

QUANTITATIVE DESCRIPTION AND FUTURE TRENDS OF HIGHLY DISTURBED FORESTS AROUND MUREE HILLS

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خلاصہ

مری پہاڑوں کے ارد گرد انتہائی پریشان کن سائٹس سے جنگل کی پودوں کی مقدار کا تجزیہ کیا گیا۔ مطالعہ سے پتہ چلتا ہے کہ زیادہ تر سائٹس میں دوبارہ تخلیق کم تھا اور بڑی سائز کی کلاسوں میں درج ذیل درختوں کو جو کہ پورے علاقے میں بھاری کاٹنے کی وجہ سے تھا جس میں جنگل کا احاطہ کرتا تھا۔ نتائج سے پتہ چلتا ہے کہ پائن کے درختوں میں کم کثافت اور خشک علاقے تھے جس میں کشیدگی والے سائٹس میں کم ترین کثافت (78 پودوں / ہیک) خاناس پور کے علاقے میں منعقد ہوئے ہیں جن میں پنس دیوار پانا اور سیڈورس ڈوڈورا کمیونٹی شامل تھے جبکہ اعلیٰ کثافت (156 پودوں / ڈنگا گلی میں واقع سیڈورس ڈوڈارا اور پنس دیوار پانا کمیونٹی شامل ہیں۔ کاسری ٹاؤن سے بیسال علاقے میں سب سے کم (4.18) میٹر / جھیک (پایانا تھا، پاریاٹا خالص پنس دیوار پانا پر مشتمل تھا جبکہ خاناس پور کے سب سے زیادہ ریکارڈ شدہ بیسالین نے 33.93 ملی میٹر / ہیک دکھایا جس میں پنس دیوار پانا اور کوکوس بولو کمیونٹی شامل تھے۔ یہ اقدار کم سے کم پریشان کن سائٹس سے کم تھے اور کثیر، بیسال علاقے اور بیجنگ کثافت میں کوئی تعلق نہیں تھا۔ مٹی متغیر کے ساتھ وہی معاملہ تھا۔ مجموعی seedlings کم 0.01 سے i.e. 40 seedlings / ہیک تھے۔ بیجنگ سائز کے طبقات کی ساخت میں فرقوں کو ظاہر ہوتا ہے کہ غریب کی بازیابی اور بھرتی کا مظاہرہ۔ درختوں کا کاٹنے والے درخت کے سائز کے طبقات میں فرق بھی پایا گیا تھا۔ بڑی تعداد میں درخت کم تھے۔ سائز طبقے کی ساخت میں فرقیں کاٹنے اور چوری سے زیادہ ہونے کی وجہ سے تھے اور دوبارہ پیدا کرنے کی ناکامی کی وجہ سے نہیں تھے۔ یہ نتیجہ اخذ کیا گیا ہے کہ اگر انسانی مداخلت اور زلزلے میں کمی کی وجہ سے ان جنگلات کو کم نہیں کیا جائے گا تو مستقبل میں غائب ہو جائے گا

Abstract

Quantitative analysis of forest vegetation from highly disturbed sites around Murree Hills was conducted. The study revealed that in most of the stands regeneration was poor and less individuals recorded in large sized classes which was due to heavy cutting in throughout the area causing enormous loss in vegetation cover. The findings showed that pine trees had lower density and basal area in the disturbed sites i.e. lowest density (78 plants/hac) observed in Khanaspur area which was comprised of *Pinus wallichiana* and *Cedrus deodara* community whereas the highest density recorded (156 plants/hac) located in Dunga gali comprised of *Cedrus deodara* and *Pinus wallichiana* community. The basal area was found lowest (4.18m²/hac) from Kaseri Town, Pariata consisted of pure *Pinus wallichiana* while highest recorded basal area was from Khanaspur showing 33.93m²/hac comprised of *Pinus wallichiana* and *Quercus baloot* community. These values were considerably lower than least disturbed sites and no correlation was recorded among density, basal area and seedling density. Same was the case with soil variables. Overall seedlings were low i.e. 0.01 to 40 seedlings/hac⁻¹. Seedling size classes show gaps in structure showing poor regeneration and recruitment. Gaps were also found in tree size classes showing cutting of trees. Large trees were low in number. Gaps in size class structure were due to cutting and over grazing and not due to regeneration failure. It is concluded that if human interference and over grazing are not reduced these forests will be vanished in future.

Introduction

Forest structure is composed of tree species and their distribution with an ecosystem. The production of new seedling, their establishment and survival are the key factors for an evenness forest population. According to Raunkier (1928) Forest structure could be best idealized by analyzing the communities and populations in it or the type of vegetation, distribution of species across various latitudes and altitudes, floristic composition and mode of association among species. Ecologists summarized their research using Phytosociological variables to describe fundamentals of vegetation, floristic composition, structure of an ecosystem and their proceeding mode

of growth (Tansley, 1920). Deforestation is the main cause of losing species richness (Johnson *et al*, 1993). Deforestation practices were initially done to find space for agriculture, housing and roads, at present it has become a regular practice mainly for earning and to establishment urban mode of living. These intentionally damaging activities on the ecosystems brought ecologists together to find out the protective measures for a habitat and to introduce conservational strategies especially to protect the threatened species worldwide. This will also very helpful for those species which are susceptible to become threatened in future (Hussain, 2003).

Arthur (1988) identified 321,212 plant species from all over the world. Pakistan consists of various ecological combinations hence brings variety in its biodiversity. The country is rich in plant species including herbs, shrubs, trees, ferns, mosses etc. although Pakistan has a good number of plant species but the forest cover in the country is only 2.2% which is itself in danger and eliminating by 0.2% yearly (FAO, 2008). Pakistan's well known Western Himalayan foothills consist of Muree forests. These are considered as the moist temperate zone as they receive a maximum rainfall 351mm in August and a minimum of 17.8mm in November. There is also a combination of sub-tropical zone at the beginning of lower altitudes of the hills while above 2700ft moist temperate zone began (Ahmed *et al*, 2006). The area supported about 93 species including trees, herbs, shrubs and ferns and mosses (Ahmed *et al*, 2006). The changes in growth and biomass of a plant are linked with its biological makeup (physiology and metabolism) which corresponds with the community dynamics (McMohan and Bonner, 1983). Forest growth can be modeled by developing an idea of ecological processes in a particular habitat, interactions between plants and its abiotic environment, plant herbivore interactions etc. (Kobe, 1996, Jackson, 1980 and Tanner, 2005).

Quantitative description and size class distribution of least disturbed forests have been investigated by various workers *i.e.* Ahmed *et al.*, (1990, 1991), Akber (2013), Hussain (2013) and Siddiqui (2011) in Pakistan, while no study was presented in highly disturbed forested areas. Density size classes of seedlings and trees in each stand show the present and possible future status of existing population and its regeneration potential of each stand. Since no such study have been done from this area. Therefore, this study were conducted with the following specific objectives

1. To present qualitative description, current status and future trends of forests/tree species in highly disturbed forested areas.
2. To explore regeneration potential of pine species.
3. To determine correlation among stand density, basal area, seedling density and soil variables.

Materials and Method

Thirty highly disturbed stands around the Muree Hill were sampled. At each location a one hec plot (*i.e.* 100×100 m) was established with a rope. All trees from 10.1 cm dbh to higher were measured using dbh tap. In each plot ten circular quadrates 1.5 m radius each were constructed and plants of ground flora were recorded including pine seedlings. Their number and dbh were also recorded. Absolute value (density and basal area) were calculated following the method given in Ahmed and Shaukat (2012). Each stand was named on the basis of species with highest density and basal area. At each stand two soil samples were obtained from surface 6 inch and 12 inch deep. Both samples were pooled together to form composite samples. These soils were brought to laboratory and their physiochemical analyses were performed using HANNA multiparameter (model). Some of the soil nutrients *i.e.* Sodium and Potassium were determined with the help of Atomic Absorption method given in Nazim (2011) and Nitrogen with AOAA of kjeldahl method. For determination of Phosphorus we used method of Jackson (1962).

Following Ahmed (1984), seedling size class one includes all seedlings under one cm dbh, while other classes have 1 cm difference. Above 10.1 to 20cm dbh, considered small trees and included in tree dbh size class 1. All classes have 10 cm dbh intervals.

Results and Discussion

Ecological characteristics of each sampling site are presented in Table.1. Absolute values of dominant species, summary of quantitative sampling and community type were presented in Table.2. Physical and chemical soil analysis were given in Table.4.3a and 4.3b respectively. Dbh size class distribution of seedlings and tree species in each stand was presented in Fig.4.1 to 4.30.

Table:1. Characteristics of the sampling sites

Stand	Location	Longitude (East)	Latitude (North)	Elevation above sea level (m)	Aspect (Facing)	Canopy
1	Lower topa close to P.A.F base	073°26'05.6"	33°53'54.3"	1956	South	Open
2	Lower topa close to P.A.F base	073°25'57.6"	33°53'52.6"	2022	South	Open
3	Khanaspur	073°25'73.6"	34°01'25.7"	2155	North	Open
4	Khanaspur	073°25'39.0"	34°01'27.0"	2213	North	Open
5	Ghordadhaka	073°25'40.9"	34°01'29.4"	2129	North	Open
6	Nathiagali behind Chairlift	073°23'55.2"	34°01'65.7"	2628	South	Open
7	Nathia gali,Ayubia (Dairy farm)	073°23'59.5"	34°01'73.0"	2672	North	Open
8	Koozagali	073°23'58.6"	34°00'91.5"	2460	North	Open
9	Koozagali	073°23'49.8"	34°00'89.2"	2464	South	Open
10	Changlagali	073°23'43.7"	34°01'02.4"	2435	South	Open
11	Dunga gali	073°23'74.7"	34°03'01.2"	2327	North	Open
12	Dunga gali	073°23'90.2"	34°03'03.3"	2328	South	Open
13	Thana Phagwari-Kohala Road	073°26'63.5"	33°55'02.3"	1858	South	Open
14	Thana Phagwari-Kohala Road	073°26'46.7"	33°54'92.0"	1869	North	Open
15	Kasari Town-Murree Road (Patriata)	073°26'31.4"	33°54'75.8"	1883	South	Open
16	Kasari Town-Murree Road (Patriata)	073°26'37.7"	33°54'68.4"	1893	North	Open
17	Serbagla	073°26'48.0"	33°54'43.5"	1919	South	Open
18	Serbagla	073°27'51.3"	33°55'28.9"	1787	North	Open
19	Sunny Bank-Jhika gali	073°24'95.6"	33°55'25.9"	2044	South	Open
20	Sunny Bank-Jhika gali	073°25'74.4"	33°55'16.8"	2087	North	Open
21	Kondla-Changla gali	073°24'03.2"	35°55'16.6"	2063	South	Open
22	Kondla-Changla gali	073°24'03.8"	33°55'09.5"	2072	North	Open
23	Bhurban	073°27'09.2"	33°56'69.2"	1918	North	Open
24	Bhurban	073°27'27.7"	33°57'54.3"	1841	South	Open
25	Bansra gali	073°22'12.6"	33°53'91.8"	1781	North	Open
26	Bansra gali	073°27'64.9"	33°27'61.9"	1699	South	Open
27	Ghora gali	073°20'89.5"	33°52'80.7"	1636	North	Open
28	Forest house-Ghora gali	073°20'82.5"	33°52'77.9"	1638	South	Open
29	T-Base-Dewal Road	073°25'76.6"	33°52'38.9"	1858	South	Open
30	T-Base- Dewal Road	073°25'79.0"	33°52'44.0"	1789	North	Open

Stand #1:

The area studied was named as P.A.F Base located in Lower topa region of Murree. The location consist of 073°26'05.6" longitude, 33°53'54.3" latitude at 1956 meters above sea level. The total area covered was 1 hectare. Slope was south facing. The stand consisted of *Pinus wallichiana* as the dominant species with *Quercus baloot* representing second dominant species. The density occupied by *Pinus wallichiana* in this area was 67 trees per hectare with 19 seedlings. Eleven seedlings of *Quercus baloot* were also seen. The stand density appeared to be 86 plants per hectare and basal area of the stand was 24.96 m²/hectare. The forest ground was densely covered with herbs and shrubs of Rosaceae members, Mulberry plants and thick grasses. Seedlings of *Pinus wallichiana* found very abundant (100%), seedlings of *Quercus dilatata*, *Berberis lycium* and *Rosa brunonii* were found in abundant (80%) form, small shrubs and herbs like *Pteris cretica*, *Echinops vineus*, *Cotonester microphyllus*, *Argemone mexicana* and *Rumex nepalens* were present frequently (60%) while seedlings of *Quercus incana* and *Quercus baloot*, *Hedera nepalensis* and *Thymus serpyllum* were found in occasional (40%) form while *Rubus ellipticus*, *Indigofera hebeptatela*, *Plantago asiatica*, *Rosa webbiana* were found rarely (20%) in the stand.

Results obtained from physical analysis of soil in the stand showed below average values of D.O, pH, organic matter, TDS, conductivity, salinity and ORP. The value of M.W.H.C was above average as shown in Table.3(a). Table.3(b) showed chemical analysis of soil showed below average values of Nitrogen, Potassium and Sodium and Phosphorus. The minimum and maximum ranges of all estimated parameters were also presented in Table.3(a and b).

