RESEARCH ARTICLE

NATURAL REGENERATION STUDY OF FOUR RHODODENDRON SPECIES IN WESTERN HIMALAYA

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Abstract: Regeneration patterns of species population can address climate change by adaptive evolution or by migrating association to survive in their favorable climate and finally decided to particular forest future. The main aim is to study to know the regeneration status of *R. arboreum*, *R. barbatum*, (2800 masl.) *R. campanulatum*, (3200 masl.) and *R. anthopogon* (3800 masl.) along the altitudinal gradient. In this paper we examined the status of regeneration potential of tree and bushy species in temperate forest, sub-alpine forest, and alpine forest at Kedarnath Wildlife Sanctuary, Tungnath-Chopta in Western Himalaya. To seedling population and distribution, we examine regeneration status in 80 random plots in study area. Total four species of rhododendron genera belonging to Ericaceae family out of which 28 seedlings of *R. arboreum*, 12 seedlings of *R. barbatum*, 23 seedlings of *R. campanulatum* and 33 seedlings of *R.anthopogon* were found in the forest. On the basis of importance value index *R. arboreum* followed by *R.anthopogon* have been found in good regeneration phage in comparison to other two species in the study area. Whereas, *R. barbatum* was found in poor regeneration phage in the study area. *R. campanulatum* and *R. anthopogon* were found above the treeline indicating that the climatic conditions were favourable for their growth. The height, diameter and density of the species differed along the elevational gradient and showed a species specific trend. Regeneration Potential of *R. anthopogon* (33 seedlings) was high in comparison to other three species followed by the second high regeneration potential i.e. *R. arboreum* (28 seedlings). Whereas, regeneration potential of *R. campanulatum* (23 seedlings) was higher in compare to *R. barbatum* (12 seedlings).

Keywords: Kedarnath Wildlife Sanctuary, Regeneration status Treeline, Elevation gradient, Density

INTRODUCTION

Natural regeneration is the process by which juvenile plants and coppice that have established naturally replace plants which have died or have been killed. Over time following a disturbance, the growth of naturally regeneration will reestablished canopy trees. Natural regeneration system exploit existing seed and seedling banks and circumvent the problem of obtaining healthy planting stocks. *R. arboreum*, *R. barbatum*, *R. campanulatum*, *R. antrhopogon* and *R. lapidotum* naturally occur in Western Himalaya, at Tungnath- Chopta region of Kedarnath Wildlife sanctuary. Western Himalaya, although dry and less dense as compaired to the Eastern Himalaya, is still one of the rich floristic regions of India (Meher-Homji, 1978). These all Rhododendron species is an ornamental shrub or trees with delicate different colour flower (*R. arboreum* colour- pinkish red, *R.barbatum*- deep red, *R. campanulatum*- violet whitish, *R. anthopogon* - yellow). *R. arboretum* and *R. barbatum* found in study area at 2800 to 3000mt., *R. campanulatum* found at sub alpine region 3100m. to 3400m. and at alpine region *R. anthopogon* found 3500 to 4000m. these all four species grows in temperate, sub temperate and alpine region. The mother plant of *R. arboreum* and *R. barbatum* was found in tree habitat, *R. campanulatum* was in creeper bushes habitat, found near tree line and *R. anthopogon* was in small bushes habitat. The limitation of its popularity may be its regeneration difficulty. Natural regeneration is also decreased by forest fire. The most likely to survive in moist, sheltered sites where the root have access to mineral soil (Cross, 1981; Shaw, 1984; Tabbush & Williamson, 1987). The regeneration of Rhododendron species is an endangered because of human's disturbance, local communities cut majority of mother plants of Rhododendron for fuel which is playing important role in the decreased of Rhododendron species. Whereas, these plants are generally avoided by grazing animals, thus giving Rhododendron a significant advantage over native vegetation(Cross, 1981; Shaw, 1984; Tabbush & Williamson, 1987). The regeneration of *R. arboreum* and *R. barbatum* is also affected by big trees of *Q. semicarpifolia* and *Taxus baccata* because shadow of big trees and frost play important role to decrease the regeneration of Rhododendron species because frost cause cold injury in new seedlings. Dense canopy of trees decreased the regeneration of *R.arboreum* and *R. barbatum*. Proper management, such as thinning of canopy areas should improve growth and establishment of the new generation.

