Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6 [9] August 2017: 01-06

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804

ORIGINAL ARTICLE **OPEN ACCESS**

Floristic Diversity and Natural Regeneration Status of Chir pine (*Pinus roxburghii* Sargent) Forest: a case study of Rajgarh Forest Division of Himachal Pradesh

Varun Attri[1], D P Sharma[2] and Rajeev Dhiman[3]
[1,2&3]Deptt. of Silviculture and Agroforestry, University of horticulture and Forestry, Nauni, Solan, H.P.
Corresponding author E-mail: attrivarun86@yahoo.com

ABSTRACT
The study was carried out on floristic composition and natural regeneration status of chir pine forests in Sirmaur district of Himachal Pradesh. The maximum density (690 individuals ha^{-1}), abundance (6.9), basal area of 44.65 m^2 ha^{-1} and IVI of 269.95 for chir pine tree species. There were 7 species of shrubs recorded with a total density of 2,160 ind. ha^{-1}, abundance of 20.00, basal area of 1,314.51 cm^2 ha^{-1} and total IVI of 300. Where, maximum density (1040 individuals ha^{-1}), abundance (8.7), basal area (575.48 cm^2 ha^{-1}) and IVI (104.69) were observed for Cassia floribunda and per cent frequency (60) for Berberis aristata. Herbaceous vegetation comprised of 11 species of herbs, out of which 7 species are grasses species, one species each of sedge and fern were recorded from the study area. Among herbs, Salvia glutinosa showed maximum density (29,000 individuals ha^{-1}) and IVI (24.18) while per cent frequency was maximum for Lespedeza gerardiana (60). In grasses, Dicanthium annulatum showed maximum density (98,000.00 individuals ha^{-1}), basal area (125290 cm^2 ha^{-1}) and IVI (86.87) and maximum abundance (24.00) was observed for Heteropogon contortus, while minimum density (14,000.00 cm^2 ha^{-1}) was recorded for Chrysopogon montanus and minimum IVI (9.17) for Setaria glauca. Assessment of natural regeneration status in different periodic blocks of chir pine stands revealed that maximum recruits (6333.33 ha^{-1}), un-established (1444.44 ha^{-1}) and established (1083 ha^{-1}) were found in PB I (Periodic Block I) there was not much difference in weighted average height and establishment index of chir pine in all the PBs. Maximum stocking index (0.58) Percent Regeneration (57.78) and Established stocking Percent 32.29) were found in PB I as compared to Others PB's.
Keywords: Floristic diversity, Chir pine, Regeneration, Recruit, Stocking Index

Received 21.04.2017 Revised 16.06.2017 Accepted 01.07.2017

INTRODUCTION

The Indian Himalayan region is known for its diverse, unique, natural, and socio-economically important flora and fauna (1). This rich biodiversity is being utilized by the inhabitants of the region for medicine, food (wild edible), fodder, fuel, timber, making agriculture tools, religious and various other purposes (2,1). With the increasing human population, the demand for the economically important biodiversity is increasing. Collection of fodder and fuel species from the forests has been identified as one of the chronic problems in the Indian Himalayan region (3,4). Chir pine scientifically known as *Pinus roxburghii* (family Coniferae) is one of the six pines of India and the most widely occurring. It is also known as Himalayan long needle pine, long leaved Indian pine, Indian chir pine, chir or chil. Chir pine is a native of the inter-ranges and principal valleys of the Himalaya, beginning from Afghanistan in the west and ending in Bhutan in the east it extends through Pakistan, India and Nepal. In India its forests are found in Jammu and Kashmir, Haryana, Himachal Pradesh, Uttar Pradesh, parts of Sikkim, West Bengal and Arunachal Pradesh. The total area under chir forests is estimated to be 8,90,000 hectares and occurs between 450 m to 2300 m altitude. Chir pine forms pure forests in its habitat but in its upper and lower limits occurs mixed with other conifers and broad leaved species though rarely: In its upper limits it is found in association with deodar, kail, ban oak, burans (Rhododendron) etc. and in the lower limits with sal, sain, khair, harad, bahera, amla, jamun etc. The anthropogenic pressures including heavy grazing coupled with the natural calamities have led to degradation of natural habitats of many species. Such practices are discouraging the moisture loving species and promoting the hardy and spiny species having little value for the society (5). In order to promote in situ conservation and preserve rich repositories, the Protected

