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Regenerational Analysis of Seedlings and Saplings of Badshahithaul Forest Area of Chamba Block (Near New Tehri Town), District Tehri Garhwal, Uttarakhand, India

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ARTICLE INFORMATION

ABSTRACT

Vegetation ecology lays emphasis on study of composition, development; geographic distribution and environmental relationship of plant communities, plants growing together have mutual relationship among themselves and with the environment. The quantitative relationship between rare and profusely growing species is an important structure property of a community. The Uttarakhand Himalaya falls in central Himalayan region of the Himalaya. The study was conducted in a part of mid Himalayan forest in and around Badshahithual Forest area of Chamba Block of district Tehri Garhwal. Three sites were selected for the study viz., North site, East site, and North-East site.. A total of 8tree species occurred in all three study areas. The common species in all three study zones are Quercus leucotrichophora, Myrica esculenta and Pinus roxburghii. Maximum concentration of dominance value is found for East Site i.e. (0.5) for sapling and (0.4) for seedling of Badshahithaul forest. The minimum concentration of dominance value is recorded for North East- site i.e. 0.3 for seedling and sapling respectively in the study area. The maximum value of diversity Index was recorded for Badshahithaul forest East facing slope 0.4 for seedling and 0.5 for sapling. The concentration of dominance is comparatively high at East-slope at Badshahithaul Forest (0.4 for seedling 0.5 for sapling). The Index of similarity observed for different Forest ranges between (0.3) to (0.8) for seedling and saplings. The index of similarity has been calculated between the North and North-East Site of Badshahithaul forest which is found (0.8) for seedling and sapling. In second step Index of similarity was calculated between North-East and East site of Badshahithaul forest which is reported (0.6 for seedling and (0.5) for sapling. In third step the index of similarity value was calculated between East and North site of Badshahithaul forest which is reported (0.5) for seedling and (0.3) for sapling, which shows that maximum index of similarity (0.8) both for seedling and sapling.

Introduction

Vegetation ecology is the study of structure of vegetation and vegetation systematic. This includes the investigation of species composition and the sociological interaction of species in communities (Mueller-Dombois and Ellenberg, 1974). It lays emphasis on study of composition, development; geographic distribution and environmental relationship of plant communities, plants growing together have mutual relationship among themselves and with the environment. Interaction among different plants and between plants and their environment is outcome of different vegetation types in different areas. The quantitative relationship between rare and profusely growing species is an important structure property of a community. There generational potential is the ability of species to complete the life cycle. Regeneration is a key process for the existence of species in a community under varied environment conditions. The Himalayan region has always been an object of botanical research since long. Champion (1933,1956) has made a preliminary survey of the forest types of India, which was later revised by Champion and Seth (1968) in which they discussed the regeneration and management of different forest types of Himalaya. Singh (1985) reviewed the work done on the environmental

regeneration of forest in central Himalaya. It would be worth to mention here that in 1911 of the total area of Kumaun and Garhwal Himalayas there was 86% forest Covered, however in 1911 it was reduced to 38% (Tiwari, 1981).This shows a dramatic reduction in the forest cover in the Himalayan zone and it needs the studies on environmental regeneration of tree species other quantitative forests at different elevation. Tree population structure and its implication for their regeneration has been studied for different forest forests stands of the Himalaya, such as Western Himalaya (Baduni and Sharma, 2001), Eastern Himalaya (Sundriyal and Sharma, 1996) and North Eastern region (Bhuyan, 2002, Bhuyan *et al.*,2003).

In natural forests of India, various studies were conducted by several workers on seed characteristics, seed germination, seedling growth and their population dynamics is response to various environmental conditions and disturbance (Bhuyan, 2002, Saxena and Singh, (1982,1984) Regenerational studies have carried out by several workers in different forests of India. Adhikari RS,Tiwari A. 1991; Bandopadhyay S(2018); Burns BR (1995) and Dutta G, Devi A(2013) have worked in the Western Ghats. In Eastern Ghats work had been reported by several workers such as Korner C*.,* (2007); Malik Z A and Bhatt B, (2016) and Gaur RD*.,* (1999) and Grubb Pj, (1977) have worked in central India. From the Himalayan regions, Shankar, (2001); Kharkwal and Rawat and Rawat,(2010) and Ahmed, (2012) might be mention. Such Studies are very lacking in relation to Tehri Garhwal forest except few workers Saxena and Chaturvedi (1985-1986) , Pramod Kumar (1998), Asha Dobhal (2003).