*Rhododendron*s are the prominent marker flowering species of Himalayan region and best indicator for climate change studies. To study the impact of climate change on the vegetation structure and phenology of *Rhododendron* species, our research work started in Chopta-Tungnath area of

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Rudraprayag district of Uttarakhand. An effort has been made to study the vegetation composition of various *Rhododendron*s species. The aim of this part of study is to know the regeneration pattern of various *Rhododendron* species and its habitat, in Western Himalayas. The selected area is very rich in vegetation diversity and all altitudinal gradients from 2800 to 3800 m asl. altitude was available in one transect with availability of all four *Rhododendron* species undertaken for study.

STUDY SITE AND CLIMATE

The present study was carried out along an altitude gradient from temperate (2800 masl.) to alpine region (3800 masl.) of Chopta - Tungnath region of Rudraprayag district of Uttarakhand. It lies in Western Himalaya between the latitude 30.74 N and longitude 79.49 E. A total three sites were selected different altitude ranges from 2800-3800 masl. altitude to examine the regeneration status of four Rhododendron species. The climatic pattern of study site is typical temperate to the sub arctic climate. The climate as well as vegetation varies here drastically along with altitude.

METHODOLOGY

The chopta- tungnath area was selected for the regeneration study because all the four species of Rhododendron are naturally distributed at different altitude in the sites. The four species undertaken for study were *R. arboreum*, *R. barbatum*, *R. campanulatum*, *R. antrhopogon*. The regeneration study was carried out by Quadrate method by calculating diameter, height and number of seedlings in per Quadrates. At each site of three altitude (2800 masl., 3400 masl., 3800 masl.) we laid four Quadrates in each sites (East, West, North, South).
Three study site were selected for the study of regeneration. At site first Chopta (2800 masl.), two species were found in natural condition and regenerate naturally, which were *R. arboreum, R. barbatum*, one species at sub alpine region at site second (3400 masl.) *R.campanulatum* and at site third 3600 masl. alpine species *R.anthopogon* found in natural condition. A Quadrate 1X1 mt. was laid out at each altitude (2800 masl., 3400 masl., 3800 masl.), four direction(East, West, North, South)for regeneration studies and each site five quadrate 2800 masl., 3400 masl., 3800 masl. was laid. Population structure of all the species occurring in each site was studied using quadrate method. Density, frequency and Abundance of the species were determined from the sampled area.

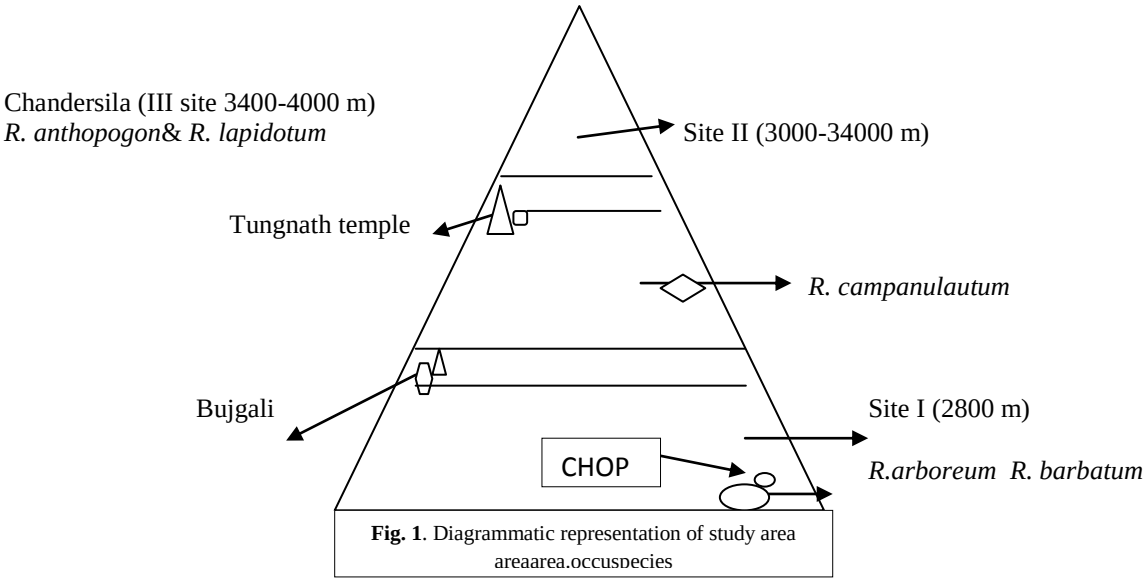

Fig. 1. Diagrammatic representation of study area
areaarea.occuspecies

1. Quantitative analysis such as density, frequency and abundance of tree species, shrubs and herbs species were determined as per Curtis and McIntosh (1950).