Area Network (PAN) programmed was initiated in India (6). Over 105 protected areas have been identified and established across the Himalayas, covering over 6 per cent of total geographical area of region (7). One of the foundations for conservation of biological diversity in forest landscapes is understanding and managing the disturbances regimes of a landscape under past natural and semi natural condition (8). The communities always experience fluctuations driven by season and long term changes that leads to expansion of dominant species and further decline in species richness (9,10) and these dominant species exert controlling effects on the fitness of their under storey vegetation. This loss of biodiversity and changing pattern of vegetation has necessitated assessing the vegetation composition and regeneration pattern of tree species of the region and prioritizing habitats, communities and species for conservation. Regeneration of any species holds its importance for the perpetuation of the forests which are so essential for the existence of human life on one hand and practice of scientific forestry on the other and is generally considered in a particular area in terms of recruits, seedlings, saplings, etc. The regeneration survey is important in scientific forestry and is generally carried out with a view to compare natural regeneration in any regeneration area and to prepare a stock map of an area proposed to be regenerated and to prescribe silvicultural treatment for various parts on the basis of status of regeneration in them.

MATERIAL AND METHODS

Study area

The study was carried out in Rajgarh Division of Sirmaur district of Himachal Pradesh, which is located between 30° 38'40" to 31° 1'14" N latitude and 77° 01' 5" to 77° 26' 13"E longitude, at elevation from 540 m to 3500 m amsl, covering an area of about 82002 (Fig 1).