Fig. 1A Map of Uttarakhand and its districts   **B** Map of Tehri Garhwal

Materials and methods
Study Area
The Uttarakhand Himalaya comes in central Himalayan region. Uttarakhand state lies between latitudes 28^0 43' to $31^0$27' N and longitudes 77^0 34' to 81^0 02' E extending from river tons in the west to river Kali in the East. Tehri Garhwal district is bounded by Uttarkashi from the North side, Pauri Garhwal from the South-Side, Rudraprayag from the East-Side and Dehradun from the west side. It covers the 3642 km^2 area of the state. The study area is situated in Chamba block at Badshahithaul forest of district Tehri Garhwal. The present study was conducted between years 2017 to 2019 in all prominent seasons *viz.* summer, rainy and autumn. The Forest of the present study is temperate moist types. The Topography is hilly slopes. The climate of the study area is monsoonal sub mountain type. The average minimum and maximum temperature are 9.55° and 19.47°C respectively, and the average annual rainfall is 108.88mm. In these temperate moist types' forests, *Quercus leucotrichophora* is the dominant over story Species, and *Eupatorium fanadulosum* as understory associated species. Three different layers in these forests clearly distinguished, *Quercus leucotrichophora* occupying the top story followed by *Pinus roxburghii* in the middle story, and the understory shrubs and herb layer.

1.*North Site***:** This site is located about 5 km far from New Tehri Town. This site is dominated by *Quercus* forest containing some other tree species.
2. North- East Site: The site is located about 5 km. far from Govt.PG Collage New Tehri. It is mixed forest containing various tree species. The elevation of the area studied is more than 1750 meter above sea level, and dominated by *Quercus leucotrichophora and Rhododendron arboreum.*
3. East Site: The site is located about 5 km far from New Tehri Town. The forest canopy of study area is dominated by Pine forests; it is almost undisturbed dense pine forest.

The study area of Badshahithaul forest deals with some Vegetation analysis, diversity, Concentration of dominance and index of similarity. A number of indices have been devised to express species diversity which is most commonly used index of general diversity in order to compare two communities. The Regeneration studies of these sites were conducted during the rainy season for seedlings and saplings in 2017-2019. The vegetation was analyzed via. Random sampling too obtain the most representative composition of the vegetation. The vegetation survey was carried out using the nested quadrate method. Ten Quadrates, each of 5m^2

size, were laid down on each site for the purpose of studying the trees. In each tree quadrate the circumference at breast height (CBH) i.e. at 0.3 m above ground level) of each seedling and 0.6 for saplings was measured. All the individuals were identified up to species level. The unidentified specimens were photograph and/ or collected and identified later consulting plant taxonomists, herbaria and literature. The utility Index of important species of the site was also collected with concerned literature as well as the information from villagers. The forests fire damage to the vegetation and soil of the area. The forest area near the road side faces the high disturbance by local people and their cattle. The road construction has also affected the vegetation of the forest. The forest areas have been studied by Quadrate method (Curtis and McIntosh, 1950) after listing the trees on one slope. The Number of Species for each slope as enumerated as the species richness (Whittaker 1960). The species was identified with the help of regional flora, Flora of district Garhwal (Gaur, 1999). The size of quadrate taken was 10×10 sq meter for trees (Misra1968).

