerardiana, Plectranthus rugosus, Chenopodium, Parrotiopsis jacquemontiana, Carum balbocastanum* and *olea cuspidata* were recorded from four stands with relatively high Frequency (Table 4).

Density and basal area: Density of Quercus baloot trees varied between 166 to 351 individuals ha^{-1} Table 2, however densities were not significantly different at all sites except site-4 which had the highest density (P=0.001). Basal area varied between 12.51 to 30.13 m^2ha^{-1}. The sites at lower altitudes (Site 1, 2, 5, and 8) were similar in having smaller basal area m^2ha^{-1}. The largest density and basal area was recorded at highest altitudes (Bumburate site-2 and Rambor site-2) respectively.

Density/Basal area were significantly correlated (R=0.858 P>0.001) Fig (3). It is recorded that low Basal area is associated with higher density stands, due to a large number of young trees, while small density stands contained large sized trees in the study area. Ahmed *et al.,* (1990a) found highly significant relation between these variable, in Juniper forests of Ziarat, Balochistan, while Ahmed (1984) and Ahmed *et al.,* (1990b) found no relation in *Agathis australis* forests in New Zealand and Juniper forests of Rodhmallazi, Baluchistan, respectively.

A non significant trend was also observed from elevation/density (r=0.152) regression analysis. This trend showed that density decreases with higher elevation. This species has restricted elevation range for its distribution and closed to its upper limit, its number gradually decreases. Elevation indicated positive weak significant relation (r=0.541) with basal area.

Density and value of basal area of some other forest are also recorded for comparison. Ahmed *et al*., (2006) reported 602 individuals ha^{-1} with Basal area of 19 m^2ha^{-1} of *Quercus incana Roxb,* occupied about 95% of the total stand density. *Quercus dilatata* Lindle.ex Royle was co-dominant species with low density from Mankial Town a few miles from (Swat) Bahrain. Ahmed *et al.,* (2010) also reported that *Quercus baloot* as a co-dominant species on the basis of IVI with *Olea ferruginea* at two locations in Medan and Kat Kala from 1415m to 1580m. The density of *Olea* was recorded 296 ha^{-1} with 18.8 basal area m^2ha^{-1}.while *Quercus* have 244 trees ha^{-1} with 10.4 basal area m^2ha^{-1} respectively. Similarly Khan *et al.,* (2010a) reported this species with another broad leaved species *Monotheca buxifolia* with 42 individual's ha^{-1} on the lower elevation from sub-tropical dry temperate area of District Dir Lower. Total density ranged between 110 to 304 trees/ha^{-1} and about 90% of individuals were estimated in small size classes.

Some other density and basal area values are available from other broad leaved forests of *Olea ferruginea* .It was recorded at Tukht-e-Sulaiman range from 1950 to 2130 meter with a co-dominant species *Pistacia Khinjuk* under dry temperate broad leaved forest. Density of this species was 200 ha^{-1} with 28 basal area m^2 ha^{-1}. In subtropical and moist temperate ecotonal zone, density of *Olea* was recorded 378 ha^{-1} with 16 basal area

m^2 ha^{-1}, in *Quercus incana* community under Broad leaved forest. Ahmed *et al.,* (2006) also reported this species on lower elevations of Murree Road, Malakand and Marghzar area occupying density ranged from 92 to 620 ha^{-1} with 10 to 26 m^2 ha^{-1} basal areas. In these areas *Olea* was associated with *Acacia modesta* and *Pinus roxburghii*. The density of *olea ferruginea* (≥10cm dbh) ranged from 56 to 1089 trees/ha^{-1} with a range of 6.62 to 37.90 $m^2 ha^{-1}$ basal area was reported by Ahmed *et al.,* (2010) from Hindukush subtropical dry temperate forests. On the basis of these investigations, it is stated that Density and Basal area values recorded during present study is in agreements with previous studies.