Fig.1 showed the density classes of seedlings and tree species. Seedling density was low, only class 2 showed higher number of seedlings. Gaps in seedling class showed sign of disturbance and low recruitment. Tree density classes showed higher number of plants in class 1 with gradually decrease in higher classes. No

tree larger than 80 cm dbh was found due to cutting. This stand may be established after protecting seedling number and growth.

Table:2. Summary of stands: Quantitative Sampling (Absolute values and communities including pine seedlings)

Stand No.	Name of Locations	Tree Density/hac	Density/hac	B.A m ² /hac	Name of Community
			(including conifer seedlings)		
1	Lower topa close to P.A.F Base	67	86	24.96	P.W-Q. B
2	Lower topa close to P.A.F base	98	138	25.67	P.W-Q.B-C.D.
3	Khanaspur	88	124	33.93	P.W-Q. B.
4	Khanaspur	81	127	40.99	P.W-C.D.
5	Ghordaka	90	113	28.26	C.D-P.W.
6	Nathiagali (Behind chair lift)	70	93	26.36	P.W.
7	Nathiagali-Ayubia dairy farm	84	107	34.30	P.W-A.P.
8	Kooza gali	98	112	39.37	Q.D-C.D-P.W.
9	Kooza gali	65	78	17.05	P.W-C.D.
10	Changla gali	88	106	20.46	P.W-A.P.
11	Dungaa gali	66	86	17.23	P.W-C.D.
12	Dungaa gali	128	156	43.52	C.D-P.W-A.P.
13	Thana Phagwari-Kohala Road	96	108	16.65	P.R-P.W- Q.D.
14	Thana Phagwari-Kohala Road	87	100	16.25	P.R-P.W.
15	Kaseri Town-Murree road-Patriata.	85	96	14.84	P.W.
16	Kaseri Town-Murree road-Patriata.	106	131	22.19	P.W.
17	Serbagla	100	134	20.11	P.R-P.W.
18	Sergagla	103	115	23.94	P.R.
19	Sunny Bank-Jhika gali	99	126	25.65	P.W- Q.D.
20	Sunny Bank-Jhika gali	68	87	19.58	P.W-A.P.
21	Kondla-Changla gali	76	90	20.25	P.W.
22	Kondla-Changla gali	113	131	33.39	A.P-P.W- Q.D.
23	Bhurban	94	104	48.06	P.W.
24	Bhurban	98	104	38.54	P.W.
25	Bansra gali	103	117	25.39	P.R-P.W.
26	Bansra gali	96	105	31.08	P.W.
27	Ghora gali	113	135	29.53	P.W-P.R.
28	Forest House-Ghora gali	116	127	28.81	P.R-C.D-Q.B.
29	T-Base	128	150	37.85	P.R- Q.D.
30	T-Base	104	118	37.53	P.R.

Note: P.W = *Pinus wallichiana*, P.R = *Pinus roxburghii*, A.P = *Abies pindrow*, C.D = *Cedrus deodara*
Q.B = *Quercus baloot*, Q.D = *Quercus dilatata*, A.I = *Aesculus indica*

Stand # 2:

This area lie in the beginning of Murree district in Lowertopa. The stand consisted of 073°25'57.6" longitude, 32°53'52.5" at 2022 meters above sea level. The location was north facing with open canopy. There were many patches of empty ground that showed disturbance as the location lie near the human population and many domestic animals also found grazing there. Litter was also present over the ground in the form of patches. Some saplings of *Pinus wallichiana* were present while very few seedlings of the same species were present. The number of saplings and seedlings may be decreased due to the presence of grazing animals. This stand was the stand of *Pinus wallichiana* as the first dominated species and *Quercus baloot* as the second dominated species, *Cedrus deodara* trees also observed at third position in the plot. The tree density was 98 plants per hectare and basal area was 25.67 m²/ hectare (Table 4.2.).

The understorey vegetation of the stand consisted of seedlings of *Pinus wallichiana* in very abundant (100%) condition while *Berberis lyceum* and *Rosa brunonii* were found in abundance (80%). *Cotonester microphyllus*, *Argemone mexicana* were frequent (60%) in the stand while *Pteris cretica*, *Echinops vineus*, *Rumex nepalensis* were occasional (40%) while seedlings of *Quercus incana*, *Quercus baloot*, *Quercus dilatata*, *Cedrus deodara*, *Hedera nepalensis*, *Thymus serpyllum*, *Rubus ellipticus*, *Indigofera hebeptela*, *Plantago asiatica* and *Rosa webbiana* were rarely (20%) present in the stand.

Table.3(a). showed above average values of D.O, TDS, conductivity and salinity and below average values of pH, temperature, ORP, organic matter and M.W.H.C. The sandy soil showed below average values of Phosphorus, Potassium, Nitrogen and Sodium (Table.4.3b).

Fig.4.2. size class structure of seedling and tree population showed similar distribution as in the first stand. In this stand, number of seedlings was higher (40seedlings.hec⁻¹) and tree population had larger trees. Absence of many tree classes showed cutting of trees for timber. Larger trees were from 180 to 190 cm dbh. This stand may be rare by increasing seedling population, while *Cedrus deodara* seems to be vanished completely from the stand.

Table:3(a). Physical analysis of soil samples from study area.

Stand#	D.O	pH	TDS	Cond	Salinity	ORP	Organic matter %	M.W.H.C %	Soil Texture
1	0	7.43	145	0.32	0.14	34.7	5.58	29	Sandy Clay
2	0.21	7.65	343	0.97	0.43	21.4	7.07	27	Sandy Clay
3	0	7.63	192	0.43	0.18	-25.9	6.9	47	Clay-Loam
4	0.14	6.96	143	0.31	0.13	-7.8	7.4	27	Silty-Clay-Loam
5	0.33	7.54	222	0.48	0.21	-0.4	7.8	25	Silty-Clay-Loam
6	0.54	7.58	151	0.33	0.14	15.7	5.8	43	Clay-Loam
7	0	7.59	203	0.45	0.19	-12.5	6.0	43	Clay-Loam
8	0	7.52	157	0.34	0.15	29.6	7.7	41	Clay-Loam
9	0	7.51	161	0.33	0.16	32.6	5.6	25	Sandy Loam
10	0.52	7.34	187	0.41	0.18	49.7	6.3	21	Silty-Clay-Loam
11	0	7.32	106	0.23	0.10	49.7	5.6	24	Silty-Clay-Loam
12	0	7.85	156	0.34	0.15	46.3	8.9	45	Clay-Loam
13	0	7.74	157	0.34	0.15	45.2	8.3	43	Clay-Loam
14	0	7.98	121	0.61	0.06	47.0	6.8	32	Sandy-Clay-Loam
15	0	8.00	200	0.44	0.19	53.1	7.42	35	Sandy-Loam
16	0	7.37	364	0.18	0.17	68.6	7.66	51	Clay-Loam
17	0	7.74	157	0.34	0.15	45.2	7.15	43	Clay-Loam
18	0	7.54	167	0.36	0.16	50.9	8.57	42	Clay-Loam
19	0	8.14	242	0.53	0.23	-2.0	9.08	48	Clay-Loam
20	0	7.98	121	0.61	0.06	47.0	8.58	23	Silty-Clay
21	0	7.60	156	0.34	0.14	35.2	8.12	20	Silty-Clay
22	0	7.54	167	0.36	0.16	50.9	7.25	32	Silty-Clay-Loam
23	0.77	7.70	300	0.25	0.24	56.3	8.56	37	Silty-Clay-Loam
24	0	7.96	182	0.40	0.17	51.2	7.51	34	Sandy-Clay
25	0	8.27	202	0.44	0.19	48.7	7.03	30	Silty-Clay
26	0	7.92	155	0.34	0.15	60.0	7.46	23	Clay-Loam
27	0	7.71	169	0.85	0.08	58.8	7.76	28	Clay-Loam
28	0	7.72	128	0.18	0.15	60.0	7.55	32	Silty-Clay-Loam
29	0	7.57	253	0.12	0.12	59.0	7.8	33	Clay-Loam
30	0	7.48	229	0.50	0.22	63.7	6.94	28	Sandy-Clay-Loam
Mean	0.09	7.66	187.86	0.40	0.16	37.00	7.34	33.66	
S.E	±0.04	±0.05	±11.27	±0.03	±0.01	±4.63	±0.18	±1.63	
Min	0	7.00	106	0.12	0.06	-26.0	5.58	20.00	
Max	0.77	8.27	364	0.97	0.43	68.60	9.08	51.00	

Note: D.O = Dissolved oxygen, Temp = Temperature, M.W.H.C = Maximum water holding capacity, ORP = Oxidation Reduction Product, Cond= Conductivity

Stand # 3:

The stand was located at area called Khanaspur having 073°25'23.3" longitude, 34°01'16.3" latitude at 2155 meters above sea level. The location was northwest facing with open canopy. The ground was covered with grasses, some small rocks were also present. Seedlings and saplings of *Pinus wallichiana* were present in a good number. The stand represented mixed community of *Pinus* and *Quercus* vegetation. The tree species were dominantly comprised of *Pinus wallichiana* while some trees of *Quercus* appeared only in classes 1, 2, and 3 Small herbs and bushes were also present. Stand tree density value was 124 plants/hectare and basal area was

33.93 m²/hectare. The seedlings of *Pinus wallichiana* were found in very abundance (100%) throughout the stand. *Campanula tenuissima* and *Cannabis sativa* were present occasionally (40%) while seedlings of *Acer ceasium* and *Quercus incana*, *Rosa brunonii*, *Rosa webbiana*, *Rubus ellipticus*, *Berberis kunawerensis*, *Fragaria vesca*, *Adiantum cappillus-veneris*, and *Rumex nepalensis* were rare (20%) in the stand.

Table.3(a) showed above average values of TDS, M.W.H.C, conductivity and salinity and below average values of pH, temperature, ORP, D.O and organic matter. The soil was clay-Loam. Table.3(b) showed below average values found in all tested elements *i.e.* N, P, K and Sodium.

Fig.4 showed density size classes of seedlings and trees in this stand. Pine seedlings were abundant but its distribution was not properly structured. Tree distribution showed higher number of individual in small size classes with gradually decrease in higher classes. Large sized trees been removed but future of this stand looked stable due to proper recruitment.

Table:3(b). Chemical analysis of soil samples from study area.

Sample	Phosphorus mg/gm	Potassium mg/gm	Sodium mg/gm	Nitrogen %/gm
1	0.23	0.40	0.1	0.11
2	0.26	0.42	0.1	0.13
3	0.26	0.45	0.16	0.15
4	0.41	0.44	0.21	0.14
5	0.32	0.42	0.51	0.13
6	0.21	2.02	0.54	1.18
7	0.26	2.32	0.76	1.10
8	0.26	2.28	0.92	1.15
9	0.26	1.86	0.1	0.15
10	0.26	1.92	0.86	0.16
11	0.46	1.63	0.85	0.17
12	0.54	2.08	0.82	1.15
13	0.53	2.16	0.64	1.20
14	0.35	1.42	0.85	0.17
15	0.35	1.68	0.82	0.18
16	0.35	2.43	0.67	1.13
17	0.26	2.50	1.23	1.21
18	0.56	2.30	0.69	1.20
19	0.35	2.56	1.31	1.24
20	0.26	1.68	1.12	0.17
21	0.39	1.97	0.87	0.18
22	0.35	2.23	0.85	1.03
23	0.26	2.37	1.42	1.12
24	0.39	1.42	1.16	0.14
25	0.26	1.67	1.12	0.16
26	0.46	2.22	0.85	1.21
27	0.54	2.38	0.82	1.24
28	0.35	1.26	0.64	0.19
29	0.35	2.46	0.85	1.20
30	0.26	1.74	1.12	0.18
Mean	0.34	1.76	0.76	0.63
S.E	±0.02	±0.13	±0.06	±0.09
Min	0.21	0.4	0.1	0.11
Max	0.56	2.56	1.42	1.24

Stand # 4:

This sampling stand site was also in Khanaspur at another location. The longitude was 073°25'73.6", latitude is 34°01'27.0" at 2213 meters above sea level. The stand was north facing with open canopy. The ground was completely covered with grasses. The area was dominated by *Pinus wallichiana* with *Cedrus deodara* as the second dominant species. Trees of *Quercus baloot* were also present as the associated species at third dominated position. Stand tree density was 81 plants per hectare and stand basal area was 40.99 m²/ha (third highest basal area). Seedlings of *Pinus wallichiana* found in very abundant (100%) form while abundant (80%) class was absent in the stand. Seedlings of *Cedrus deodara* and *Acer ceasium* were frequent (60%) in the

stand. Seedlings of *Quercus incana* and small herbs and shrubs like *Rosa brunonii*, *Campanula tenuissima*, *Cannabis sativa*, *Ulmus wallichiana* (Kair) and *Rumex nepalensis* were present occasionally (40%). *Rosa webbiana*, *Rubus ellipticus*, *Berberis kunawerensis*, *Fragaria vesca* and *Adiantum cappillus-veneris* were rare (20%) in the stand. This stand showed highest (46) pine seedling density.

Table.3(a) showed above average value of only two parameters *i.e.* D.O and organic matter while below average values of pH, temperature, ORP, TDS, conductivity and salinity and M.W.H.C results obtained from physical analysis of soil in stand 4. The soil was silty clay Loam. Table.3(b) showed above average value of Phosphorus only while Sodium, Potassium and Nitrogen were found above average in chemical analysis of soil. Size class structure (Fig.4) showed similar structure as stand 3 but this diagram indicating some gaps in both seedlings and tree structure. *Cedrus deodara* is in poor condition representing in a few classes with many gaps, might be disappeared in future while *Pinus wallichiana* will be in stable condition in future.