The present study has the following objectives:
To study the structure and composition of the forest of study; To determine the quantitative features of the seedlings and sapling of the forest of study; To determine the similarity index,

Formulas used for different quantitative characters such as frequency, density, dominance, their relative values and important value index (IVI) are as follows:

$$\% \text{ Frequency} = \frac{\text{No. of quadrates of occurrence of a species}}{\text{Total number of quadrate studied}} \times 100$$

$$\text{Density (unit area)} = \frac{\text{Total no. of individuals of a Sp. in all quadrates}}{\text{Total number of quadrate studied}}$$

$$\text{Abundance} = \frac{\text{Total number of individuals of a species in all quadrates}}{\text{Total number of quadrate in which species occurred}}$$

$$\text{A/F Ratio} = \frac{\text{Abundance value of a species}}{\% \text{ frequency value of a species}}$$

Mean Basal Area (MBA) $= \frac{C^2}{4\pi}$; *Where C = Average circumference of a species π = 3.14*

Total Basal Cover (TBC) = MBA × Density of the species

$$\% \text{ Relative Frequency} = \frac{\text{Frequency value of a species}}{\text{Sum of frequency value of all species}} \times 100$$

$$\% \text{ Relative Density} = \frac{\text{Density value of a species}}{\text{Sum of density value of all species}} \times 100$$

$$\% \text{ Relative Dominance} = \frac{\text{TBC value of a species}}{\text{Sum total of TBC value of all species}} \times 100$$

Importance Value Index (IVI) = Relative Frequency + Relative Density + Relative Dominance

Diversity and Concentration of Dominance
The index of dominance or the concentration of dominance (Cd) is calculated by using Simpsons (1944) index as:-

Index of Dominance (Cd) = $\sum (ni/N)^2$

The index of diversity (H) was computed by using Shannon and Wiener's information index (Shannon and Wiener 1963).

Diversity Index (H) = $-\sum [(ni/N) \log (ni/N)]$
Where, ni = Importance value (density) of each species; N = Total importance value of all species

The Index of Similarity (S) is calculated to compare the forest of two elevations (Whittaker 1967) as:

S = 2C/A+B

Where, C = Number of common species occurring in both communities; A = Number of species in forest A; B = Number of species in forest B

Results

Field observation and analysis of seedlings and saplings on Badshahithaul forest area (North site) are given in Table 1a and 1b respectively.

Table 1a : Regeneration Analysis Of Seedling Of North-Site.

SN	Name Of Species	F (%)	D	A	MBA	TBC	RF (%)	RD (%)	RDo (%)	A/F (%)	IVI
1	*Quercus leucotrichophora*	100	17.4	17.4	0.019	0.33	38.46	71.60	87.76	0.17	197.8
2	*Rhododendron arboreum*	80	5.4	6.75	0.003	0.016	30.76	22.22	4.25	0.08	57.23
3	*Myrica esculenta*	60	1.3	2.16	0.0007	0.0009	23.07	5.34	0.23	0.03	28.64
4	*Lyonia ovalifolia*	20	0.2	01	0.179	0.03	7.692	0.82	7.97	0.05	16.48

Table 1b : Regeneration Analysis Of Sapling Of North-Site.

SN	Name Of Species	F (%)	D	A	MBA	TBC	RF (%)	RD (%)	RDo (%)	A/F (%)	IVI
1	*Quercus leucotrichophora*	100	6.7	6.7	0.71	4.75	34.48	46.85	35.34	0.067	116.67
2	*Rhododendron arboreum*	90	5.9	6.5	1.27	7.49	31.03	41.25	55.72	0.072	128
3	*Myrica esculenta*	70	0.7	01	0.71	0.49	24.13	4.89	3.64	0.014	32.66
4	*Lyonia ovalifolia*	30	01	3.33	0.71	0.71	10.34	6.99	5.28	0.11	22.61