Size structure: The dbh frequency distribution of *Quercus baloot* and *Quercus dilatata* population were quite different in different altitude in all locations in the present study (Fig. 2). In Both stands of Gol National Park small trees Dbh ≥ 10cm accounted for over 70% of *Quercus baloot* trees, where big size trees were rare and no trees were found over 50cm in dbh. In Rambor (1280m) the smallest two classes 10 to 20 and 20 to 30cm dbh accounted for 212 trees ha^{-1} and 226 tree/ha^{-1} respectively. The amount of individuals decrease gradually with increase in dbh. Bumburate and Birir show a reverse J-shaped frequency distribution of dbh. According to Khamyoung *et al.,* (2004) Distribution curves that drop exponentially with increasing dbh (reverse J-shaped) are characteristics for species with continuous regeneration. The smallest and biggest dbh classes (dbh 10cm and 64 cm) had only small fraction of individuals (46 tree/ha-1 and 25trees/ha^{-1}) respectively. Whereas 10 to 20 and 20 to 30 cm classes accounted for 50% of individuals in the study area in all stands. On the basis of the present investigation it is suggested that these forests can be maintained by increasing number of seedlings and reducing disturbance (over grazing and cutting). Gaps were obseverd at Bumburate site-2 and Rambor site-2 in large size classes may be due to past cutting history of these forests in particular size classes for fuel wood and other uses by the local inhabitants and no regeneration in past. This pattern of tree structure indicates an inadequate recruitment (Knight, 1975) producing unstable population.Similar type of investigation is also reported by Wahab *et al*., (2008) and Khan *et al*., (2010b). Therefore it may be concluded that due to anthropogenic disturbances these forests are in unstable and in degrading stage therefore an immediate steps should be taken to save these ecologically and economically important forests and species.

Soil analysis: Soil factors include all the physical, chemical and biological properties of the soil. The nature of soil profile, soil pH and nutrient cycle between soil and trees are some of the important dimensions in determing the site quality (Sharma & Kumar, 1991). The pH of the soil ranged from 5.5±0.20 to 6.6±0.26 clearly indicated that the soil is acidic in nature and there is not much variation in the pH values of different soil sample in all stands at different locations (Table 3). The soil analysed for maximum water holding capacity (%) and moisture (%). Significant correlation (r=0.72 p>0.01 and r=0.27 p>0.05) was obtained between altitude, soil moisture and maximum water holding capacity (Fig. 3). The maximum water holding capacity and soil moisture ranged from 47±2.4% to 62±4.6% and 28±0.57% to 57±0.49% respectively. Maximum water holding capacity (MWHC) and Soil moisture (SM) showed similar results both increase with increase in altitude (Table 3). The percentage Nitrogen (N) varied from 0.07±0.04 to 0.52±0.02%. Maximum potassium contents were observed 2.3±0.18%, in Rambor site-1, while minimum 0.97±0.05% in Bumburate site-2. The availability of Na% and Mg% ranged from 0.4±0.09% to 1.5±0.07% and 0.38±0.15% to 0.65±0.07% respectively.

Table 3. Characteristics of soil in *Quercus* forests.

Location	PH	MWHC %	Soil moisture %	N%	K%	Na %	Mg %
Gol National Park	5.7 ± 0.20	49 ± 3.9	28 ± 0.57	0.45 ± 0.3	2.0 ± 0.31	1.5 ± 0.07	0.38 ± 0.15
Gol National Park	5.5 ± 0.27	51 ± 2.0	32 ± 040	0.52 ± 0.02	1.6 ± 0.18	0.96 ± 0.2	0.45 ± 0.06
Bumburate Site 1	6.0 ± 0.21	56 ± 3.1	47 ± 036	0.16 ± 0.07	1.3 ± 0.22	0.42 ± 0.07	0.42 ± 0.05
Bumburate Site 2	6.5 ± 0.09	62 ± 4.6	55 ± 049	0.07 ± 0.04	0.97 ± 0.05	0.4 ± 0.09	0.51 ± 0.05
Rambor Site 1	6.4 ± 0.07	47 ± 2.4	42 ± 0.39	0.17 ± 0.10	2.3 ± 0.18	0.54 ± 0.02	0.42 ± 0.04
Rambor Site 2	6.5 ± 0.24	53 ± 3.0	57 ± 0.49	0.28 ± 0.06	2.2 ± 0.14	0.58 ± 0.06	0.65 ± 0.07
Birir Site 1	6.5 ± 0.11	51 ± 2.8	40 ± 0.31	0.13 ± 0.09	2.1 ± 0.27	0.38 ± 0.23	0.58 ± 0.06
Birir Site 2	6.6 ± 0.26	59 ± 2.0	55 ± 0.46	0.10 ± 0.02	1.5 ± 0.18	0.63 ± 0.07	0.38 ± 0.23