Stand # 5:

The stand was located at Ghoradhaka near Dongagali. The longitude was 073°25'40.9", latitude was 34°01'29.4" at 2129m above sea level. The area was north facing with open canopy. Ground was oftenly covered with grasses, herbs and small bushes. *Cedrus deodara* appeared to be the first dominant species in the stand with *Pinus wallichiana* as the second dominant species. Stand tree density was 90 trees per hectare and Basal area was 28.26 m²/hectare. Seedlings (45) of *Cedrus deodara* and *Pinus wallichiana* present in abundance (80%) in this stand. No plant was found in frequent (60%) class. Seedlings of *Acer ceasium* present occasionally (40%) while herbs and shrubs of *Rosa brunonii*, *Rosa webbiana*, *Rubus ellipticus*, *Berberis kunawerensis*, *Campanula tenuissima*, *Fragaria vesca*, *Adiantum cappillus-veneris*, *Cannabis sativa*, *Ulmus wallichiana* (Kair) were found rarely (20%).

According to Table.3(a), physical condition of soil in stand 5 indicated above average values of D.O, TDS, organic matter, conductivity and salinity while pH, temperature, ORP, and M.W.H.C were below average. Table.3(b) indicated below average condition of Phosphorus, Sodium and Nitrogen and Phosphorus in the soil. Fig.5 indicated that low number of seedlings belong to *Pinus wallichiana* and *Cedrus deodara* with random distribution in seedling classes and poor recruitment. *Pinus wallichiana* showed poor distribution *i.e.* small sized trees with many gaps while *Cedrus deodara* young trees were found in higher density than older classes. It seems without proper recruitment these trees will be vanished by time.

Stand # 6:

The stand was located in Nathiagali at the longitude 073°23'55.2", latitude 34°01'65.7" at 2nd highest elevation (2628m) above sea level. The area was south facing with open canopy. The area was densely covered with bushes and grasses. A wide variety of herbs and shrubs was seen. The stand consisted of dominated trees of *Pinus wallichiana* making the pure stand of the species. There area had small rocks with different levels of elevation and depths. The density was 70 trees/ha and basal area was 26.36 m²/ha. Seedlings of *Pinus wallichiana* were present in very abundant (100%) class while no plant was found in abundance (80%) class in the stand. seedlings of *Acer ceasium* and *Rosa moschata* were frequent (60%). Herbs and shrubs like *Rubus ellipticus*, *Aristida cyanatha* and *Rumex nepalensis* were occasional (40%) while *Ulmus wallichiana*, *Hedera nepalensis* and *Thymus serpyllum* were rare (20%).

Table.3(a) showed above below values of TDS, conductivity and salinity, pH, and organic matter while only D.O, ORP and M.W.H.C were appeared to be above average in the stand. Table.3(b) indicated below average condition of Phosphorus while above average condition of Potassium, Sodium and Nitrogen in the soil. Fig.6 indicated greater number of individuals in the initial seedling classes as well as in tree classes. There were gaps in higher seedling classes. Tree classes also showed poor density in larger tree classes. Structure of this stand indicted that no recruitment took place in *Pinus wallichiana* over a longer period.

Stand #7:

The stand selected in Ayubia in the area called dairy farm having latitude 073°23'59.5", longitude 34°01'73.0" and was at highest elevation (2672m) above sea level. The slope was north facing in open canopy. The site is covered with lush green grasses on the straight slope. There was a very less variety of herbs and shrubs. The tree species found there are *Pinus wallichiana* and *Abies pindrow* in the dominated condition respectively. The stand tree density consisted of 84 trees per hectare of both the species and basal area was 34.3 m²/ha. The stand consisted of *Abies pindrow*, *Pinus wallichiana* seedlings, *Salix australis*, *Cannabis sativa* in abundant (80%) class. Seedlings of *Juglans regia* and *Fragaria vesca* were present frequently (60%). Seedlings of *Acer ceasium*, *Berberis lycium*, *Ulmus wallichiana* and *Rosa moschata* and *Rumex nepalensis* were present occasionally (40%) while seedlings of *Viburnum grandiflorum*, *Populus nigra* and *Betula utilis* and *Sophora mollis* were rare (20%).

According to Table.3(a), physical condition of soil in stand 7 indicated above average values of TDS, conductivity, salinity and M.W.H.C while D.O, pH, ORP and organic matter were below average. Table.3(b).

indicated below average condition of Phosphorus while above average condition of Potassium and Nitrogen and Sodium was at average in the soil.

Fig.7 showed *Pinus wallichiana* and *Abies pindrow* seedlings and trees. Seedlings of *Pinus wallichiana* were spreaded and almost all classes found in greater density in lowest class while *Abies pindrow* seedlings were in very less number and found in lower sized classes. Similarly in tree size classes, both the species were distributed upto medium tree level but no mature tree found in this stand. Density decreases from younger to mature classes.

Stand # 8:

The area selected for sampling belongs to Kooza gali having latitude 073°23'58.6", longitude 34°00'91.5" at 4th highest location (2460 meters) above sea level. The slope was north facing in open canopy. The area was roughly grassy, herbs and shrubs were also found in disturbed condition may be due to the human interference. Saplings and seedlings of pines and many angiospermic trees were also present to invade the area. The stand consisted of mixed community of *Quercus dilatata*, *Cedrus deodara*, *Pinus wallichiana* and *Aesculus indica* in the dominated pattern respectively. Tree density of the stand was 98 plants per hectare and basal area is 39.37 m²/hectare. The ground had flat surface but sloppy from four sides. Bushes were present around the angiospermic trees. *Sophora mollis* (100%) mostly found in the area seems to be toxic and important allelopathic plants. Seedlings of *Cedrus deodara* and *Pinus wallichiana* and *Ranunculus acris* were also in very abundant (100%) form while seedlings of *Ficus palmata* and *Rumex nepalensis* and *Crotalaria juncea* were in abundant (80%) form. Seedlings of *Aesculus indica*, *Quercus dilatata* and *Pyrus pashia*, *Iris hookeriana* were present frequently (60%). Seedlings of *Populus ciliata*, *Punica granatum*, *Prunus domestica* and *Pyrus* spp. And *Urtica dioica* were present occasionally (40%) in the stand while seedlings of *Prunus cornuta*, *Salix australis*, *Cornus macrophylla*, *Ulmus wallichiana* and *Paeonia emodi* were found rarely (20%).

In stand 8, the physical soil conditions were below average in all parameters except organic matter and M.W.H.C while Potassium, Sodium and Nitrogen appeared above average than Phosphorus from the findings obtained by physical analysis as shown in Table.3(a and b) soil texture consisted of clay loam particles.

Fig.8 showed a combination of conifer and angiosperm species. Seedling classes showed less number of individuals of all species in this stand with many gaps in higher classes of seedlings. Initial tree classes were comprised of all four species while attaining maturity the trees were disappeared. Only few trees of *Quercus dilatata* found in higher class after a long gap.

Stand # 9:

Another sampled area from Koozah gali at the latitude of 073°23'49.8" and longitude 34°00'89.2" at 3rd highest elevation 2464m above sea level. The stand was facing south slope and open canopy. The tree density of the stand was 65 trees per hectare and basal area was 17.05 m²/hectare. The area was covered with herbs and bushes mostly while grasses were lower in number than herbs. Some small snakes were also present in the soil hidden beneath the herbs. Stand consisted of mosaic patch of *Pinus wallichiana* and *Cedrus deodara* community. *Viola odorata* formed the area covered with its herbs. Area found near hotels. *Ranunculus acris* and *Viola odorata* were most abundantly (100%) found in the stand while seedlings of *Ficus palmata* were abundantly (80%) found with *Crotalaria juncea*. Seedlings of *Aesculus indica* and *Quercus dilatata* and *Sophora mollis*, *Iris hookeriana* were frequently (60%) found. Seedlings of *Populus ciliata*, *Punica granatum* and *Prunus domestica*, *Rumex nepalensis*, *Urtica dioica* found occasionally (40%). Seedlings of *Pinus wallichiana* and *Cedrus deodara* were found occasionally (40%). Seedlings of *Prunus cornuta*, *Pyrus* spp. and *Pyrus pashia* with herbs and shrubs like *Salix australis*, *Cornus macrophylla*, *Ulmus wallichiana*, *Paeonia emodi* showed their presence rarely (20%) in the stand.

Soil analysis appeared to be below average in the second stand of Koozah gali again in its physical condition as shown in Table.3(a). The chemical results showed above average values of D.O, TDS, conductivity, salinity, ORP while the rest of the parameters were below average. Potassium and Sodium while Nitrogen and Phosphorus were below average mentioned in Table.3(b). the soil was sandy loam.

Fig.9 *Pinus wallichiana* and *Cedrus deodara* occupied most of the classes in seedling stage with only two gaps. In trees, the initial classes were occupied by *Cedrus deodara* while *Pinus wallichiana* extended upto higher dbh classes with some gaps. Both conifer species showed greater density at younger stages.

Stand# 10:

The sampled area was in Changla gali at latitude 073°23'43.7" and longitude 34°01'02.4" at 2435m above sea level. The stand was facing south slope and open canopy. Tree density of the stand was 88 plants per hectare and basal area was 20.46 m²/hectare. Stand consisted of mosaic patch of *Pinus wallichiana* and *Abies pindrow* community. The area was poorly covered with grasses and herbs due to heavy urban disturbance. There were different temporary hotels present of local people. Monkeys were also present jumping on the trees. Seedlings of *Pinus wallichiana*, *Abies pindrow* were in occasional (40%) form with *Ranunculus acris*. Another herb

Crotalaria juncea was present in abundant (80%) form. Frequent (60%) class found absent in the tree species while it was only represented by a single herb species of *Iris hookeriana* in the stand while seedlings of *Punica granatum* and some herbs and shrubs like *Rumex nepalensis*, *Urtica dioica* and *Sophora mollis* were the representatives of occasional (40%) class. Seedlings of *Aesculus indica*, *Prunus cornuta*, *Ficus palmata*, *Prunus domestica*, *Pyrus spp*, *Pyrus pashia* and some herbs like *Salix australis*, *Cornus macrophylla*, *Paeonia emodi* were found rarely (20%).

Table.3(a). showed above average values of D.O, conductivity, salinity while below average values belonged to pH, TDS, organic matter, ORP and M.W.H.C. Table.3(b). showed below average value of Nitrogen, Phosphorus while Sodium and Potassium were above average. Soil texture was silty clay loam in this stand. In Fig.10 two pine species *i.e.* *Pinus wallichiana* and *Abies pindrow* found distributed with gaps in classes 3, 5 and 8. Overall density of pine seedlings appeared to be low whereas in tree classes, greater number of individuals seen in both the species showing L shaped distribution.

Stand # 11:

The sampled area was in Dunga gali at the latitude 073°23'74.7" and longitude 34°03'01.2" at 2327 feet above sea level. The stand was facing north slope and open canopy. The density of the stand was 66 trees per hectare and basal area was 17.23 m²/hectare. Stand consisted of mosaic patch of *Pinus wallichiana* and *Cedrus deodara* community. Area was covered with grasses and herbs some places found empty from flora. Rocks were exposed at some places. Frequent interference of human and livestock seen. Seedlings of *Pinus wallichiana* and *Cedrus deodara* were present rarely (20%). Only *Urtica dioica* and *Crotalaria juncea* were found in abundance (80%) while seedlings of *Quercus incana*, *Sophora mollis* and *Iris hookeriana* were frequently (60%) found in the stand. The occasionally (40%) found tree seedlings were of *Aesculus indica*, *Punica granatum* and *Ficus palmata* and some herbs in this class were *Rumex nepalensis* and *Urtica dioca* whereas the seedlings of *Prunus cornuta*, *Cornus macrophylla*, *Prunus domestica*, *Pyrus spp.* and *Pyrus pashia*, *Ranunculus acris*, *Paeonia emodi* and *Salix australis* were rare (20%).

Results from soil physical analysis gave above average values in ORP only while the other parameters had below average values as given in Table.3(a). On the other hand chemical results were produced in Table.3(b). Potassium and Sodium showed above average values. The soil was silty clay loam.

A very low density and recruitment level seen in this stand as showed in Fig.11. The stand comprised of *Cedrus deodara* in class 1, 4, 8 and 9 while *Pinus wallichiana* appeared only in 4, 7 and 9. Very low number of seedlings found in this stand showing poor regeneration potential. Similarly in tree classes *Cedrus deodara* and *Pinus wallichiana* found vanished after class 8. Poor recruitment level seen in this stand.

Stand# 12:

Another sampled area was taken from Dunga gali at the latitude 073°23'90.2" and longitude 34°03'03.3" at 2328m above sea level. The stand was facing south slope and open canopy. This showed highest density and 2nd highest basal area. The density of the stand was 128 trees per hectare and basal area was 43.52 m²/hectare. Stand consisted of *Cedrus deodara*, *Pinus wallichiana* and *Abies pindrow* community. Stand was covered with grasses, some monkeys were also present. Human interference was observed due to visitors in that area. *Ranunculus acris* was found in most abundance (100%) while *Urtica dioca* in abundance (80%). Seedlings of *Pinus wallichiana* and *Quercus incana*, *Sophora mollis* were present frequently (60%) while seedlings of *Aesculus indica*, *Punica granatum* and *Ficus palmate*, *Crotalaria juncea* and *Rumex nepalensis* were occasionally (40%) present. Rarely (20%) present tree species were *Cedrus deodara*, *Abies pindrow*, *Prunus cornuta*, *Cornus macrophylla*, *Prunus domestica*, *Pyrus spp.* *Pyrus pacshia*, *Ficus auriculata* while *Paeonia emodi* and *Iris hookeriana*, among herbs were also rare (20%).