Quercus leucotrichophora has maximum density value (17.4 for seedling, 6.7 for saplings) followed by *Rhododendron arboreum (5.9 for saplings, 5.4 for seedlings* and *Myrica esculenta* (1.3 for seedling and0.7 for sapling). The minimum density value is shown by *Lyonia ovalifolia* (0.2 for seedling, 1 for saplings). The highest frequency % on this site was shown by *Quercus leucotrichophora* (100% both for seedling and sapling) followed by *Rhododendron arboreum (seedling 80%, sapling 90%* and The minimum frequency value is shown by *Lyonia ovalifola* (20% seedling, sapling 30%). The highest value of relative frequency on this site is shown by *Quercus leucotrichophora (seedling 38.46%*, sapling 34.48%) followed by *Rhododendron arboreum* (seedling 30.76%,sapling 31.03%). The highest value of relative density is shown by *Quercus leucotrichophora*(seedling 71.60%,sapling 46.85%) followed by *Rhododendron arboreum (22.22 %seedling ,sapling41.25%*).The minimum relative density value is shown by *Myrica esculenta* (4.89 sapling) *Lyonia ovalifolia* (0.82 seedling). The highest value of relative dominance is reported for *Quercus leucotrichophora* (seedling87.76, sapling35.34) followed by *Rhododendron arboreum* (seedling 4.25, sapling 55.72).The minimum relative dominance is shown by *Myrica esculenta* (0.23 seedling,3.64 sapling). *Quercus leucotrichophora* is the most dominance species in this site. This species has maximum Importance Value Index (197.8 for seedling), but in sapling the most dominant species is *Rhododendron arboreum* having IVI 128

Field observation and analysis of seedlings and saplings on Badshahithaul area (East-Site) are given in Table 2a and 2b respectively.

The *Quercus leucotrichophora* has maximum density value (9.2 for seedlings, 2.7 for saplings) followed by *Rhododendron arboreum* (1.8 for seedling, 1.7 for sapling). The minimum density value is shown by *Prunus ceracoides and Lyonia ovalifolia*(0.2 for seedlings ,0.1 for saplings). The highest frequency percentage on this site is shown by *Quercus leucotrichophora* (100% for seedlings, 90% for saplings) followed by *Rhododendron arboreum* (80% seedling, 50% saplings).

The minimum frequency percentage value is shown by *Prunus ceracoides* (10% seedlings) *Lyonia ovalifolia* (10% for saplings). The highest value of relative frequency on this site is shown by *Quercus leucotrichophora* (28.57% seedlings, saplings 40.90) followed by *Rhododendron arboreum* (22.85% seedling, 22.72%sapling).

The minimum value of relative frequency is shown by *Prunus ceracoides* (2.85% seedling and 4.54 for sapling for *Lyonia ovalifolia*.The highest value of relative density is shown by *Quercus leucotrichophora* (63.44% sapling, 51.92 seedling) followed by *Rhododendron arboreum (12.41%*seedlings, 32.69 saplings). The minimum relative density value is shown by *Prunus ceracoides* (1.37% for seedlings, *Lyonia ovalifolia* 1.92 for saplings). The highest value of relative dominance is reported for *Quercus leucotrichophora* (58.68% seedling, 42.82% saplings) followed by *Rhododendron arboreum* (1.26% seedling, 48.20% sapling).

Table 2a : Regeneration Analysis Of Seedlings O F North- East Site.

SN	Name of Species	F (%)	D	A	MBA	TBC	RF (%)	RD (%)	RDO (%)	A/F (%)	IVI
1	*Quercus leucotrichophora*	100	9.2	9.2	0.028	0.25	28.57	63.44	58.68	0.092	150.69
2	*Rhododendron arboreum*	80	1.8	2.25	0.003	0.0054	22.85	12.41	1.26	0.028	36.52
3	*Pinusroxburghii*	60	1.7	2.83	0.003	0.0051	17.14	11.72	1.197	0.047	30.05
4	Myricaesculenta	60	0.9	1.5	0.179	0.161	17.14	6.20	37.79	0.025	61.13
5	Lyoniaovalifola	40	0.7	1.75	0.007	0.0049	11.42	4.82	1.15	0.04	17.39
6	Prunusceracoides	10	0.2	02	0.0007	0.00014	2.85	1.37	0.032	0.2	4.25

Table 2b: Regeneration Analysis Of Saplings Of North-East Site.