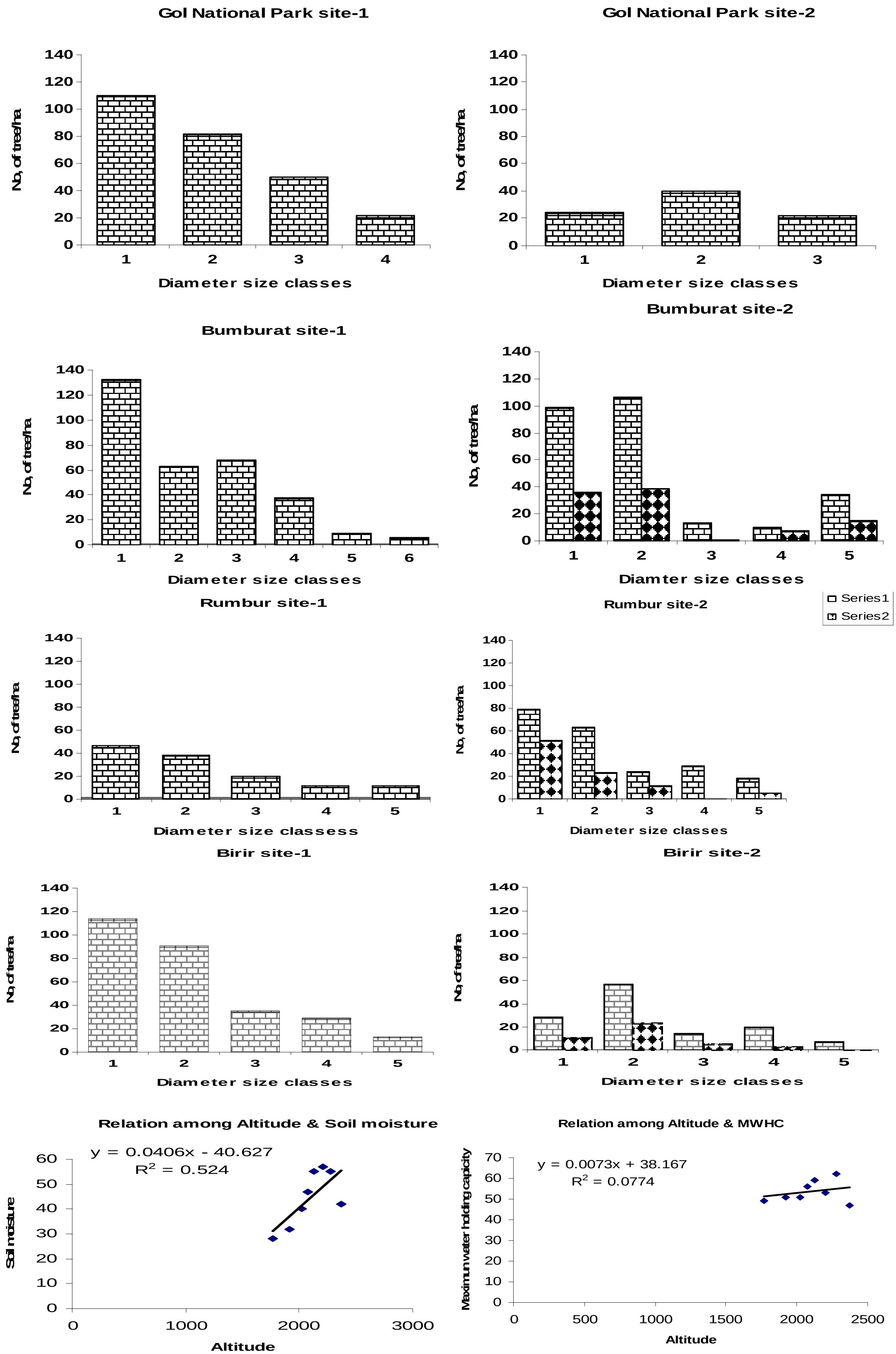

Fig 2. Structure of the *Quercus* forests (individual stands)

Table 4. Summary of the Distribution of Circular plot species in sampling areas. Species are listed in decreasing order in number of stands in which a species was present.