(a) Density = $\frac{\text{Total number of individual of a species in all quadrates}}{\text{Total number of quadrates studied}}$

(b) Frequency (%) = $\frac{\text{Number of quadrates in which the species occurred}}{\text{Total number of quadrate studied}} \times 100$

(c) Abundance = $\frac{\text{Total number of individuals of a species in all quadrates}}{\text{Total number of quadrates in which the species occurred}}$

(d) Relative density = $\frac{\text{Number of individual of the species}}{\text{Number of individual of all the species}} \times 100$

(e) Relative frequency = $\frac{\text{Frequency of a species}}{\text{Total frequency of all species}} \times 100$

(f) Relative dominance = $\frac{\text{Total basal area of the species}}{\text{Total basal area of all the species}} \times 100$

(g) Importance value index (IVI) = Relative density + Relative frequency + Relative dominance

RESULTS AND DISCUSSION

At 2800 m asl which is below the timberline *R. arboreum* was the dominant species with an IVI of (83.4397) and density 14,000/haseedlings per hectare other associated tree species at this site were *R. barbatum*, Quercus *semicarpifolia, Taxus baccata*. Myrica esculenta and *Abies pindrow*.However, *R. barbatum* was least dominant species with an IVI (63.442) in our study site. Whereas, the sub-alpline species *R. campanulatum* was at the timber line recorded third dominant species with the an IVI (75.7471) and associated with *Betula utilis, Abies pindrow* and *Taxus baccata*. While alpine species *R. anthopogon* was second most dominant species with the an IVI (77.3708) associated with another rhododendron species *R. lapidotum*. However TheCo-dominant species of the site was *Quercus semicarpifolia* and *Abies pindrow* which showed their IVI values of (82.93 and 16.92) respectivelyand density (4 and 1 plants /quadrate respectively) (Nautiyal et al.,2010). The number (density) of seedling of any species can be considered as the regeneration potential of the species. From the density value (Table 2, 3, 4, 5) it is concluded that the regeneration Potential of *R. anthopogon* (33 seedlings) was high in comparison to other three species followed by the second high regeneration potential i.e. *R. arboreum* (28 seedlings). While regeneration potential of *R. campanulatum* (23 seedlings) was higher in compare to *R. barbatum* (12 seedlings). however alarming as has been pointed out elsewhere (Saxena *et al.*,1978; Ralhan *et al.,* 1982; Tiwari and Singh, 1982; Saxena and Singh, 1984; Bankoti *et al.*,1986).

It is a well known fact that the altitude represents a complex gradient along which many environmental variables change concomitantly. Rahbek (1997) explain the patterns in species richness decrease with altitude. Highly diverse compositional pattern of forests characteristic of western Himalaya has been explored by Singh & Singh 1987. Besides the ecosystem functions, the distribution and occurrence of species had been affected by human interventions reported by Singh *et al*, 1987. Among human influence, commercial exploitation, agricultural requirements, forest fire, and grazing pressure are the important source of disturbance (Singh *et al*, 1992).The result of present sturdy showed that the maximum seedling density was observed at alpine zone which gradually decrease with decreasing altitude towards sub-alpine zone. Only small bushes of *Rhododendron anthopogon* and *R. lapidotum* are found at the elevation higher to 3600 m, might be geographical situations such that only bushy structure can survive under these extreme low temperature conditions and sustain heavy load of snow during winters. The human interferences particularly eco-tourism and grazing pressure is found the major cause of disturbance and concern in this area.

Table 1. Table showing the number of seedling /hectare, mean seedling height (cm.), Mean collar diameter (mm).