In stand 12, the physical soil conditions were above average in pH, M.H.W.C, organic matter and ORP. Phosphorus and Nitrogen appeared above average than Potassium, Phosphorus, Nitrogen and Sodium from the findings obtained by physical and chemical analysis as shown in Table.3(a and b). Soil texture consisted of clay loam particles.

A combination of these conifer species *i.e.* *Pinus wallichiana*, *Cedrus deodara* and *Abies pindrow* appeared to be extended upto class 7 in tree sizes but mature class was absent as shown in Fig.12. *Cedrus deodara* seedlings showed greater number of individuals and distribution in all the classes except 5 and 9, while *Abies pindrow* was completely absent from the seedling classes. *Pinus wallichiana* appeared with low density and uneven distribution.

Stand # 13:

The stand was plotted in Thana Phagwari near Kohala road at the latitude 073°26'63.5" and longitude 33°55'02.3" at 1858m above sea level. The stand was facing south slope and open canopy. The density of the trees was 96 trees per hectare (second highest density) and basal area was 16.65 m²/hectare. Stand consisted of *Pinus roxburghii*, *Pinus wallichiana* and *Quercus dilatata* community. Stand faced South aspect and

disturbances due to the presence of nearby villages. In this stand, seedlings of *Pinus roxburghii* were present area (20%) class while seedlings of *Pinus wallichiana* were not found. *Urtica dioica* was frequently (60%) found herb species in the stand. *Populus ciliata*, *Quercus incana* and *Quercus dilatata* seedlings were frequently (60%) found tree species. Occasionally (40%) found tree species include *Punica granatum* and *Ficus palmata* while this class also includes some herbs and shrubs like *Rumex nepalensis*, *Aquilegia vulgaris*, *Narcissus poeticus*, *Canabis sativa* and *Platanus orientalis*. Tree species in the form of seedlings were of *Quercus dilatata*, *Aeculus indica*, *Prunus cornuta*, *Prunus domestica*, *Pyrus* spp. *Pyrus pashia*, *Cassia glauca* while herbs of *Aquilegia vulgaris* were rarely (20%) present in the stand.

According to Table.3(a), physical condition of soil in stand 13 indicated above average values of pH, ORP, organic matter and M.W.H.C while D.O, conductivity, temperature, TDS and salinity were below average. Table.3(b). indicated below average condition of Potassium, Phosphorus and Nitrogen while only Sodium showed above average condition in the soil.

Fig.13 showed L shaped distribution of *Pinus roxburghii* trees upto class 10. *Pinus wallichiana* trees were only present in the younger tree classes with lower density. *Quercus dilatata* species was found to be vanishing in this stand showed very few individuals in class 1, 3 and 6. The condition of seedling was very poor in this stand as very less individuals appeared only in 1,2 and 6 classes hence proving a threatened condition of regeneration in this location.

Stand# 14:

This stand was also plotted in Thana Phagwari near Kohala road at the latitude 073°26'46.7" and longitude 33°54'92.0" at 1869 meters above sea level. The stand was facing north slope and open canopy. The density of the stand was 87 plants per hectare and basal area was 16.25 m²/hectare. Stand consisted of *Pinus wallichiana* and *Pinus roxburghii* community. There were greater level of disturbance due to the visitors, villagers and grazing animals. Seedlings of *Pinus wallichiana*, *Pinus roxburghii* were found abundantly (80%) in the stand while the most abundant (100%) class was absent due to presence of bare area at the extreme northwest portion of the stand. *Urtica dioica* were also in abundance (80%). Seedlings of *Quercus dilatata*, *Populus ciliata*, *Quercus incana* were frequently (60%) present. Seedlings of *Punica granatum*, *Ficus palmata*, *Platanus orientalis*, *Rumex nepalensis*, *Aquilegia vulgaris*, *Narcissus poeticus* and *Canabis sativa* were occasionally (40%) found. Seedlings of tree species *Aeculus indica*, *Prunus cornuta*, *Prunus domestica*, *Pyrus* spp. *Pyrus pashia*, *Cassia glauca* were found rarely (20%).

Soil physical analysis in the second stand of Thana Phagwari showed above average condition in pH, conductivity and ORP while below average condition in D.O, TDS, salinity, organic matter and M.W.H.C as shown in Table.3(a). The chemical results showed below average values of Potassium and Nitrogen while Phosphorus, Sodium was above average mentioned in Table.3(b).. The soil texture was sandy clay loam.

Fig.14 showed very low density of both species *i.e.* *Pinus wallichiana* and *Pinus roxburghii* in seedling classes while in tree class only class 1 exhibited a considerable number of individuals of both the species whereas the other classes showed poor distribution and density.

Stand# 15:

The sampled area was in Kasari town in New Murree Patriata at the latitude 073°26'31.4", longitude 33°54'75.8" on 1883 meters above sea level. The stand was facing south slope and open canopy. The density of the stand was 85 trees per hectare and basal area was 14.84 m²/hectare. Stand consisted of *Pinus wallichiana* as a pure dominant tree species. Heavy disturbance in the area found due to the tourism developments and urbanization. The most abundant (100%) class of the stand was represented by seedlings of *Pinus wallichiana* trees while the abundant (80%) class was absent among tree species and only represented by herb *Urtica dioica*. The frequent (60%) class was represented by the seedlings of tree species of *Populus ciliata*, *Quercus incana* and *Quercus dilatata*. Seedlings of *Ficus palmata* and *Punica granatum* trees were occasional (40%) in the stand while *Aquilegia vulgaris*, *Canabis sativa*, *Platanus orientalis*, *Rumex nepalensis* were also occasionally (40%) found herbs and shrubs. *Aesculus indica*, *Prunus cornuta*, *Prunus domestica*, *Pyrus* spp. *Pyrus pashia* were the rare (20%) seedlings of tree species while *Cassia glauca* was also rarely (20%) found shrubs.

Soil analysis appeared to be above average in all parameters except D.O in physical condition whereas the rest of all parameters given in Table.3(a). were above average. The chemical results showed below average values of Potassium and Nitrogen while Phosphorus and Sodium were above average mentioned in Table.3(b). The soil was sandy loam.

Poor recruitment level seen in this stand as presented in Fig.15. The seedlings of *Pinus wallichiana* were clearly expected to be diminished in future because of low density with gaps in seedling classes. Relatively greater density observed in tree class 1 and 2 which gradually decreased upto class 8 with a gap in class 6. Stand showed unstable condition.

Stand# 16:

The sampled area was in Kasari town in New Murree Patriata at the latitude 073°26'37.7" and longitude 33°54'68.4" on 1893 meters above sea level. The stand was facing north slope and open canopy. The density of the stand was 106 trees per hectare and basal area was 22.19 m²/hectare. Stand consisted of *Pinus wallichiana* as a pure dominant tree species. Conditions were similar of this stand with stand 15 as the whole area known for tourism hence the visitors found throughout the year. The stand consisted of rarely (20%) found seedlings of *Pinus wallichiana* species while no other tree species found in abundance (80%) with exception of *Urtica dioica* among other plant species besides pines. The frequent (60%) class was represented by the seedlings of tree species of *Populus ciliata*, *Quercus incana* and *Quercus dilatata*. Seedlings of *Ficus palmata* and *Punica granatum* trees were occasional (40%) in the stand while herbs of *Aquilegia vulgaris*, *Cannabis sativa*, *Platanus orientalis*, *Rumex nepalensis* were also occasionally (40%) found. *Aeculus indica*, *Prunus cornuta*, *Prunus domestica*, *Pyrus* spp. *Pyrus pashia* were the rare seedlings of tree species while *Cassia glauca* was rarely (20%) found shrub.

In stand 16, the physical soil conditions were below average in pH, conductivity and D.O. Phosphorus, Potassium and Nitrogen appeared above average while Sodium found below average as shown in Table.3(a and b). Soil texture consisted of clay loam particles.

Fig.16, showed gaps in initial seedling classes showing poor regeneration condition of this stand while classes 4, 7, 8 and 10 consisted of few pine seedlings. Trees of this stand showed L shaped distribution showing absence of mature trees. This stand may be maintained by protecting seedling and promote recruitment.

Stand # 17:

The sampled area was in Serbagla in New Murree Patriata at the latitude 073°26'48.0" and longitude 33°54'43.5" on 1919 meters above sea level. The stand was facing south slope and open canopy. The density of the stand was 100 trees per hectare and basal area was 20.11 m²/hectare. Stand consisted of *Pinus roxburghii* and *Pinus wallichiana* community while *Quercus dilatata* found as the third dominant species. The area was having patches of grasses and bushes. The flora seems to be removed or migrated due to frequent interference of visitors. The selected stand was near the chirlifts and there were paths constructed nearby hence the natural vegetation got damaged even in the untouched portions of the land and no immigration of species observed. The stand consisted of rarely (20%) found seedlings of *Pinus wallichiana* and *Pinus roxburghii* pine tree species while no other tree species found in abundance (80%) class but a herb *Urtica dioica* was only present in abundance (80%). The frequent (60%) class was represented by the seedlings of tree species of *Populus ciliata*, *Quercus incana* and *Quercus dilatata*. Seedlings of *Ficus palmata* and *Punica granatum* trees were occasional (40%) in the stand while herbs of *Aquilegia vulgaris*, *Canabis sativa*, *Platanus orientalis*, *Rumex nepalensis* were also occasionally (40%) found. *Aesculus indica*, *Prunus cornuta*, *Prunus domestica*, *Pyrus* spp. *Pyrus pashia* were the rare (20%) seedlings of tree species while *Cassia glauca* was rarely (20%) found shrub.

In this stand, the physical soil conditions were above average in pH, ORP and M.W.H.C while conductivity, D.O, organic matter, TDS, salinity were below average as shown in Table.4.3(a). Phosphorus appeared below average while Nitrogen, Potassium and Sodium were above average as shown in Table.3(b). Soil texture consisted of sandy clay loam particles.

Fig.17 showed low distribution in class 1, 2, 4 and 10 in seedling classes. Tree size distribution was uneven with low density in medium trees. Very few number of individuals appeared in young classes. The stand did not show mature trees hence chances of regeneration were minimal.

Stand # 18:

The sampled area was in Serbagla in New Murree Patriata at the latitude 073°27'51.3" and longitude 33°55'28.9" on 1787 meters above sea level. The stand was facing north slope and open canopy. The density of the stand was 103 plants per hectare and basal area was 23.94 m²/hectare. Stand consisted of *Pinus roxburghii* forming a pure stand. The stand consisted of rarely (20%) found seedlings of *Pinus roxburghii* pine tree species. *Urtica dioica* was only present in abundance (80%). The frequent (60%) class was represented by the seedlings of tree species of *Populus ciliata*, *Quercus incana* and *Quercus dilatata*. Seedlings of *Ficus palmata* and *Punica granatum* trees were occasional (40%) in the stand with *Aquilegia vulgaris*, *Cannabis sativa*, *Platanus orientalis*, *Rumex nepalensis*. *Aeculus indica*, *Prunus cornuta*, *Prunus domestica*, *Pyrus* spp. *Pyrus pashia* were the rare (20%) seedlings of tree species while *Cassia glauca* was rarely (20%) found shrub.

In stand 18, physical soil conditions were above average in salinity, organic matter, ORP and M.W.H.C while D.O, pH, conductivity, TDS were below average as shown in Table.3(a).. Phosphorus, Potassium and Nitrogen appeared above average while Sodium was below average as shown in Table.3(b).. Soil texture consisted of sandy clay loam particles.

Fig.18 showed greater tree density of *Pinus roxburghii* with evenly distributed in all young sized classes upto class 9 except class 7. Mature trees were absent. Seedling classes showed uneven distribution and density decreased from lower to higher classes.

Stand # 19:

The sampled area was in the area called Sunny bank in the vicinity of Jhika gali at the latitude 073°24'95.6" and longitude 33°55'25.9" on 2044 meters above sea level. The stand was facing south slope and open canopy. The density of the stand was 99 plants per hectare and basal area was 25.65 m²/hectare. Stand consisted of *Pinus wallichiana* and *Quercus dilatata* community. Seedlings of *Pinus wallichiana* and *Quercus dilatata* were rare (20%). Ground flora was missing at different places therefore herbs and shrubs were eliminated from the area and found absent in the most abundant (100%) and abundant (80%) classes. Seedlings of *Quercus incana* and *Myrcin* were frequent (60%) in the stand. *Juglans regia*, *Populus ciliata* and *Olea ferruginea* seedlings were occasionally (40%) present as angiospermic tree species while *Barberis lyceum*, *Rosa moschata*, *Fragaria vesca*, *Aquilegia vulgaris*, *Narcissus poeticus* were also occasional (40%). *Aesculus indica*, *Prunus cornuta*, *Punica granatum*, *Cornus macrophylla*, *Diospyros lotus* in the form of seedlings of associated tree species were rarely (20%) present. Some herbs like *Rubus* and *Imperata cylindrica* were also found rarely (20%). In stand 19, physical soil conditions were below average D.O and ORP while pH, TDS, conductivity, organic matter, salinity and M.W.H.C were above average as shown in Table.3(a). Phosphorus, Potassium, Nitrogen and Sodium appeared above average were below average as shown in Table.3(b).. Soil texture consisted of sandy clay loam particles.