Name of the species	PRST	FR (range)
1. *Quercus baloot* Griff	8	6.9−100
2. *Impatients brachycentra* Kar. & Kir	6	10.9−52
3. *Rumex hastatus* D. Don	6	3.4−42
4. *Tulipa stellata* Hk. F.	6	4.7−39.4
5. *Impatiens balssamina* L.	6	6.3−43.4
6. *Oxalis corniculata* L.	5	3.7−44
7. *Ormopterum tuberosum* E. Nasir	5	4.6−56.3
8. *Cedrus deodara* G. Don	5	6.4−36.5
9. *Silene vulgaris* (Moench) Garcke	5	7.8−40.2
10. *Artemisia brevifolia* Wall. ex DC.	5	9.4−28.6
11. *Urtica dioica* L.	5	9.1−22.2
12. *Plantago lanceolata* L.	5	7.2−32.6
13. *Berberis lycium* Royle	4	3.6−19.4
14. *Ephedera gerardiana* Wall. ex Stapf, l.c.	4	9.8−42.3
15. *Impatiens edgeworthii* Hk. F	4	12.6−52
16. *Plectranthus rugosus* Wall. ex Bth.	4	3.9−33.5
17. *Chenopodium foliolosum* (Moench) Aschers	4	23−49.3
18. *Parrotiopsis jacquemontiana* (Dene.) Rehder	4	11.5−36.8
19. *Carum balbocastanum* Clarke	4	6.3−10.6
20. *Olea cuspidata* Wall. ex DC.	4	3.8−16.5
21. *Capparis spinosa* L.	4	12.6−29.4
22. *Sambucus wightiana* Wall. ex Wight	3	3.1−21.6
23. *Ajuga parviflora* Bth. L. c.	3	2.8−20.6
24. *Rumex acetosa* L.	3	9.1−16.5
25. *Fragaria vesca* Lindl. ex Hk. f.	3	6.9−9.7
26. *Indigofera heterantha* Wall. ex Brand	3	3.6−29.3
27. *Micromeria biflora* (Ham.) Bth.	3	4.6−26.2
28. *Ranunculus muricatus* L.	3	4.5−35.4
29. *Viola canescens* Wall. ex Robx	3	7.5−16.3
30. *Cousinia thomsonii* C. B. Clarke	3	11.2−27.4
31. *Malva neglecta* Wallr.	3	6.6−21.4
32. *Quercus dilatata* Lindle. ex Royle,	3	12.4−31.2
33. *Lonicera quinquelocularis* Hardw.	2	5.5−8.5
34. *Rosa webbiana* L.	2	3.6−10.2
35. *Daphne mucronata* Royle	2	7.5−16.4
36. *Artemisia maritima* L.	2	6.6−11.5
37. *Astragulus anisacanthus* Boiss.	2	4.5−25.5
38. *Viola rupestris* Schm.	2	7.4−16.2
39. *Artemisia parviflora* Roxb.	2	3.9−33.3
40. *Pinus gerardiana* Wall. ex Lamb.	2	6.9−45
41. *Convolvulus arvensis* L.	2	7.3−17.3
42. *Verbascum thapsus* L.	2	12.6−27.4
43. *Pedicularis chitralensis* Penn.	2	6.8−15.3
44. *Delphinium uncinatum* H. & T.	2	5.6−9.6
45. *Consolida ambigua* (L.) Ball Heywood	2	9.7−16.6
46. *Sophora mollis* (Royle) Baker	1	10.5
47. *Impatiens bicolor* Ro	1	17.2
48. *Euphorbia aucheri* Boi.	1	6.5
49. *Periploca aphylla* Dcen.	1	3.2
50. *Clematis orientalis* L.	1	8.5
51. *Delphinium denudatum* Wall. ex H. & T.	1	13.4

Note: PRST= Presence in number of stands, RF= Relative frequency (range) in stands. Species <10dbh cm are also given in this table.