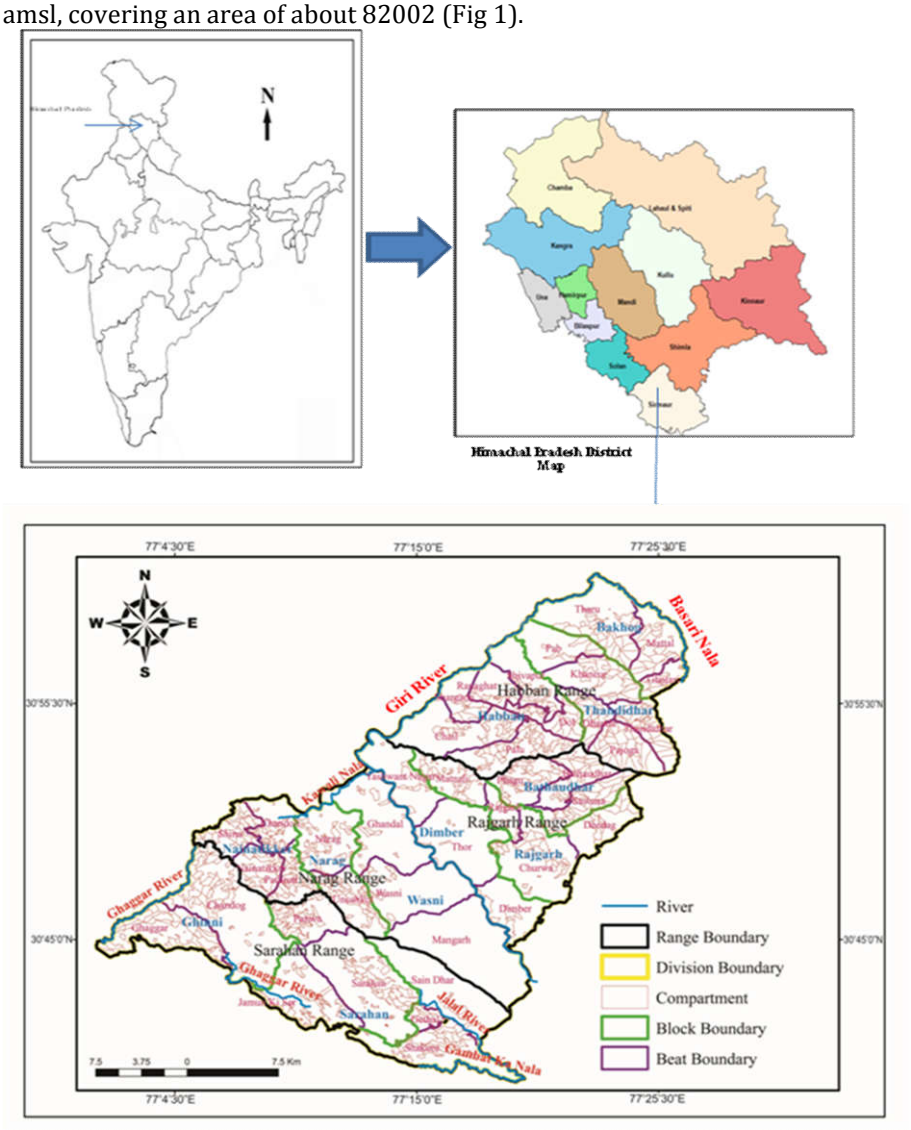

Fig. 1: Map of the study area

Floristic diversity

In chir pine forest community type, 10 quadrates of 10 m X 10 m (100 m^2) size were randomly laid to study tree species. The tree species includes all the saplings, poles and trees present in the study area. The shrub and herbaceous species were studied by laying 10 quadrates randomly in each forest community type. In each quadrate, a sub-quadrate of 5m X 5m (25 m^2) size for shrubs and a sub-quadrate of 1m X 1m (1 m^2) for herbaceous vegetation were selected.

Density of trees was calculated by counting trees in each sample plot. Basal area of each tree in the sample plot was determined by tree calliper or tap. Density of shrubs was calculated by counted plants of different species in each sub-plot. The basal area of shrub was calculated by using digital calliper. While in case of herbaceous vegetation, from each quadrate was segregated species wise and identified. The help of herbarium in then university, experts, FRI Dehradun, journals and research books was taken to identify them. Each species was analyzed quantitatively for various parameters viz., basal area, density and frequency. The field work was carried out within two years from 2013 to 2015. In the first year, floristic composition of major forest community, identification of plant sample, regeneration survey and collection of soil samples was done (2013-14) and soil analysis was done in 2014-2015, in the Silviculture laboratory of the Department of Silviculture and Agroforestry (Solan). The parameters studied are ***Basal Area, Abundance (AB), Per cent frequency, Density (D) and Importance value index (IVI).***

Regeneration Survey

The observations were recorded for *Pinus roxburghii*. It is stated that 2500 established plants per hectare were desired to express satisfactory regeneration. The quadrate was considered fully stocked when it contained one established plant (11).

The systematic survey was carried out in each Periodic Block, The quadrate of size 2 x 2m in each sampling unit (having 3 recording units each) were laid out for regeneration study. The survey was conducted for recruits (r), which may be defined as current years seedlings, unestablished regeneration (u) seedling other than recruits which have not established by not achieving establishment height of 2 m, here 4 unestablished plants were taken equivalent to one established plant and established regeneration (e) having height more than 2 m (12). The data thus collected was analyzed using formulae given by Chacko (11) as follows:

$$\textbf{Recruits(r)/ha} = \frac{2500 \text{ X Total number of recruits}}{\text{Total number of recording Units}}$$

$$\textbf{Un-established(u)/ha} = \frac{2500 \text{ X Total number of un-established plants in Sampling units}}{\text{Total number of recording units}}$$

$$\textbf{Established(e)/ha} = \frac{2500 \text{ X Total number of established plants in Sampling units}}{\text{Total number of recording units}}$$

Established stocking per cent

It is common to define a number of derived units' indices which numerically express the overall status of regeneration in the areas. The established stocking per cent was computed using formulae given by Chacko (11) as:

Establishment Stocking per cent = 100 (I_1 X I_2)

Where I_1 and I_2 were calculated by using formulae

$$\textbf{Establishment Index } (I_1) = \frac{\text{Weighted average height}}{\text{Establishment height}}$$

The weighted height was determined as:

$$\textbf{Weighted average height (m)} = \frac{\text{Total height of un-established regeneration + (number of established Plants X establishment height)}}{\text{Total un-established plants + Total established plant}}$$

$$\textbf{Stocking index } (I_2) = \frac{1}{2500} \frac{\text{(un-established regeneration/ ha + established regeneration/ha)}}{4}$$

Regeneration success per cent

It was determined following Chacko (11). The established plants as 2500 per hectare was taken as standard to calculate per cent regeneration.

Regeneration success (%)

Regeneration success (%) = Stocking index (SI) X 100

RESULTS AND DISSCUSSION

The major forest communities that existed in the Rajgarh forest division are *Abies pindrow, Cedrus deodara, Picia smithiana, Pinus roxburghii, Pinus wallichiana, Acacia catechu, Dalbergia sissoo, Pyrus pashia and Quercus leucotricophora*. The *Pinus roxburghii* was studied under the present study.

The Chir forest community that was comprised of Chir and Kainth reported a total density of 740 individuals ha^{-1}, abundance of 7.40, basal area of 44.65m^2 ha^{-1}, per cent frequency of 130 and IVI of 300 (Table 4). Chir showed maximum density (690 individuals ha^{-1}), abundance (6.9), basal area of 44.65 m^2 ha^{-1}, per cent frequency of 100 and IVI of 269.95.

Table 1:Density, Basal area, Per cent frequency and IVI of Trees and Shrubs in Chir Forest community

Sr. No	Floristic composition of Chir forest community						
	Trees	Chir Forest	Density (individuals ha^{-1})	Abundance (AB)	Basal area (m^2 ha^{-1})	Percent frequency	IVI
1		Chir	690	6.9	44.56	100	269.95
2		kainth	50	0.5	0.09	30	29.86
Total			740	7.4	44.65	130	300
Sr. No	Shrubs	Shrubs	Density (individuals ha^{-1})	Abundance (AB)	Basal area (cm^2 ha^{-1})	Percent frequency	IVI
1		*Berberis aristata*	160	0.7	132.73	60	44.64
2		*Cassia floribunda*	1040	8.7	575.48	30	104.69
3		*Coriaria nepalensis*	280	3.5	118.84	20	30.86
4		*Meriandra strolibifera*	80	2	31.59	10	10.58
5		*Rubus ellipticus*	200	1	190.15	50	46.28
6		*Woodfordia fruticosa*	320	2.7	181.24	30	41.97
7		*Ziziphus mauritiana*	80	1.5	84.48	20	20.97
		Total	**2,160.00**	**20.00**	**1,314.51**	**220.00**	**300.00**

Table 2: Density, Basal area, Per cent frequency and IVI of Herbs in Chir Forest Community

Sr. No		Herbs/Grass/Ferns/Climber	Density (individuals ha^{-1})	Abundance (AB)	Basal Area (cm^2 ha^{-1})	Per cent Frequency	IVI
1	Herbs	*Anaphalis busua*	5,000.00	5.00	700	10	3.40
2		*Argemone mexicana*	6,000.00	6.00	1270	10	11.96
3		*Asclepias curassavica*	21,000.00	7.00	7090	30	13.68
4		*Bidens pilosa*	13,000.00	6.50	2010	20	7.80
5		*Cassia mimosoides*	7,000.00	1.75	1350	40	9.72
6		*Cincus argyracanthus*	6,000.00	6.00	700	10	3.66
7		*Commelina obliqua*	8,000.00	4.00	310	20	5.87
8		*Justicia simplex*	19,000.00	6.33	3980	30	3.88
9		*Lespedeza gerardiana*	21,000.00	3.50	9200	60	20.06
10		*Salvia glutinosa*	29,000.00	7.25	24020	40	24.18
11		*Verbascum thapsus*	4,000.00	2.00	820	20	5.04
12	Grasses	*Apluda mutica*	35,000.00	8.75	27010	40	26.88
13		*Avena fatua*	24,000.00	12.00	12390	20	14.66
14		*Cenchrus ciliaris*	19,000.00	9.50	5230	20	10.59
15		*Chrysopogon montanus*	14,000.00	4.67	13210	30	14.28
16		*Dicanthium annulatum*	98,000.00	14.00	125290	70	86.87
17		*Heteropogon contortus*	24,000.00	24.00	16250	10	14.32
18		*Setaria glauca*	15,000.00	7.50	4200	20	9.17
19	Sedge	*Carex nubigena*	6,000.00	6.00	130	10	3.43
20	Fern	*Woodsia elongata*	18,000.00	6.00	1040	30	10.55
		TOTAL	**392,000.00**	**147.75**	**256,200.00**	**540.00**	**300.00**