Name of Species	Site	No. of seedling /hectare	Mean seedling height (cm.)	Mean collar Diameter (mm)
R. arboreum	East	14,000	10.16	4.86
	West	16,000	8.62	4.28
	North	14,000	7.75	3.55
	South	12,000	6.86	3.15
Mean		14,000	8.34	3.91
R. barbatum	East	6,000	8.56	3.88
	West	6,000	7.52	3.75
	North	4,000	8.20	3.92
	South	8,000	9.34	4.95
Mean		6,000	8.40	4.28
R.campanulatum	East	10,000	7.65	3.94
	West	12,000	9.44	4.45

	North	12,000	8.73	4.88
	South	12,000	6.95	3.35
Mean		11,500	8.19	3.98
R. anthopogon	East	16,000	3.84	2.45
	West	16,000	4.50	2.72
	North	16,000	2.98	1.91
	South	18,000	5.38	2.55
Mean		16,500	4.17	2.80

Table 2. Table showing the Frequency (%) Density, Abundance of East aspect.

S.No.	Name of the plant species	Number of seedlings in each quadrate					Total no. of seedlings	No. of quadrate in which species occurred	Total no. of quadrate studied	Frequency (%)	Density	Abundance
		1	2	3	4	5						
1	*R. arboreum*	3	1	-	1	2	07	04	05	80	1.4	1.75
2	*R. barbatum*	1	1	1	-	-	03	03	05	60	0.6	01
3	*R.campanulatum*	2	-	-	1	2	05	03	05	60	01	1.66
4	*R. anthopogon*	2	2	3	1	-	08	04	05	80	1.6	02

Table 3. Table showing the Frequency (%), Density, Abundance of West aspect.

S.No.	Name of the plant species	Number of seedlings in each quadrate					Total no. of seedlings	No. of quadrate in which species occurred	Total no. of quadrate studied	Frequency (%)	Density	Abundance
		1	2	3	4	5						
1	*R. arboreum*	2	4	1	-	1	08	04	05	80	1.6	02
2	*R. barbatum*	1	-	1	-	1	03	03	05	60	0.6	01
3	*R.campanulatum*	2	1	2	-	1	06	04	05	80	1.2	1.5
4	*R. anthopogon*	3	2	1	1	1	08	05	05	100	1.6	1.6

Table 4. Table showing the Frequency (%), Density, Abundance of North aspect.

S.No.	Name of the plant species	Number of seedlings in each quadrate					Total no. of seedlings	No. of quadrate in which species occurred	Total no. of quadrate studied	Frequency (%)	Density	Abundance
		1	2	3	4	5						
1	*R. arboreum*	1	1	2	2	1	07	05	05	100	1.4	1.4
2	*R. barbatum*	1	-	1	-	-	02	02	05	40	0.4	01
3	*R.campanulatum*	3	-	1	2	-	06	03	05	60	1.2	02
4	*R. anthopogon*	3	1	-	2	2	08	04	05	80	1.6	02

Table 5. Table showing the Frequency (%), Density, Abundance in South aspect.

S.No.	Name of the plant species	Number of seedlings in each quadrate					Total no. of seedlings	No. of quadrate in which species occurred	Total no. of quadrate studied	Frequency (%)	Density	Abundance
		1	2	3	4	5						
1	*R. arboreum*	-	-	2	3	1	06	03	05	60	1.2	02
2	*R. barbatum*	1	2	-	1	-	04	03	05	60	0.8	1.33
3	*R.campanulatum*	2	-	2	1	1	06	04	05	80	1.2	1.5
4	*R. anthopogon*	3	2	-	2	2	09	04	05	80	1.8	2.25

Table 6. Table showing the basal area, frequency, density, abundance, relative frequency, relative density, relative abundance and importance value index (IVI) of all the species observed.

S.No.	Name of the plant species	TBA (mm)	Freq. (%)	Density (Kg/m^3)	Abund.	R. freq.	R.den.	R. dom.	IVI
1	*R. arboreum*	48.0046	80	1.4	1.75	27.5862	29.1666	26.6869	83.4397

2	*R. barbatum*	57.5197	55	0.6	1.0909	18.9655	12.5	31.9765	63.442
3	*R.campanulatum*	49.7388	70	1.15	1.6428	24.1379	23.9583	27.6509	75.7471
4	*R. anthopogon*	24.6176	85	1`.65	1.9411	29.3103	34.375	13.6855	77.3708

TBA=Total basal area, Freq. =Frequency, Abund.=Abundance, R. Freq.=Relative frequency, R. den.= Relative density, R. Dom.= Relative dominance, IVI= Important value index