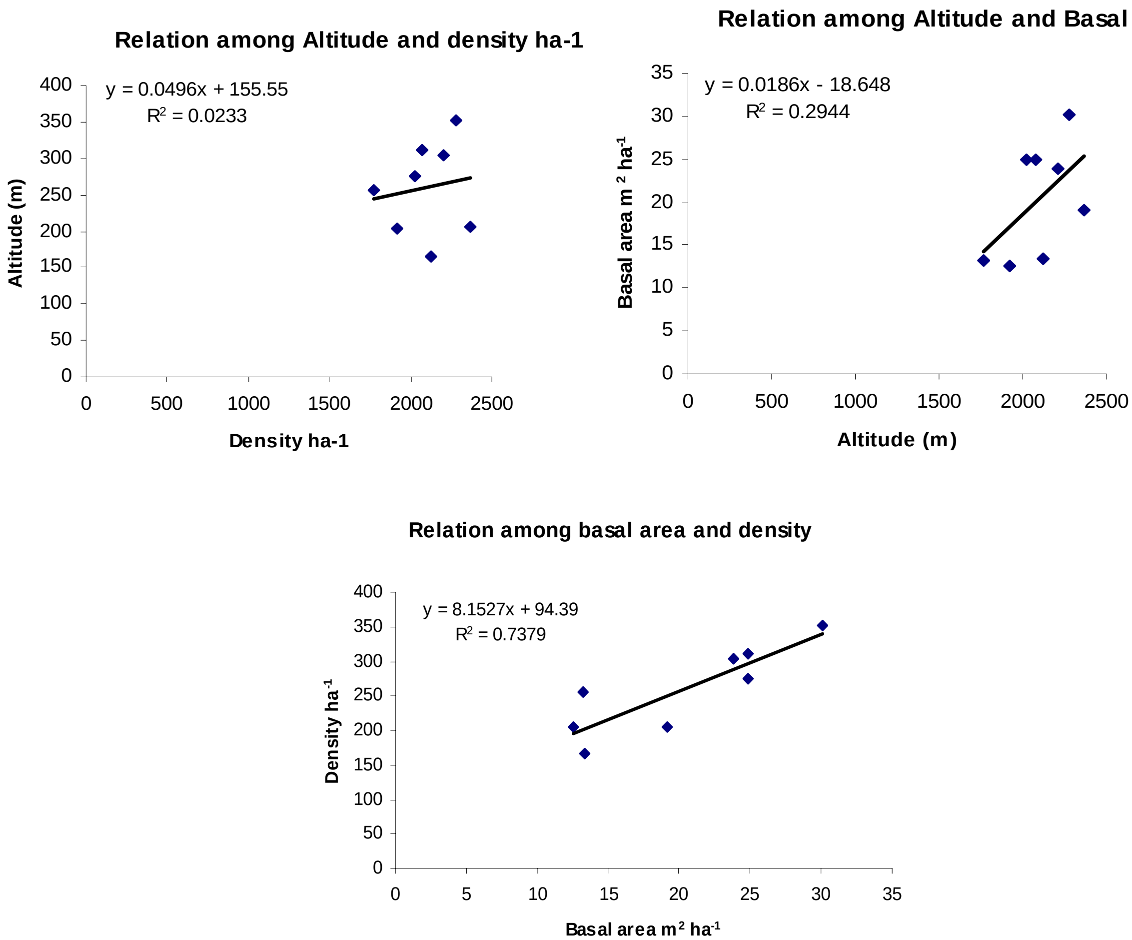

Fig.3. Regression between some variables.

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References

Ahmed, M. 1984. Ecological and dendrochronological studies on *Agathis australis* Salisb Kauri. Ph.D thesis, Auckland University, New Zealand.

Ahmed, M., E.E. Naqvi and E.L.M. Wang. 1990. Present Status of Juniper in Rodhmallazi forest of Baluchistan. Pakistan. *Pak. J. Forestry,* 227-236.

Ahmed, M., N. Khan, M. Wahab, S. Hamza, M.F. Siddiqui, K. Nazim and M.U. Khan. 2010. Description and structure of *Olea ferruginea* (Royle) forest of Dir Lower District of Pakistan. *Pak. J. Bot.,* 41(6): 2683-2683.

Ahmed, M., S.S. Shaukat and A.H. Buzdar. 1990. Population structure dynamics of *Juniperus excelsa* in Baluchistan, Pakistan. *J. Veg. Sci*., 1: 271-276.

Ahmed, M., T. Hussain, A.H. Sheikh, S.S. Hussain and M.F. Siddiqui. 2006. Phytosociology and structure of Himalayan forests from different climatic zones of Pakistan. *Pak. J. Bot*., 38(2): 361-383.