Pinus wallichiana seedlings appeared in few classes as shown in Fig.19, whereas no seedling of *Quercus dilatata* was present. In tree classes *Pinus wallichiana* tree occurred in younger classes from class 1 to 5 and 9 after gaps. 22 plants of *Quercus dilatata* were also distributed in the younger classes. No mature tree was found in both the species. *Pinus wallichiana* may be protected by increasing and seedling in this stand.

Stand # 20:

The sampled area was also located in Sunny bank in Jhika gali at the latitude 073°25'74.6" and longitude 33°55'16.8" on 2087 meters above sea level. The stand was facing north slope and open canopy. The density of the stand was 68 trees per hectare and basal area was 19.58 m²/hectare. Stands consisted of *Pinus wallichiana* and *Abies pindrow* community. Seedlings of *Pinus wallichiana* and *Abies pindrow* were rare (20%) whereas seedlings of *Quercus incana* were in abundance (80%) as the associated angiospermic tree species present. Ground flora was missing at different places therefore there was herbs and shrubs were eliminated from the area and found absent in the most abundant and abundant classes. Seedlings of *Quercus dilatata* and shrubs of *Myrcin* were frequent (60%) in the stand. *Juglans regia*, *Populus ciliata* and *Olea ferruginea* seedlings were occasionally (40%) present as angiospermic tree species while *Barberis lyceum*, *Rosa moschata*, *Fragaria vesca*, *Aquilegia vulgaris*, *Narcissus poeticus* were also occasional (40%). *Abies pindrow*, *Aesculus indica*, *Prunus cornuta*, *Punica granatum*, *Cornus macrophylla*, *Diospyros lotus* in the form of seedlings of associated tree species were rarely (20%) present. Some herbs like *Rubus* and *Imperata cylindrica* were also found rarely (20%).

In this stand, the physical soil conditions were above average in pH, conductivity, organic matter and ORP while M.W.H.C and D.O, TDS and salinity were below average as shown in Table.3(a).. Phosphorus, Nitrogen, Potassium were in below average condition and Sodium was in above average condition as shown in Table.3(b). Soil texture consisted of silty clay particles.

Very low number of individuals appeared in this stand as represented in Fig.20 which clearly showed gaps in seedlings of *Pinus wallichiana* and *Abies pindrow* trees were found in only class 1, 4, 5 and 7 in a less number while *Pinus wallichiana* trees showed higher density in class 1 but the tree density was drastically decreased in the consecutive classes with gaps at class 5 and 9. It clearly showed the signs of cutting of trees in this stand both species may be saved by protecting seedlings.

Stand# 21:

The sampled area called Kondla in Changla gali at the latitude 073°24'03.2" and longitude 33°55'16.6" on 2063 meters above sea level. The stand was facing south slope and open canopy. The density of the stand was 76 trees per hectare and basal area was 20.25 m²/hectare. Stand consisted of *Pinus wallichiana* as a pure tree species. Seedlings of *Pinus wallichiana* were rare (20%) whereas seedlings of *Quercus incana* were in abundance (80%). Ground flora was missing at different places therefore herbs and shrubs were eliminated from the area and found absent in the most abundant and abundant classes. Seedlings of *Quercus dilatata* and shrubs of *Myrcin* were frequent (60%) in the stand. *Juglans regia*, *Populus ciliata*, *Diospyros lotus* and *Olea ferruginea* seedlings were occasionally (40%) present as angiospermic tree species while *Berberis lycium*, *Rosa moschata*, *Urtica dioica*, *Fragaria vesca*, *Aquilegia vulgaris*, *Narcissus poeticus* were also occasional (40%). *Abies pindrow*, *Aesculus indica*, *Prunus cornuta*, *Punica granatum*, *Cornus macrophylla*, in the form of seedlings of associated tree species were rarely (20%) present. *Rubus* and *Imperata cylindrica* were also found rarely (20%). The physical soil value was above average in organic matter only whereas pH and conductivity had average values while ORP, D.O, TDS, M.W.H.C, salinity were below average as shown in Table.3(a).. Phosphorus,

Potassium and Sodium showed above average value while Nitrogen showed below average value as shown in Table.3(b). Soil texture consisted of silty clay particles.

Dbh size class structure showed at seedling density occurred only in class 4 and 10 that showed a poor recruitment level. Among tree classes, the younger trees were present in high density whereas gaps occurred while reaching mature classes as shown in Fig.21. This may be promoted if number of seedlings are increased and protected.

Stand # 22:

The sampled area was in Kondla located in Changla gali at the latitude 073°24'03.8" and longitude 33°55'09.5" on 2072 meters above sea level. The stand was facing north slope and open canopy. The density of the stand was 113 trees per hectare and basal area was 33.39 m²/hectare. Stand consist of *Abies pindrow* and *Pinus wallichiana* community. Seedlings of *Pinus wallichiana* were rare (20%) whereas seedlings of *Quercus incana* were in abundance (80%) as the associated angiospermic tree species present. Ground flora was missing at different places therefore there was herbs and shrubs were eliminated from the area and found absent in the most abundant and abundant classes. Seedlings of *Quercus dilatata* were frequent (60%) in the stand. *Abies pindrow*, *Juglans regia*, *Populus ciliata*, *Diospyros lotus* and *Olea ferruginea* seedlings were occasionally (40%) present as angiospermic tree species while *Berberis lycium*, *Myrsine africana*, *Rosa moschata*, *Urtica dioica*, *Fragaria vesca*, *Aquilegia vulgaris*, *Narcissus poeticus* were also occasional (40%). *Aesculus indica*, *Prunus cornuta*, *Punica granatum*, *Cornus macrophylla* in the form of seedlings of associated tree species were rarely (20%) present. *Rubus* and *Imperata cylindrical* were also found rarely (20%).

Table.3(a). presented above average value of ORP while conductivity, organic matter, M.W.H.C, D.O, pH and TDS appeared as below average parameters. Salinity appeared in average condition. Table.3(b). presented above average values of Nitrogen, Phosphorus, Potassium and Sodium. The soil texture was sandy clay loam. In Fig.22 young trees of *Pinus wallichiana*, *Abies pindrow* and *Quercus dilatata* occupied the initial classes upto class 9, no mature tree was present. In seedlings, *Abies pindrow* occupied density class from 4 to 7 and after gaps it found in class 10 with low density whereas few *Pinus wallichiana* seedlings were present in class 4 and 7. *Quercus dilatata* was completely absent in the seedling classes.

Stand# 23:

The sampled area was in Bhurban at the latitude 073°27'09.2" and longitude 33°56'69.2" on 1918 meters above sea level. The stand is facing north slope and open canopy. The density of the stand was 94 trees per hectare and basal area was 48.06 m²/hectare (highest basal area). Stand consisted of *Pinus wallichiana* as a pure tree species. The stand consisted of seedlings of *Pinus wallichiana* in rare (20%) condition. Seedlings of *Quercus incana* were in abundance (80%) with the absence of herbs and shrubs in both the classes. Seedlings of *Quercus dilatata* and *Myrsine africana*, *Platanus orientalis* were frequently (60%) present. Seedlings of *Juglans regia*, *Populus ciliata*, *Olea ferruginea*, *Cupressus sempervirens*, *Diospyros lotus*, *Berberis lycium*, *Cassia glauca*, *Rosa mocshata*, *Fragaria vesca*, *Aquilegia vulgaris*, *Narcissus poeticus*, *Viola odorata*, *Urtica dioica* were found occasionally (40%). Seedlings of *Aesculus indica*, *Prunus cornuta*, *Punica granatum*, *Cornus macrophylla*, *Imperata cylindrica*, *Magnolia champaca*, *Symphotrichum dumosum* were found rarely (20%) in the stand.

Table.3(a). presented below average value of conductivity only whereas M.W.H.C, D.O, pH, ORP, salinity, organic matter and TDS appeared as above average parameters. Table.3(b). presented above average values of Potassium, Nitrogen and Sodium while Phosphorus was in below average condition. The soil texture was silty clay loam.

Trees of *Pinus wallichiana* represented from class 3 to 12, the higher the density classes were vacant. Seedlings were 10 in class 4, 7 and 10 as shown in Fig.23. This stand may also be protected or maintained by increasing the number of seedlings.

Stand# 24:

The sampled area was in Bhurban at the latitude 073°27'27.7" and longitude 33°57'54.3" on 1841 meters above sea level. The stand was facing south slope and open canopy. The density of the stand was 98 trees per hectare and basal area was 38.54 m²/hectare. Stand consisted of *Pinus wallichiana* as a pure tree species. Seedlings of *Pinus wallichiana* found rarely (20%) while the seedlings of *Quercus incana* were in abundance (80%) without any mature individual, absence of herbs and shrubs in both the classes. Seedlings of *Quercus dilatata* and *Myrsine africana*, *Platanus orientalis* were frequently (60%) present. Seedlings of *Juglans regia*, *Populus ciliata*, *Olea ferruginea*, *Cupressus sempervirens*, *Diospyros lotus*, *Berberis lycium*, *Cassia glauca*, *Rosa mocshata*, *Fragaria vesca*, *Aquilegia vulgaris*, *Narcissus poeticus*, *Viola odorata*, *Urtica dioica* were found occasionally (40%). Seedlings of *Aesculus indica*, *Prunus cornuta*, *Punica granatum*, *Cornus macrophylla*, *Imperata cylindrica*, *Magnolia champaca*, *Symphotrichum dumosum* were found rarely (20%) in the stand.

In this stand, above average values observed in pH, conductivity, ORP, salinity and organic matter, M.W.H.C while D.O and TDS appeared as below average parameters (Table 4.3a). Table.3(b). presented above average values of Phosphorus and Sodium while Potassium and Nitrogen were in below average condition. The soil texture was sandy clay.

Fig.24 showed worst seedling condition in this stand in which five seedlings were present in class 8 and 10. Trees were also found in few dbh classes *i.e.* 1 to 4. Plants from 5 to 19 classes were seemed to be removed by the people.

Stand # 25:

The sampled area was in Bansra gali at the latitude 073°22'12.6" and longitude 33°53'91.8" on 1781 feet above sea level. The stand was facing north slope and open canopy. The density of the stand was 103 plants per hectare and basal area was 25.39 m²/hectare. Stand consisted of *Pinus wallichiana* and *Pinus roxburghii* community. Seedlings of *Pinus wallichiana* and *Pinus roxburghii* were rare (20%) in the stand. Seedlings of *Quercus incana* were in abundance (80%) with the absence of herbs and shrubs in both the classes. Seedlings of *Quercus dilatata* and shrubs of *Myrsine africana*, *Platanus orientalis* were frequently (60%) present. Seedlings of *Juglans regia*, *Populus ciliata*, *Olea ferruginea*, *Cupressus sempervirens*, *Diospyros lotus*, *Berberis lycium*, *Cassia glauca*, *Rosa mocshata*, *Fragaria vesca*, *Aquilegia vulgaris*, *Narcissus poeticus*, *Viola odorata*, *Urtica dioica* were found occasionally (40%). Seedlings of *Aesculus indica*, *Prunus cornuta*, *Punica granatum*, *Cornus macrophylla*, *Imperata cylindrica*, *Magnolia champaca*, *Symphotrichum dumosum* were found rarely (20%) in the stand.

This stand showed above average values of pH, TDS, conductivity, salinity and ORP while below average values appeared in D.O, organic matter and M.W.H.C as shown in Table.3(a). Elements from chemical analysis of soil samples include Sodium at above average and Nitrogen, Potassium and Phosphorus at below average as shown in Table.3(b).. Soil texture was found to be silty clay.

Dbh size structure (Fig.25) showed tree density from class 1 to 7 in which some trees of *Pinus wallichiana* were present in class 1, 2 and 3 while other classes were occupied by *Pinus roxburghii*. Seedling classes showed *Pinus wallichiana* seedlings in class 4 and 10 while *Pinus roxburghii* was present in only class 4. Both species show poor regeneration/recruitment potential.

Stand # 26:

The sampled area was in Bansra gali at the latitude of 073°27'64.9", the longitude 33°27'61.9" and elevation is 1699 meters high. The stand is facing South slope and open canopy. The density of the stand was 96 trees per hectare and basal area was 31.08 m²/hectare. Stand consisted of *Pinus wallichiana* as a pure tree species. Seedlings of *Pinus wallichiana* were rare (20%). Seedlings of *Quercus incana* were in abundance (80%) with the absence of herbs and shrubs in both the classes. Seedlings of *Quercus dilatata* and shrubs of *Myrcin*, *Platanus orientalis* were frequently (60%) present. Seedlings of *Juglans regia*, *Populus ciliata*, *Olea ferruginea*, *Cupressus sempervirens*, *Diospyros lotus*, *Berberis lycium*, *Cassia glauca*, *Rosa mocshata*, *Fragaria vesca*, *Aquilegia vulgaris*, *Narcissus poeticus*, *Viola odorata*, *Urtica dioica* were found occasionally (40%). Seedlings of *Aesculus indica*, *Prunus cornuta*, *Punica granatum*, *Cornus macrophylla*, *Imperata cylindrica*, *Magnolia champaca*, *Symphotrichum dumosum* were found rarely (20%) in the stand.