S.No.	Name of Species	F (%)	D	A	MBA	TBC	RF (%)	RD (%)	RDO (%)	A/F (%)	IVI
1	*Quercus leucotrichophora*	90	2.7	03	0.71	1.91	40.90	51.92	42.82	0.33	135.64
2	*Rhododendron arboreum*	50	1.7	3.4	1.27	2.15	22.72	32.69	48.20	0.06	103.61
3	*Pinus roxburghii*	30	0.3	01	0.71	0.21	13.63	5.76	4.70	0.03	24.09
4	*Myrica esculenta*	30	0.3	01	0.31	0.09	13.63	5.76	2.017	0.03	21.40
5	*Symplocox*	10	0.1	01	0.31	0.03	4.54	1.92	0.67	0.1	7.13
6	*Lyonia ovalifolia*	10	0.1	01	0.71	0.071	4.54	1.92	1.59	0.1	8.05
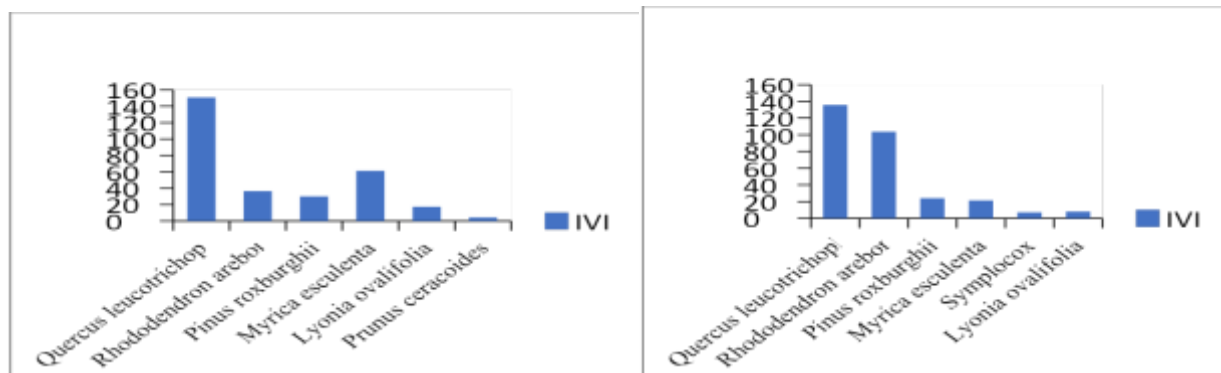
Fig 2a and b: Seedlings And Bar Diagram Showing Relative Ivi Values Of Saplings At Badshahithaul Area (North-East Site).

Quercus leucotrichophora is the most dominant species on this site. This species has the maximum Importance Value Index (150.69 seedlings, 135.64 for saplings. Field observation and analysis of Seedlings and saplings of Badshahithaul area (East Site) are given in Table 3a and 3b respectively. *Pinus roxburghii* has maximum density value (1.9 for saplings, 2.5 for seedlings). The minimum density value is shown by *Pyrus pashia* (0.1 for seedling).

The highest frequency percentage was shown by *Quercus leucotrichophora* (100% for seedlings. In saplings the highest frequency percentage was shown by *Pinus roxburghii* (90%). The highest value of relative frequency on this site is shown by *Quercus leucotrichophora* in seedlings (47.61%).In saplings the highest relative frequency was shown by *Pinus roxburghii* (69.23%) The minimum relative frequency is shown by *Pyrus pashia(* 4.76). The highest value of relative dominance is reported for *Pinus roxburghii* (64.62 % seedlings, 72.25 % saplings).