Ajaz, A 2004. Non-Timber products: A substitute for livelihood of the marginal community in Kalash valley, Northern Pakistan. *Ethnobotanical Leaflets*, 11: 97-105. 2007.

Alamgir, K.G. 2004. A study on the condition, use, management and trends of major forest types in Chitral District.

Haider, A. and M. Qaiser. 2005. Sustainable *use of plant wealth of Chitral and preparation of Red Data List* (Unpublished report submitted to HEC-Pakistan) pp: 1-70.

Haider, A. and M. Qaiser. 2009. The Enthnobotany of Chitral valley, Pakistan with particular references to medicinal Plants. *Pak. J. Bot*., 41(4): 2009-2041.

Anonymous .1998. District Census Report of Chitral. PCO, Govt. of Pakistan.

Beg, A.R. 1974. Vegetation on the scree slope of Chitral Gol. *Pak. J. For.,* 24(2): 393-402.

Beg, A.R. and M.H. Khan. 1984. Some more plant communities and the future of dry oak forest zone in Swat valley. *Pak. J. Forest*., 34: 25-35.

Bingham, F.T .1949. Soil Tests for Phosphate. California: Agriculture 3:11-14.

Bremner, M.M .1965. Total Nitrogen. In: *Method of soil Analysis*, (Ed.): C.A. Black. Part II. pp. 1149-1178. Madison: Amar Soc of Agr Inc Pub.

Champion, G.H., S.K. Seth and G.M. Khattak. 1965. Forest types of Pakistan. Pakistan Forest Institute, Peshawar. pp. 238.

Cheema, M.S.Z.A and S.A. Qadir. 1973. Autecology of *Acacia Senegal* (L.) Willd. *Vegetatio*, 27(1): 131-162.

Cottam, G. and J.T. Curtis. 1956. The use of distance measures in Phytosociological sampling. *Ecology,* 37(3): 451-460.

Curtis, J.T. and McIntosh R.P. 1950. The interrelation of certain analytic and synthetic Phytosociological characters. *Ecology*, 31: 434-455.

Curtis, J.T. 1959. The vegetation of Wisconsin. Madison: University of Wisconsin Press, 657 pp.

Hussain, F. 1989. Field and laboratory manual of Plant Ecology. National Academy of Higher Education, University grant commission, H-9 Islamabad.

Keen, 1931. The physical properties of soil. New York: Longman Green and Company pp 380.

Khan, M.H. 1978. Phytosociological studies in Chitral Gol. *Pak. J. For*., 28(2): 99-110.

Khan, N., M. Ahmed, M. Wahab and M. Ajaib. 2010a. Studies along an altitudinal gradient in Monotheca buxifolia forest District Dir Lower Pakistan (Accepted *Pak. J. Bot*.).

Khan, N., M. Ahmed, M. Wahab and M. Ajaib. 2010b. Size class structure and regeneration potential of *Monotheca buxifolia* and associated tree species District Dir Lower Pakistan (Accepted *Pak. J. Bot*.).

Khamyoung, S., A.M. Lykke, D. Seramethakun and A.S. Barfod. 2004. Species composition and vegetation structure of an upper Montane forestat summnit of Mt. Doi Inthanon. *Thailand Nordic Journal of Botany* , 23: 83-97.

Knight, D.H. 1975. A Phytosociological analysis of species rich tropical forests on Barro Island, Panama. *Eal. Monigr*, 45: 259-284.

Peach and English .1944. Rapid micro-chemical soil test. *Soil Science*., 57:167-195.

Pratt, P.F.F. 1965. Potassium. In: *Method of soil Analysis*. (Ed.): C.A. Black. Part II. Madison: Amer Soc of Agron Inc Pub.

Sharma, C.M. and A. Kumar. 1991. Community structure of some Natural forest stands in landowne forest range of Garhwal Himalaya. *Journal of Tropical Forest Science*, 5(1): 8-12.

Wahab, M., M. Ahmed and N. Khan. 2008. Phytosociology and dynamics of some pine forest of Afghanistan. *Pak. J. Bot*., 40(3): 1071-1079.

Zarif, M.R. 2003-2004. Vegetation baseline study in Chitral Gol National Park N.W.F.P Pakistan.

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