CONCLUSION

The study provides regeneration status or phytosociology of *Rhododendron arboreum*, *R. barbatum*, *R.campanulatum* and *R. anthopogon* at three sites and four aspects in Western Himalaya. In all-natural forest stands the associated or companion of dominant species can also have played important role for the establishment and sustainability of particular species. The broad-leaved character of *Quercus leucotrichophora* major associates *Rhododendron arboreum* have been reported to capable conserve the water moisture at large amount in hill area and also beneficial in erosion control. The study concludes as these species may also be a part of research for their regeneration, establishment and sustenance at same preference of *Quercus leucotrichophora*. *Rhododendron arboreum* are extracted from edible product and small but considerable scale therefore may be investigated for their conservation point of view. The regeneration of *R. arboreum* and *R. barbatum* is also affected by big trees of *Q. semicarpifolia* and *Taxus baccata* because shadow of big trees and frost play important role to decrease the regeneration of Rhododendron species because frost cause cold injury in new seedlings . Dense canopy of trees decreased the regeneration of *R.arboreum* and *R. barbatum*. Proper management, such as thinning of canopy areas should improve growth and establishment of the new generation. The flower of *Rhododendron arboreum* is medicinally important at local and regional level peoples are extracted for making of Juice and Squesh from its flower to serve the upliftment of local economy and livelihood. While *R. anthopogon* leaves used as a coffier by mountain ladies. The other rhododendron species, *R. campanulatum* was key and dominant species of timber line. However it was noticed that *R. campanulatum* shifting upward indicating global warming. It's reached up to alpine zone from sub-alpine zone. Therefore in future regeneration status of alpine species and sub-alpine species of rhododendron will be in risk. Because *R. campanulatum* face extreme low temperature of alpine zone. Lower density, IVI value and regeneration areas indicate for their attention toward future research overcome the upcoming problems. Negligence of the species may be affect the future composition, diversity and regeneration of the existing oak forest mixed stand therefore conservation approach for *Rhododendron arboreum*, *R. barbatum*, *R. campanulatum* and *R. anthopogon* must be needed as research front in the Gahwal Himalayan region.

Natural Regeneration of four Rhododendron species at altitude gradient:

Plate: 1. Regeneration of *R. arboreum* at 2800 mt.

Plate:2. Regeneration of *R. barbatum* at 2800 mt.

Plate: 3. Regeneration of *R. campanulatum at* 3400 mt. **Plate: 4.** Regeneration of *R. anthopogon at* 3800 mt.

REFERENCES

Bankoti, T.N.S., Melkania, V. and Saxena, A.K. (1986). Vegetation analysis along an altitudinal gradient in Kumaon Himalaya. *Indian J. Ecol.*, 13: 211- 221.

Cross, J.R. (1981). The establishment of *Rhododendron ponticum* in the Killarney Oakwoods, S.W Ireland . *Journal of ecology* **63**:345-363.

Meher-Homji, V.M. (1978). Vegetation classification. Need we disseminate environmental terminologies from the physiognomic nomenclature, Ind. Forester 104:653-660.

Rahbek, C. (1997). The relationship among area, elevation and regional species richness in Neotropical birds. Am. Nat., 149, 875-902.

Saxena, A.K., Pandey, Uma and Singh, J.S. (1978). On the ecology of oak forest in Nainital hills, Kumaon Himalaya. In: Singh, J.S., Brij Gopal (Eds), Glimpses of ecology: Prof. R. Misra commemoration volume. International Scientific Publication, Jaipur. Pp. 167 180.

Saxena, A.K. and Singh, J.S. (1982). A phytosociological analysis of woody species in forest communities of a part of Kumaon Himalaya. *Vegetation*, 50: 3 22.

Shaw, M. W. (1984). *Rhododendron ponticum*-Ecological regions for the success of an alien species in Britain and features that may assist in its control. *Aspect of applied biology* **5**:231-242.

Singh, J. S. and Singh, S. P. (1987). Forest vegetation of the Himalaya; Bot. 52 80-192.

Singh, J. S. and Singh, S.P. (1992). Forest of Himalaya: Structure, Functioning and impact of Man, Gyanodaya Prakashan, Nanital.

Tabbush, P.M. and Williamson, D.R. (1987). *Rhododendron ponticum* as a Forest Weed. Forestry Commission Bulletin No. 73. HMSO, London.

Tiwari, A.K. (1983). Analysis of vegetation and land use in parts of Kumaon Himalaya through remote sensing and traditional techniques. Ph. D Thesis, Kumaon University, Nainital, India.