This stand showed above average values of pH, ORP and organic matter while below average values appeared in D.O, TDS, conductivity, salinity and M.W.H.C as shown in Table.3(a).. Chemical analysis of soil samples indicated Phosphorus, Nitrogen, Potassium and Sodium at above average as shown in Table.3(b). Soil texture was found to be clay loam.

Fig.26 showed poor recruitment as there were only two classes (4 and 10) occupied by *Pinus wallichiana*. On the other hand tree density showed L shaped condition with *Pinus wallichiana* in class 1 to 7 only.

Stand # 27:

The sampled area was in Ghora gali at the latitude 073°20'89.5" and longitude 33°52'80.7" on lowest location (1636 meters above sea level). The stand is facing north slope and open canopy. The density of the stand was 113 plants per hectare and basal area was 29.53 m²/hectare. Stand consisted of *Pinus wallichiana* and *Pinus roxburghii* community. The stand consisted of seedlings of *Pinus wallichiana* were occasional (40%) while *Pinus roxburghii* were rarely (20%) present. Seedlings of *Quercus incana* were also in abundance (80%) with the absence of herbs and shrubs in both the classes. Seedlings of *Quercus dilatata*, *Myrsin africana*, *Platanus orientalis* were frequently (60%) present. Seedlings of *Juglans regia*, *Populus ciliata*, *Olea ferruginea*, *Cupressus sempervirens*, *Diospyros lotus*, *Berberis lycium*, *Cassia glauca*, *Rosa mocshata*, *Fragaria vesca*, *Aquilegia vulgaris*, *Narcissus poeticus*, *Viola odorata*, *Urtica dioica* were found occasionally (40%). Seedlings of *Aesculus indica*, *Prunus cornuta*, *Punica granatum*, *Cornus macrophylla*, *Imperata cylindrica*, *Magnolia champaca*, *Symphotrichum dumosum* were found rarely (20%) in the stand.

This stand gave above average values of pH, conductivity, ORP and organic matter while below average values appeared in D.O, TDS, salinity and M.W.H.C as shown in Table.3(a). Chemical analysis of soil samples indicated Phosphorus, Nitrogen, Sodium and Potassium at above average as shown in Table.3(b). Soil texture was found to be clay loam.

Fig.27 showed many gaps in seedling classes dominantly occupied by *Pinus wallichiana* seedlings with a small number of *Pinus roxburghii* species. Both the species were found in tree classes 1 to 5. This stand also showed unstable condition since both species will be eliminated if seedling population was not increased and maintained properly.

Stand # 28:

The sampled area was in Forest house located in Ghora gali at the latitude 073°20'82.5" and longitude 33°52'77.9" on almost lowest location (1638m above sea level). The stand was facing south slope and open canopy. The density of the stand was 116 trees per hectare and basal area was 28.81 m²/hectare. Stand consisted of *Pinus roxburghii*, *Cedrus deodara* and *Quercus baloot* community. The stand lacked most abundant (100%) class from its area which had a poor condition of ground flora due to frequent human activities of urbanization and presence of livestock in the area. Seedlings of *Quercus incana* represented the abundance (80%) class. Seedlings of *Quercus dilatata* represented the tree species in frequent (60%) class while the presence of *Pinus roxburghii*, *Cedrus deodara*, *Quercus baloot* was rare (20%). No shrubs present in this class while *Myrsine africana* and *Platanus orientalis* were present frequently (60%). Seedlings of *Aesculus indica*, *Populus ciliata*, *Diospyros lotus*, *Olea ferruginea*, *Juglans regia*, *Cupressus sempervirens* were present occasionally (40%) as tree species in this stand while *Berberis lycium*, *Rosa mocshata*, *Urtica dioica*, *Fragaria vesca*, *Aquilegia vulgaris*, *Narcissus poeticus* were also present occasionally (40%) on the ground. Seedlings of *Prunus cornuta*, *Punica granatum*, *Cornus macrophylla*, *Magnolia champaca* present rarely (20%) in the stand.

Ghora gali stand consisted of pH, ORP and organic matter as above average parameters while D.O, conductivity, salinity, TDS, M.W.H.C and ORP were below average parameters as shown in Table.3(a). Table.3(b). showed Phosphorus at above average while Nitrogen, Potassium and Sodium at below average. The soil texture was silty clay loam.

Fig.28 showed gaps in seedlings classes occupied by *Pinus roxburghii* and *Quercus baloot*. No seedling of *Cedrus deodara* was found indicating this species will eliminate in future. *Pinus roxburghii* will be supported by increasing its seedlings. Tree classes showed *Cedrus deodara* and *Quercus dilatata* trees with *Pinus roxburghii* and *Quercus baloot* from class 1 to 5. Only young trees and poles were present in this stand.

Stand # 29:

The sampled area was in T-Base in Dewal road at the latitude 073°25'76.6" and longitude 33°52'38.9" on 1858m above sea level. The stand was facing south slope and open canopy. The density of the trees was 128 per hectare and basal area was 37.85 m²/hectare. Stand consisted of *Pinus roxburghii* and *Quercus dilatata* community. The most abundant (100%) class of understorey vegetation was absent in this stand which was due to the developmental projects running nearby areas for tourism. Seedlings of *Quercus incana* represented the abundance (80%) class as only tree species while no herb or shrub found in this class as well as in most abundant class. Seedlings of *Quercus dilatata* and *Pinus roxburghii* present in the frequent class (60%) as tree species of the stand. No shrubs present in this class while *Myrsine* and *Platanus orientalis* were present frequently (60%). Seedlings of *Aesculus indica*, *Populus ciliata*, *Diospyros lotus*, *Olea ferruginea*, *Juglans regia*, *Cupressus sempervirens* were present occasionally (40%) as tree species in this stand while *Berberis lycium*, *Rosa mocshata*, *Urtica dioica*, *Fragaria vesca*, *Aquilegia vulgaris*, *Narcissus poeticus* were also present occasionally (40%) on the ground. Seedlings of *Prunus cornuta*, *Punica granatum*, *Cornus macrophylla*, *Magnolia champaca* present rarely (20%) in the stand.

The stand consisted of pH, TDS, ORP and organic matter as above average parameters while D.O, salinity, conductivity and M.W.H.C were below average parameters as shown in Table.3(a). Table.3(b). showed Sodium, Nitrogen, Potassium and Phosphorus at above average. The soil texture was clay loam.

Pinus roxburghii trees were presented in classes 1 to 6 with some trees of *Quercus dilatata*. Both the species had seedlings in lower density with gaps in seedling classes. Seedlings are in unstable condition. It should be promoted to protect *Pinus roxburghii*.

Stand # 30:

The sampled area was in T-Base in Dewal road at the latitude 073°25'79.0" and longitude 33°52'44.0" on 1789m above sea level. The stand was facing north slope and open canopy. The density of the stand was 104 trees per hectare and basal area was 37.53 m²/hectare. Stand consisted of *Pinus roxburghii* pure stand. Seedlings of *Quercus incana* and *Pinus roxburghii* represented the abundance (80%) class as only tree species while no herb or shrub found in this class as well as in most abundant (100%) class. Seedlings of *Quercus dilatata* present in the frequent (60%) class as tree species of the stand. No shrubs present in this class while *Myrsine*

africana and *Platanus orientalis* were present frequently (60%). Seedlings of *Aesculus indica*, *Populus ciliata*, *Diospyros lotus*, *Olea ferruginea*, *Juglans regia*, *Cupressus sempervirens* were present occasionally (40%) as tree species in this stand while *Berberis lycium*, *Rosa mocshata*, *Urtica dioica*, *Fragaria vesca*, *Aquilegia vulgaris*, *Narcissus poeticus* were also present occasionally (40%) on the ground. Seedlings of *Prunus cornuta*, *Punica granatum*, *Cornus macrophylla*, *Magnolia champaca* present rarely (20%) in the stand.

The stand consisted of conductivity, TDS, ORP, salinity as above average parameters while pH, D.O, organic matter and M.W.H.C were below average parameters as shown in Table.3(a).. Table.3(b). showed Sodium at above average while Potassium, Nitrogen and Phosphorus at below average. The soil texture was sandy clay loam.

This stand presented 14 seedlings of *Pinus roxburghii* in classes 4, 5 and 10 while *Pinus roxburghii* trees were found in classes 1 to 7. Like other stands, this stand show young trees in L shape structure, but seedling situation is not stable. To protect this forest, seedling number should be increased and maintained.

Table.4.showing correlations among Tree density, basal area and seedling density.

Correlations(All stands)	R ² - value	P – value
T.D v/s B.A	0.184	Non- Significant
T.D v/s S.D	0.001	Non- Significant
B.A v/s S.D	0.020	Non- Significant

Note: T.D = Tree density, B.A = Basal area and S.D = Seedling density.

As shown in Table 4.4 correlation between tree density and basal area, tree density and seedling density as well as correlation between basal area and seedling density were non-significant in all 30 stands due to the higher nature of disturbance.

Disturbance lies at every level in the whole Murree forest. The emphasis of this chapter has given to size class structure of seedlings and trees. This size structure is presented on the basis of dbh which is the key for the formation of stem sizes. Particular attention has given to the seedlings and saplings to determine regeneration potential of the forest as they are highly influenced by certain external factors. According to Goff and Zedler (1968), the study sites can be examined by both species and habitat so as to confer their relationship on regional scale. The chapter also focuses on the density and basal area and diameters of the local pine species which are the primary requirements for all further statistical estimations. The pine species are compared with each other to determine the kind or future trend of relationship of these species with each other and with a set of environmental conditions prevailing in the area. Pederson *et al.* (2007) has compared the age of different species and concluded that this comparison is an important struggle for better understanding of growth and environmental relationship of trees.

From the present survey, four pine species (*Pinus wallichiana*, *Pinus roxburghii*, *Cedrus deodara*, *Abies pindrow*) occurred in dominating position at different stands some are found associated with angiospermic tree species.

Density hec^{-1} and Basal area $\text{m}^2/\text{ha}^{-1}$:

There is a clear differentiation in each stand in their density hec^{-1} and basal area hec^{-1} . Historical backgrounds and environmental factors are assumed to be the regulators of stem density. It shows the existence of only 4 pine species in Galyat of Murree Hills that persist in the valleys while facing different kinds of interference like deforestation as the main issue of the area. *Pinus wallichiana* has appeared to attain the highest absolute density and absolute basal area in most of the stands. Different sizes of *Pinus wallichiana* stems are found widely distributed throughout the forest i.e. from lower elevation to the top of the hills in both pure stand and mosaic patches. The species showed a reasonable values of density and basal area per hectare when present with other pine species (*Pinus roxburghii*, *Abies pindrow*, *Cedrus deodara*) as well as with other associated angiospermic tree species (*Quercus baloot*, *Quercus incana*, *Aesculus indicum*). *Pinus wallichiana* observed in a good association with *Pinus roxburghii* as the both the species found in the form of community at lower elevations in the locations of Bhurban, Forest house (Ghora gali) and Jhika gali; attaining greater values of absolute density and basal area. Mixed community of blue pine and cheer pine produced a comprehensive appearance of ecosystem as there was a variety of understory and associated other angiospermic tree species were also present in greater frequency in those stands. *Pinus wallichiana* formed single pine stand at different Galyat like Nathia gali, Jhika gali, Thana Phagwari, Bansra gali, Bhurban, Ghora gali. The species showed high density ha^{-1} in all pure stands while there is variation in basal area ha^{-1} as it showed higher and lower values at the stand of Thana Phagwari. The results proved *Pinus wallichiana* to be the dominant species in Galyat of Murree as it stands across all kinds of ecological gradients in the valleys even in the phase of destruction in the area. Similar studies produced by Ahmed and Naqvi (2005), they mentioned 96 plants/ ha^{-1} of *Pinus wallichiana* from Miandam that attained 18% basal area. Ahmed *et al.* (2006) presented *Pinus wallichiana* densities from

different areas of Pakistan at different climatic zones like from Balochistan (Takht e Sulaiman) 337 stems ha^{-1} were recorded which is a great density level at such a dry forest, from Rama (a northern area), 232 stems hec^{-1} were recorded and from Nalter (Gilgit) 387 stems hec^{-1} were recorded. Our density values (85 to 159 ha^{-1}) are considerably lower than previous studies in least disturbed forests. Hence *Pinus wallichiana* has appeared to be one of the most successfully distributed and tolerant species as by origin it is a species of conifers of moist temperate climate. *Pinus wallichiana* were also found in community with *Abies pindrow* and *Cedrus deodara*. *Abies pindrow* is a species of higher elevations such as Nathia gali, Dunga gali, Ayubia but very few trees of *Abies pindrow* were also found in Serbagla in association with *Pinus wallichiana* and *Cedrus deodara* which is a relatively lower elevated area than Ayubia (high elevation point). In the past, it was assumed that there might be more communities of *Abies pindrow* in that area as the signs of its presence have observed from present study but it is also observed to be eliminating from these areas due to the vulnerable climatic conditions in these regions as *Abies pindrow* is known for the pine species of cooler regions. From another study conducted on Murree Hills by Ahmed *et al.* (2006), 71% of the total density and 65% of the total basal area of *Abies pindrow* was recorded from Dunga gali. Siddiqui (2011) concluded *Abies pindrow* as the second highest density attaining species in the moist temperate areas of Pakistan. Our values of this species were also considerably lower than above mentioned studies.