The minimum value of relative dominance is shown by *Pyrus pashia* (1.13% seedlings). *Pinus roxburghii* is the most dominant species on this site. This species has maximum Importance Value Index (198.76 saplings and 146.5 in seedlings
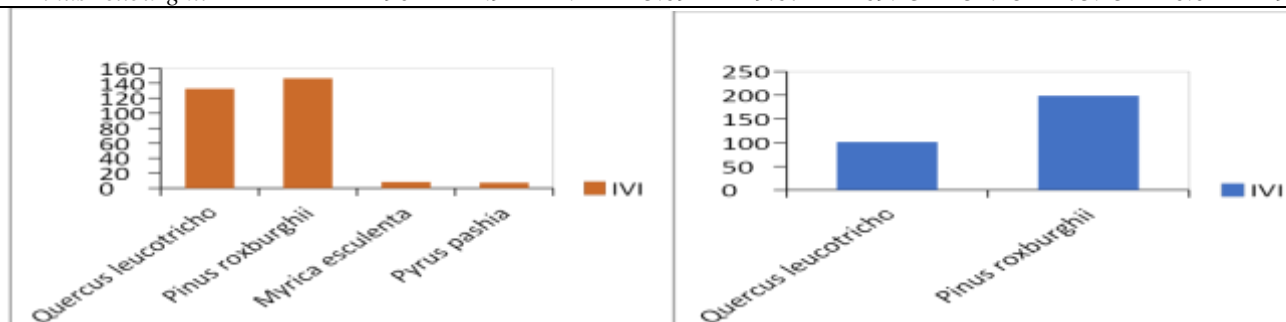
Diversity index
The diversity value for these forests ranged between 0.3 to 0.5 for seedling and saplings. The maximum value of diversity Index was recorded for Badshahithaul forest east facing slope 0.4 for seedling and 0.5 for sapling. The concentration of dominance is comparatively high at East-slope at Badshahithaul Forest (0.4 for seedling 0.5 for sapling). The Index of similarity observed for different Forest ranges between (0.3) to (0.8) for seedling and saplings. Diversity Values of the Forest has been given in the diversity table (9.1-9.6). Maximum diversity value (0.5) occurred in East facing slope of Badshahithaul followed by (0.4) for North and East site.

Table 3a : Regeneration Analysis Of Seedlings At Badshahithaul Forest Area At East Site

SN0.	Name of Species	F (%)	D	A	MBA	TBC	RF (%)	RD (%)	RDO (%)	A/F (%)	IVI
1	*Quercus leucotrichophora*	100	3.7	3.7	0.007	0.02	47.61	57.81	32.31	0.03	137.73
2	*Pinus roxburghii*	90	2.5	2.7	0.019	0.04	42.85	39.06	64.62	0.03	146.53
3	*Myrica esculenta*	10	0.1	01	0.012	0.0012	4.76	1.56	1.93	0.1	8.25
4	*Pyrus pashia*	10	0.1	01	0.007	0.0007	4.76	1.56	1.13	0.1	7.45

Table 3b: Regeneration Analysis Of Saplings At Badshahithaul Forest Area At East Site

SN	Name of Species	F (%)	D	A	MBA	TBC	RF (%)	RD (%)	RDO (%)	A/F (%)	IVI
1	*Quercus leucotrichophora*	40	1.6	04	1.99	3.18	30.76	45.71	24.74	0.4	101.21
2	*Pinus roxburghii*	90	1.9	2.1	5.09	9.67	69.23	54.28	75.25	0.02	198.76

Fig. 3a and b. Comparative account of IVI value of Seedlings and Sapling at East- Site of study area

Diversity, Dominance and Similarity Index

Diversity index:

The concept of diversity relates simple to the richness of a community. Diversity is usually considered as a function of the relative distribution of Individuals among the species that is of relative abundance, relative number of individuals in each species, species richness is expressed by simple ratios between the total number of species and total of importance values such ratios known as species diversity indices.

Diversity Values of the Forest has been given in the Table 4a, 4b and 4c. Maximum diversity value (0.5) occurred in East facing slope of Badshahithaul followed by (0.4) for North-east and East site for seedling and sapling.

Table 4a. Value of Index Of Diversity And Index Of Dominance For Seedling And Sapling On North Site.

SN	North Site Of Badshahithaul Forest	Index Of Diversity (H)		Index Of Dominance (Cd)	
		Seedling	Sapling	Seedling	Sapling
01	*Quercus leucotrichophora*	0.42	014	0.434	0..151
02	*Rhododendron arboreum*	0.03	017	0.036	0.182
03	*Myrica esculenta*	0.009	0.01	0.009	0.011
04	*Lyonia ovalifolia*	0.002	0.004	0.003	00056
	Total	**0.461**	**0.324**	**0.482**	**0349**

*Dominance Concentration***:**

The restriction of the abundance of one species by a more efficient competitor is known as dominance. In order to evaluate the degree to which dominance was concentrate in one or several species with in a community. When dominance is more concentrated in one species, the values are high, and when several species contribute equally well, the values are low.