Table 3: Regeneration status of Chir pine under different Periodic Blocks

Periodic Blocks	Recruits/ha	Un Established /ha	Established /ha	Weighted average height	Establishment Index (I_1)	Stocking Index(I_2)	Per cent Regeneration	Established Stocking Per cent
PB I	6333.33	1444.44	1083.33	1.26	0.63	0.58	57.78	37.29
PB II	2305.56	666.67	444.44	1.25	0.63	0.24	24.44	14.95
PB III	1944.44	666.67	305.56	1.15	0.57	0.19	18.89	11.12
PB IV	2666.67	916.67	611.11	1.23	0.62	0.34	33.61	20.42

There were 7 species of shrubs which reported a total density of 2,160 individuals ha^{-1}, abundance of 20.00, basal area of 1,314.51cm^2 ha^{-1}, per cent frequency of 220 and total IVI of 300 (Table 4). A maximum values for density (1040 individuals ha^{-1}), abundance (8.7), basal area (575.48 cm^2 ha^{-1}) and IVI (104.69) was observed in case of *Cassia floribunda* whereas, and per cent frequency (60) was recorded maximum for *Berberis aristata*. In contrary, a minimum density (80 individuals ha^{-1}), basal area (31.59 cm^2 ha^{-1}), per cent frequency (10) and IVI (10.58) were observed in case of *Meriandra strolibifera* and abundance (1.5) in case of *Ziziphus mauritiana*.

Herbaceous vegetation was comprised of 11 species of herbs, 7 species of grasses, one species each of sedge and fern (Table 5). On the whole they resulted in a total density of 392,000.00 individuals ha^{-1}, abundance of 147.75, basal area of 256,200.00 cm^2 ha^{-1}, per cent frequency of 540.00 and IVI of 300. Among herbs, *Salvia glutinosa* showed maximum values for density (29,000 individuals ha^{-1}) and IVI (24.18). Per cent frequency was noted maximum in case of *Lespedeza gerardiana* (60%). On the other hand, *Verbascum thapsus* showed minimum values for density (4,000 individuals ha^{-1}), abundance (1.50). Whereas, basal area (310 cm^2 ha^{-1}) were minimum in case of *Commelina oblique* and IVI is minimum in case of *Anaphalis busua* (3.40). The results are in agreement with the findings of Singh and Gupta (13) and Devlal and Sharma (14), who has reported highest density for oak in various sites among all species. Mir et al. (15) has reported 240.74 individuals ha^{-1}, 11.11-36.37 individuals ha^{-1} and 236.37-333.33 individuals ha^{-1} at different sites for *Pinus roxburghii, Quercus leucotrichophora* and *Cedrus deodara*, respectively in Chaupal Forest Division of Himachal Pradesh. The results are in agreement Devlal and Sharma (16), that had shown dominance of oak in among other species along altitudinal gradient in the temperate forest of Narayanbagar of Chamoli district of Uttrakhand.