Cedrus deodar was also found in the form of mosaic patches at high elevations above 5800ft. *Cedrus deodar* is thought to be rapid respondent to topographic conditions hence it is also found to be eliminating or migrating from Murree Galyat may be because of constructions in the area that has changed the topographic conditions as well as climatic conditions. Ahmed *et al.* (2006) recorded 336 stems hec^{-1} of *Cedrus deodar* and 82 $\text{m}^2\text{hec}^{-1}$ from Matian glaciers at 2350m, while 433 stems hec^{-1} and 78 $\text{m}^2\text{hec}^{-1}$ were recorded from Charyan rest house near Murree Hills. This species is also in degraded condition in present area. According to Champion *et al.* (1965) it preferred dry temperate areas.

Density Size Class Structure:

The development of density size classes is a useful way for the estimation of present and future trends of any species in a forest. It may also helpful for the current situation and future predictions of forest health. By presenting density size classes a "Climax" can be easily identified as it is found absent or replaced by other species which may be a pine species or it may be any angiosperm. Moreover, if a species appears in only the largest size classes or in the form of older trees only then it would be presumed as it will be replaced or eliminated in the coming years. (McCune and Grace, 2002). The mortality rate of trees in the past years of any study is although very difficult to quantify but age frequency distribution classes contain some historical signatures about the species mortality in a stand. According to Ogden (1985) the size class distribution structure are also reliable. Regeneration gap can be emphasized by the sampling at selective small scale stands. (Wardle, 1963).

Size class structure in diagrams show that some pure stands of pine species are more frequently distributed in small size classes while in case of mosaic mixed stands, the frequency distribution have gaps in the classes. The seedling size classes i.e >0.1 and $\leq 1\text{cm}$ classes show poor frequency distribution in almost all stands except in stand 4, *Pinus wallichiana* recorded to be widely distributed in all seedling classes as compared to tree classes. *Pinus wallichiana* in mosaic stands with other pine species like *Abies pindrow* and *Cedrus deodara* appeared dominantly in some of the stands as well as occupied lower number in size classes and trees which confirm the current firmness of the species in the area and also be predicted as the era of blue pine in the coming years however the poor number and scattered distribution of seedling size classes is alarming. The concentration of individuals of *Pinus wallichiana* in the stands with associated angiosperm species like *Quercus baloot*, *Quercus dilatata* and *Aesculus indica* are rarely associated due to cutting of pine wood.

Pinus roxburghii was observed more flourished in pure form as the density classes are well distributed in the stands. The number of individuals of the pine species is low in the stand and it appeared to be restricted to initial tree classes upto medium tree class only hence the mature tree classes are absent, similarly a very few number of individuals recorded in seedling size classes therefore a poor regeneration potential of the species can be concluded. The most likely reason is that the areas have heavy construction projects that cause mortality to the newly formed seedlings.

In undisturbed forest, gaps in size class structure are considered as generation gaps. These gaps are created due to extremely slow or no growth of light demanding tree seedlings. This way no proper recruitment of trees from seedling growth is taken place. When mature tree falls due to its maximum age, sickness, storm or logging, sunlight reaches to ground and new young seedling have chance to grow faster (Ahmed *et al.*, 1984). According to Ahmed (1984 and 2008) this situation does not existed in Pakistan's forests due to a long history of logging even in least disturbed forest. In addition, little is known about the seedling of natural tree species about their light or shade demanding nature. However, like other workers *i.e.* Ahmed (1984), Ahmed *et al.* (1991 and 2006), Khan (2011 and 2017), Wahab (2011), Akber (2013), Hussain (2013), Siddiqui (2013), Iqbal (2017) it is

concluded that these gaps are due to over grazing, different types of construction and large scale of cutting of trees.

Correlations

Ahmed *et al.* (1991) found significantly positive correlation among stand density, basal area and seedling density while working in Juniper forest and *Pinus gerardiana* forest of Baluchistan since young seedling required shade for their establishment. In addition, Siddiqui (2011) estimated significant correlation between tree density and basal area of conifers from moist temperate areas in least disturbed locations. Wahab *et al.* (2008) found no correlation between tree density and basal area on *Picea smithiana* trees. However, our results did not show any relation among these variables, might be due to logging, more space among plants created more sun shine on ground, over grazing and plants clearing for pasture and loss of seeds during rainy season. Edaphic conditions are supposed to be great factor to predict succession and development of behavioral statistics of a forest. Malik *et al.* (1973) and Jones (1983) studies soil samples from Dir that had pH in between 5.8 to 6.5 which favored the growth of conifers in the area. Soil from Baluchistan forest consisted of nearly neutral pH (7.1 to 7.8) which supported better health of *Pinus gerardiana* trees. Our soil study showed more basic results in pH, which is not an ideal pH value to produce vegetation. Siddiqui (2011) analyzed soil from the undisturbed forests from the same area, salinity was very low *i.e.* -0.1 to 1.3% which is similar with the current studies as both show low salinity level. TDS was also recorded by Siddiqui (2011) found in the range of 16.8 to 377 mg/ltr whereas present study showed lower TDS from the disturbed sites of the same areas. Organic matter from Pir Chinasi Hills, Azad Kashmir which is also a moist temperate area was in the range of 3.3 to 6.7% (Malik *et al.*, 1973). The organic matter of present study was estimated to be higher *i.e.* 5.58 to 9.08% showing more potential for regeneration but due to higher disturbance it was not possible in this area. Water holding capacity (WHC) was highest observed in Kumrat (65%) and lowest (32.5%) with a vigorous forest growth (Siddiqui, 2011). Our study area consisted of 21% (lowest) and 51% (highest) WHC which is poor moisture level and could produce adverse growth condition. Lowest amount of Nitrogen was recorded by Malik (1973) from Dir *i.e.* 0.13 to 0.16% which is similar to our studies *i.e.* (0.11 to 1.24%) showing poor condition of availability of this macronutrient for the vegetation. Malik *et al.* (2007) observed Potassium concentration as 100 to 500ppm from Pir Chinasi Hills, Azad Kashmir which is an ideal concentration for a forest while current study estimated lower concentration of another macronutrient proving less appropriate situation for vegetation growth. Soil conditions were not appeared towards promotion of forest as well as the regeneration signs were also concluded to be poor due to lack of nutrients and other parameters were also not in ideal form.

It is concluded that due to highly disturbed nature no significant relation was possible among absolute values of vegetation and soil characteristics. It is suggested that to save and protect these forests and infra structure, grazing, tree cutting should be stopped and plantation should be promoted in these areas.