Table 4a, 4b, and 4c reflect that maximum concentration of dominance value is found for East Site i.e. (0.5) for sapling and (0.4) for seedling of Badshahithaul forest. The minimum concentration of dominance value is recorded for North East- site i.e. 0.3 for seedling and sapling respectively in the study area.

This observation indicate the East Site of Badshahithaul forest is dominated by one particular species i.e .*Pinus roxburghii* other tree species do not contribute in forest cover significantly. While other two sites of forest is composed of those species which contribute significantly in forest covering area

Table 4b. Value Of Index Of Diversity And Index Of Dominance For Seedling And Sapling On North-East Site.

S.No	North Site Of Badshahithaul Forest	Index Of Diversity (H)		Index Of Dominance (Cd)	
		Seedling	Sapling	Seedling	Sapling
01	*Quercus Leucotrichophora*	025	0.20	0.252	0.204
02	*Rhododendron Arboreum*	0014	0.11	0.014	0.1193
03	*Pinus Roxburghii*	0.01	0.006	0.010	0.007
04	*Myrica Esculenta*	0.04	0.004	0.041	0.0050
05	*Lyonia Ovalifolia*	002	0.0004	0.003	0.0005
06	*Prunus Ceracoides*	0.0001	0.0004	0.0002	0.0007
	Total	**0.316**	0.3208	**0.3202**	0.3365

Table 4c. Value Of Index Of Diversity And Index Of Dominance For Seedling And Sapling On East Site.

S.N	North Site Of Badshahithaul Forest	Index Of Diversity (H)		Index Of Dominance (Cd)	
		Seedling	Sapling	Seedling	Sapling
01	*Quercus Leucotrichophora*	0.20	0.10	0.210	0.1138
02	*Pinus Roxburghii*	0.23	0.43	0.238	0.439
03	*Myrica Esculenta*	0.0004	----	0.0007	------
04	*Pyrus Pashia*	0.024	-------	0.0006	--------
	Total	**0.4544**	**0.53**	**0.4493**	**0.5528**

Index of Similarity
The index of similarity has been given in table 5 which is calculated between the North and North-East Site of Badshahithaul forest which is found (0.8) for seedling and sapling. Index of similarity between North-East and East site of Badshahithaul forest which is reported 0.6 for seedling and 0.5 for sapling. W2hile the index of similarity between East and North site of Badshahithaul forest is reported (0.5) for seedling and(0.3)for sapling, This reflects that maximum index of similarity (0.8) both for seedling and sapling between North and North –east sites

Table 5: Index Of Similarity Between Different Forest Sites For Seedlings

S. No	Forest Sites	Index Of Similarity	
		Seedling	Sapling
01	North And North-East Sites	0.8	08
02	North-East And East	0.6	0.5
03	East And North Sites	0.5	0.5

Conclusion
The present studies were aimed to have the knowledge of about Regenerational characteristics and diversity of different species forest as well as index of similarity between forests of different areas. A total of 8 species of seedlings and saplings occurred in all three study sites. The common species in all three study zones is *Quercus leucotrichophora*. Regenerational characters differ among different forest locality and among seedlings and saplings in the same forest. In all forest stands the maximum value of IVI, density and TBC was exhibited by the dominant species. East Site of Badshahithaul forest is dominated by one particular species *i.e .Pinus roxburghii* other tree species do not contribute in forest cover significantly. While other two sites of forest are composed of those species which contribute significantly in forest covering area. Hill base showed the more species diversity of three layers as compared of hill slope and hill top. Hill slope have the minimum diversity of seedlings and saplings. The high intensity of anthropological disturbance regularly disturbs the natural balance and alpine vegetation communities, thus preventing them to reach the climax stage of maturity. The dominance of pine in east site is led by forest fire, anthropogenic activity, animal trampling causing decrease in N,P,K content which does not allow the favorable conditions for other species to germinate and flourish.

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