In grasses *Dicanthium annulatum* showed maximum values for density (98,000.00 individuals ha^{-1}), basal area (125290 cm^2 ha^{-1}), per cent frequency (70) and IVI (86.87) and maximum abundance (24.00) in case of *Heteropogon contortus* minimum values for density (14,000.00 cm^2 ha^{-1}) were noted in case of *Chrysopogon montanus* and minimum value of IVI (9.17) in case of *Setaria glauca*. There was one species each of sedge (*Carex nubigena*) and fern (*Woodsia elongata*). *Carex nubigena* had a density of 6,000 individuals ha^{-1}, basal area of 130 cm^2 ha^{-1}, abundance of 6.00, and per cent frequency of 10 and IVI of 3.43. Whereas, *Woodsia elongata* had a density of 18,000 individuals ha^{-1}, basal area of 1040 cm^2 ha^{-1}, abundance of 6.00, per cent frequency of 30 and IVI of 10.55. However, Mir et al. (15) has reported a basal area of 34.07, 0.84-8.74 and 41.56-240, for *Pinus roxburghii, Quercus leucotrichophora and Cedrus deodara,* respectively in different sites of Chaupal Forest Division in Himachal Pradesh. This distribution pattern of basal area in different forest communities may be attributed to the dominance of one species over other species in their respective habitat. The lower density of shrubs in Chir forest community was reported by Kumar and Thakur (17) and Sharma (18) in Solan region in HP, Dangwal et al. (19) in Kashmir forests and Siddiqui et al. (20) in Pakistan forests.

Regeneration Assessment

On the basis of primary data for recruits, un established and established regeneration of *Pinus roxburghii* stands. Perusal of data presented in Table-3 revealed that maximum recruits ha^{-1} (6333.33), unestablished (1444.44) and established ha^{-1} (1083) were found in PB-I there was not much difference in weighted average height and establishment index of *Pinus roxburghii* in all the PBs. Maximum stocking index (0.58), Percent Regeneration (57.78) and Established stocking Percent (32.29) were found in PB-I as compared to Others PB's. This is due to the fact that PB-I consisted of areas which were to be regenerated. Whereas, in PB-IV, the plantation areas where the regeneration has come up and crop had reached in pole stage previously allotted to PB-I (21).

CONCLUSION

In the present study, herb basal area, per cent frequency for herbaceous vegetation and Herb basal area in Chir forest community. Per cent frequency for herbaceous vegetation in Chir forest community which has

minimum similarity index. The vegetation was comprised of 6.66 per cent trees, 23.33 per cent shrubs and 70 per cent herbs, *Cassia floribunda* (shrub) and *Dicanthium annulatum* (herb) were dominant in Chir forest community. Species diversity in case of herbs was maximum in Chir forest. Herbaceous vegetation richness of 3.18 was reported in Chir forest. The shrub species dominance of 0.8 in Chir forest community. Regeneration studies of *Pinus roxburghii* stands revealed that maximum recruits ha^{-1} (6333.33), unestablished (1444.44) and established ha^{-1} (1083) were found in PB-I, there was not much difference in weighted average height and establishment index of *Pinus roxburghii* in all the PBs. Maximum stocking index (0.58) Percent Regeneration (57.78) and Established stocking Percent (32.29) were found in PB-I as compared to Others PB's. This is due to the fact that PB-I consisted of areas which were to be regenerated. Whereas, in PB-IV, the plantation areas where the regeneration has come up and crop had reached in pole stage previously allotted to PB-I.