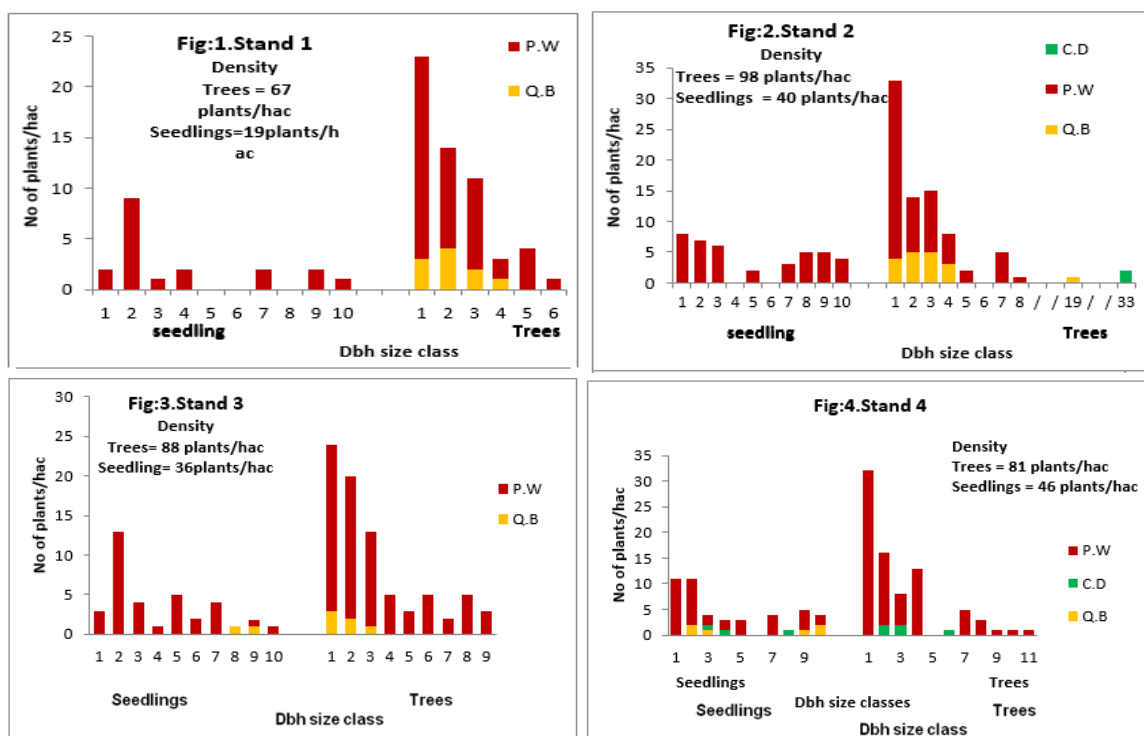
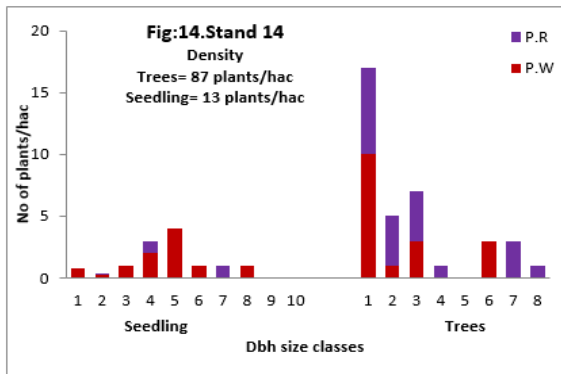
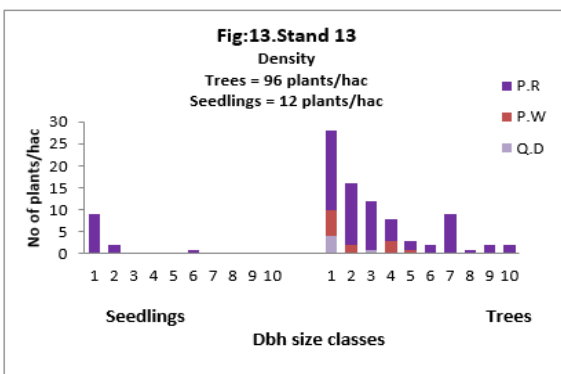
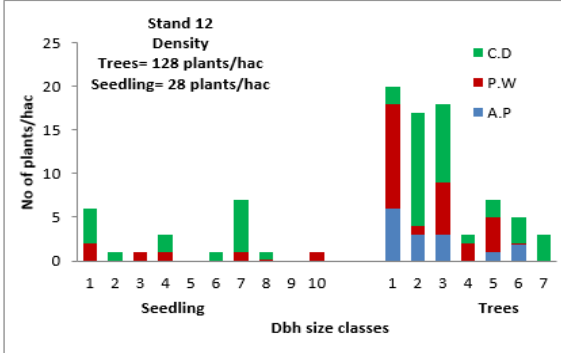
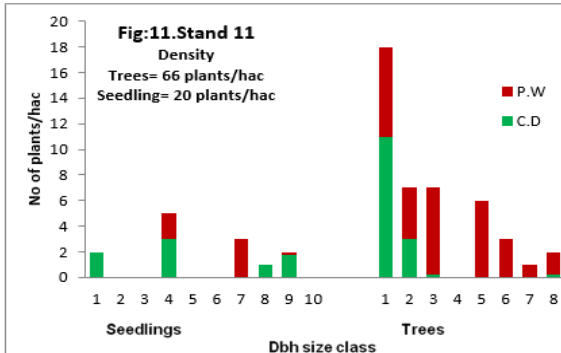
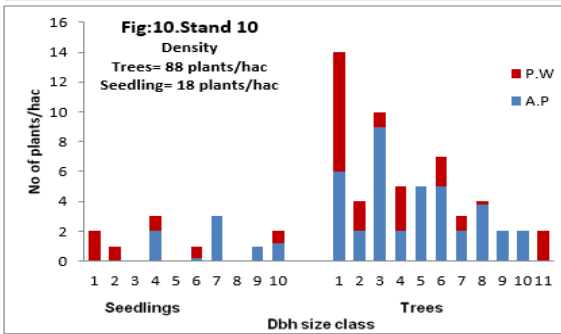
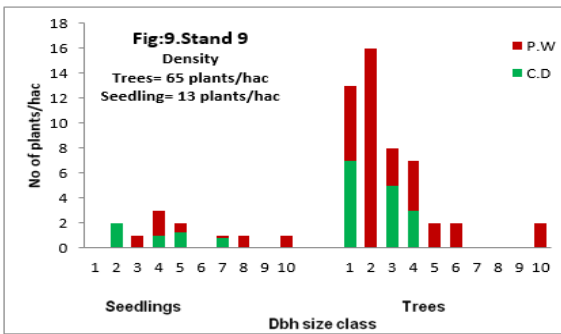
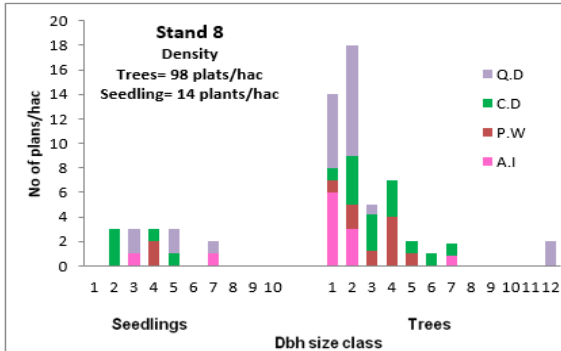
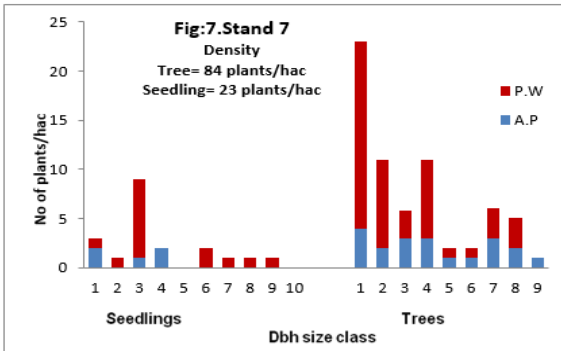
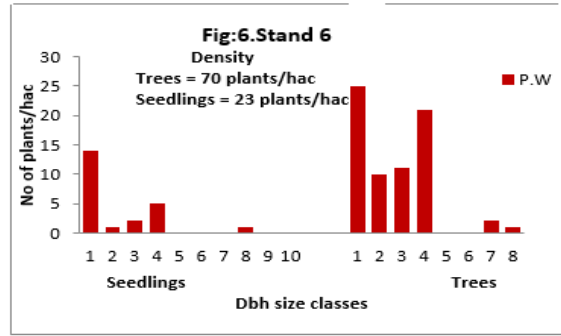
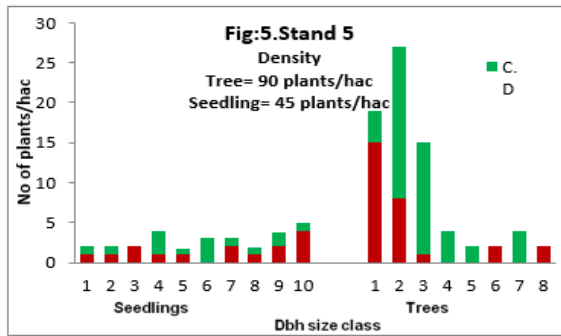
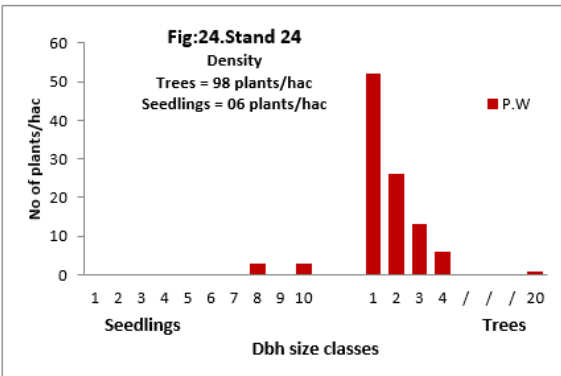
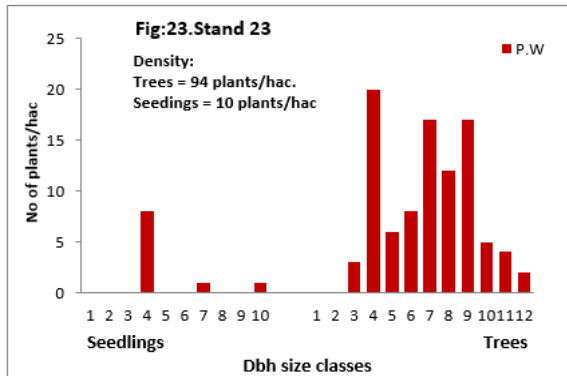
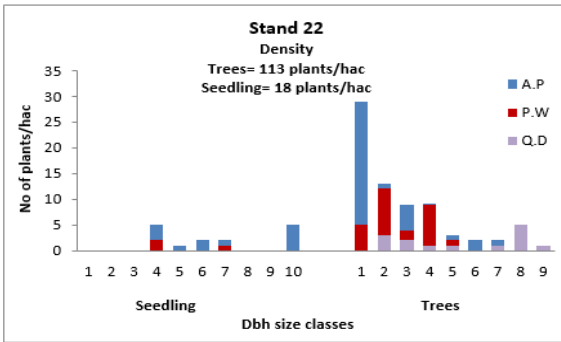
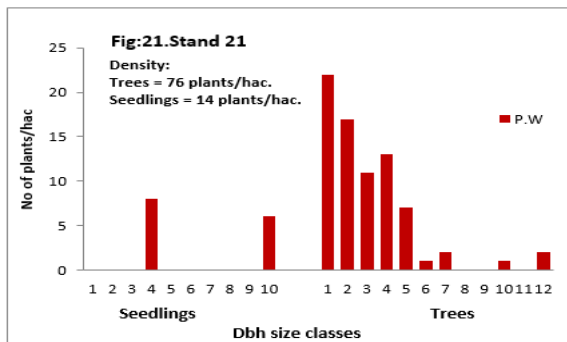
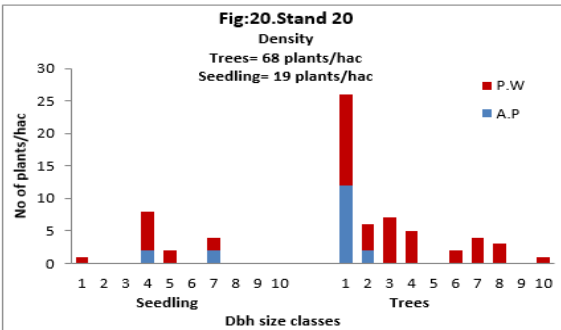
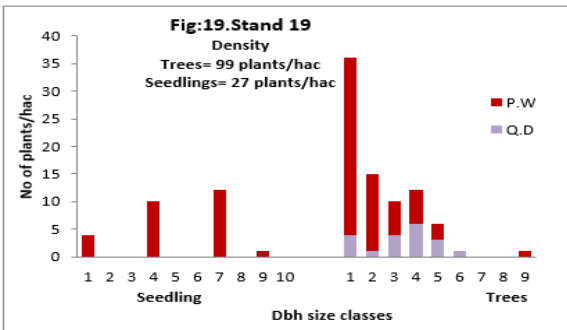
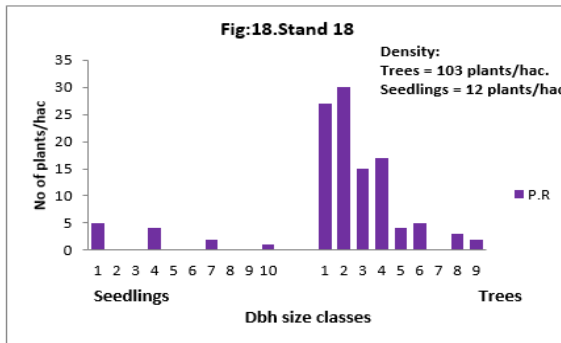
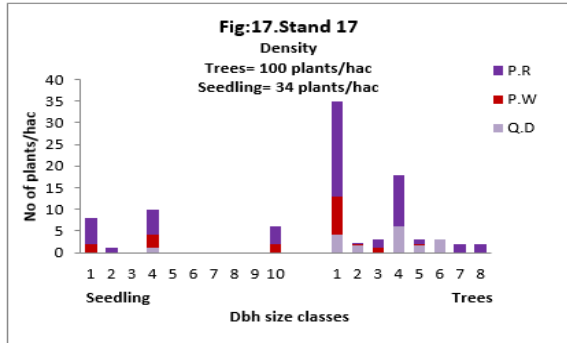
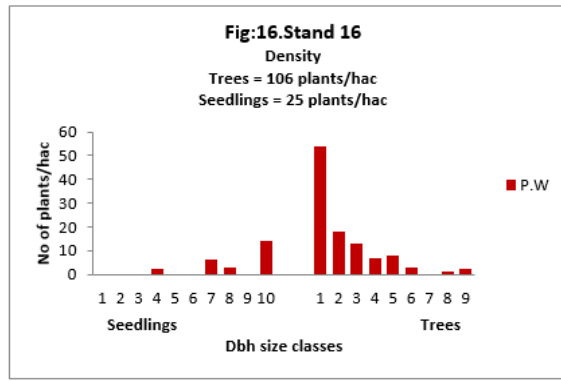
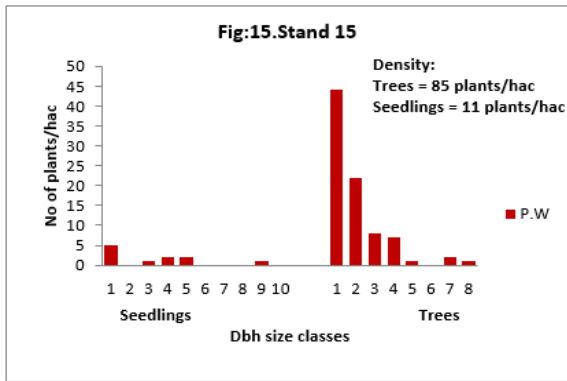


Fig. 4. Size class distribution of species in each stand.





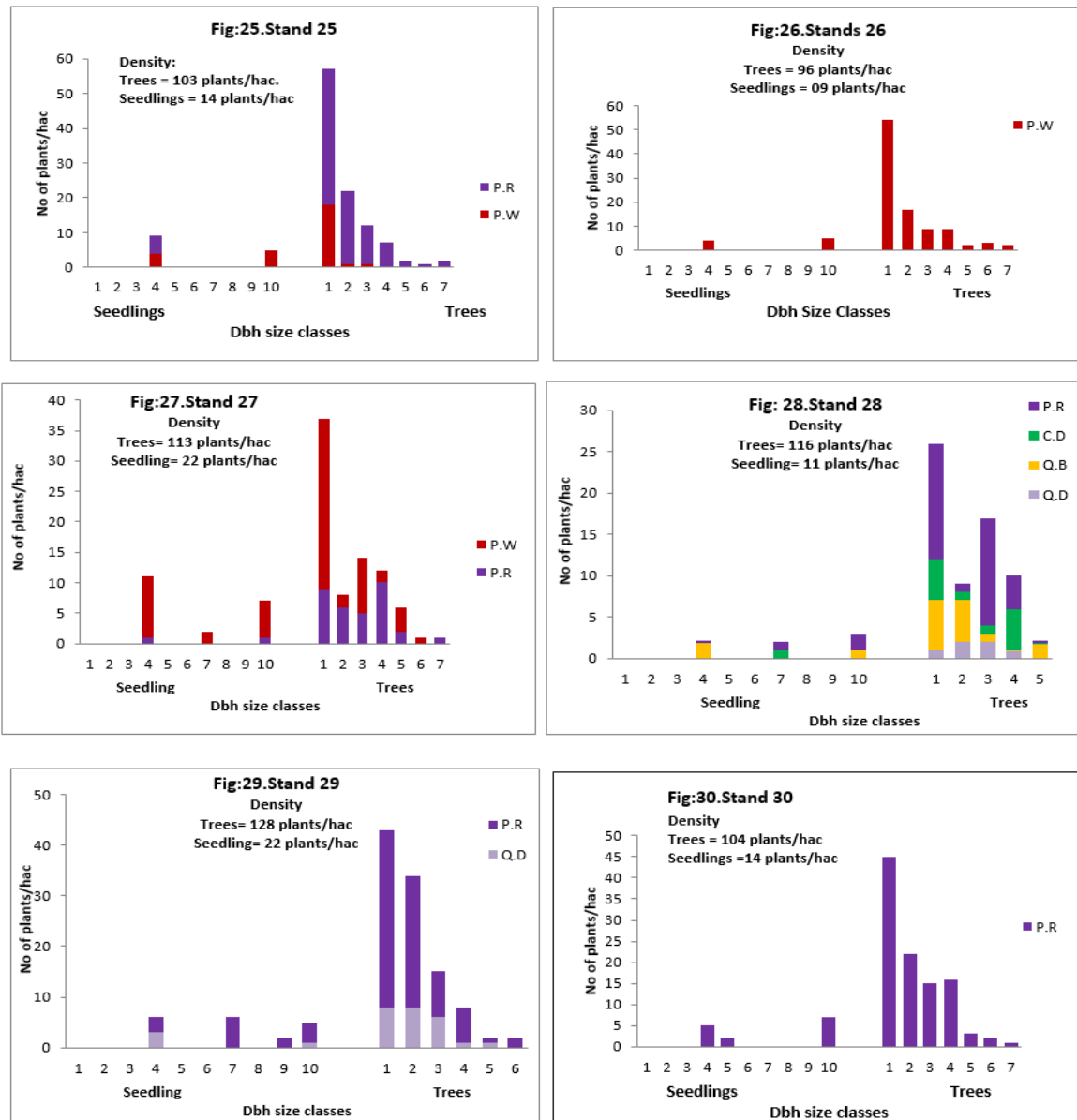


Fig.(1 to 30). Showing density.ha⁻¹ in each Dbh size class of seedlings and trees.

Acknowledgement

I want to acknowledge Department of Forestry, Punjab and Khyber Pukhtunkhuwah.

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