REFERENCES

1. Samant SS, Dhar U, Palni LMS. (1998). Medicinal plants of Indian Himalaya: diversity distribution potential values. Gyanodaya prakashan, Nanital.
2. Samant SS, Dhar U. (1997). Diversity, endemism and economic potential of wild edible plants of Indian Himalaya. *International Journal of Sustainable Development and World Ecology*, 4: 179-191.
3. Samant SS, Rawal RS, Dhar U. (2006). Diversity, extraction and status of fodder species in Askot. Administration. New Delhi. pp. 29-42.
4. Singh SK. 1998. Vegetation structure under North and South aspects in the temperate zone of Tirthan valley, Western Himalaya. *Indian Journal of Forestry*, 21: 217-223.
5. Samant SS, Palni, LMS. (2000). Diversity, distribution and indigenous uses of essential oil-yielding medicinal plants of the Indian Himalayan region. *Journal of Medicinal and Aromatic Plant Sciences*, 22(1B): 671-684.
6. Rodger WA, Panwar HS. (1988). Planning a Wildlife Protected Area Network in India Vol I, Wildlife Institute of India. *New Forest,* Dehradoon (India).
7. Green MJB. (1993). Nature reserves of the Himalaya and the mountains of Central Asia. World Conservation Union.
8. Spies TA, Turner MG. (1999). Dynamics forest mosaics. In: Hunter MLJr. (ed.). Maintaining biodiversity in forest ecosystems. Cambridge University Press, Cambridge, U.K. pp. 95-160.
9. Thomas AS. (1960). Changes in vegetation since the advent of Myxomatosis. *Journal of Ecology*, 48: 287-306.
10. Smith CJ, Elon J, Bunting AH. 1971. Effects of cutting and fertilizer treatment on the yield and botanical competition of Chalk turf. *Journal of the British Grassland Society*, 26: 213-223.
11. Chacko VJ. (1965). Manual of sampling techniques for forest surveys. Manager Publications, Delhi (India). pp. 172.
12. Champion HG. (1935). Silvicultural research manual for use in India. Vol I. The experimental manual. Government of India Press, New Delhi, pp. 110.
13. Singh A and Gupta NK. 2009. Assessment of floristic diversity and regeneration status of *Cedrus deodara* stands under forest management systems in western Himachal Himalayas: case study of Shimla district. *Indian Journal of Forestry*, 32(1): 45-54.
14. Devlal R, Sharma N. (2010). Dominance, diversity and species richness of tree species along an altitudinal gradient of a catchment of Garhwal Himalaya. *Indian Forester*, 136(7): 943-950.
15. Mir ZA, Giri N, Kumar P. (2011). Ecological studies of woody species in Chopal forest division of Himachal Pradesh. *Indian Journal of Forestry*, 34(4): 433-43.
16. Devlal R and Sharma N. (2008). Altitudinal changes in dominance-diversity and species richness of tree species in a temperate forest of Garhwal Himalaya. *Life Science Journal*, 5(2): 53-57
17. Kumar R, Thakur V. (2008). Effect of forest fire on trees, shrubs and regeneration behavior in chir pine forest in northern aspects under Solan Forest Division, Himachal Pradesh. *Indian Journal of Forestry,* 31: 19-27.
18. Sharma N. (2012). GIS based land use planning for watershed management. PhD. Thesis, Dr. Y.S. Parmar UHF, Nauni, Solan, (HP), India. pp. 155.
19. Dangwal LR, Singh T, Singh A, Sharma A. (2012). Plant diversity assessment in relation to disturbances in subtropical chirpine forest of the Western Himalaya of district Rajouri, J & K (India). *International Journal of Plant, Animal and Environmental Science*, 2(2): 206-213.
20. Siddiqui MF, Moinuddin A, Wahab M, Khan N, Khan MU, Nazim K, Hussain SS. (2009). Phytosociology of *Pinus roxburghii* Sargent (Chir pine) in lesser Himalaya and Hindu Khush range of Pakistan. *Pak. J. Bot*., 41(5): 2357-2369.
21. Shrivastava MB, Siaguru P. (1997). Silvicultural system and sustainable management of cedar and pine forest in western Himalayas. *Indian Journal of Forestry,* 20(1): 26-38.

CITATION OF THIS ARTICLE

Varun Attri, D P Sharma and Rajeev Dhiman. Floristic Diversity and Natural Regeneration Status of Chir pine (*Pinus roxburghii* Sargent) Forest: a case study of Rajgarh Forest Division of Himachal Pradesh. Bull. Env. Pharmacol. Life Sci., Vol 6 [9] August 2017: 01-06