REGENERATION OF *SHOREA ROBUSTA*. GAERTN IN TROPICAL FOREST OF PALPA DISTRICT, CENTRAL NEPAL

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Abstract: A study on the regeneration of the *Shorea robusta* Gaertn in tropical forest of Palpa district was carried out during June-November, 2005. The altitude of study area ranged from 200 m -700 m asl in north facing slope. The study area was natural forest where, *Shorea robusta* and *Terminalia alata*, were dominant species .The size class distribution of *Shorea robusta* resembled the reverse J-shaped curve indicates better regeneration of sal in study area. Sapling and seedling density of *Shorea robusta* significantly correlated (p=0.01) but was no significant relation with soil parameter.

Keywords: Regeneration; Shorea robusta; Size Class distribution Tropical Forest.

INTRODUCTION

Shorea robusta Gaertn. (Sal) is a tall timber yielding plant. It is a deciduous species and changes leaves every year. It is extremely gregarious species and is not at all rich in associated species. Stainton (1972) classified sal forest on Nepal as Terai sal forest and hill sal forest. Sal forest grows on Terai, bhabar, dun valleys and outer foothills. Sal does not grow usually much above 3,500ft., though it can be found at almost 5000ft. Rural people depend on sal forest for fuel wood, fodder and timber. Sal is multipurpose tree. In addition to timber and fuel wood produces fodder. Leaves can be used for plates, seed for oil. Besides, associates of sal produce edible fruits, fodder, medicinal grass, thatch grass, brooms and many other products depending on the species composition (Stainton 1972). Practice of litter collection can be seen in hill sal forests.

Counting of seedlings and saplings and analysis of size class distribution are methods for the regeneration analyses (Vetaas 2000, Koirala 2004). The diameter distribution of trees has been used to represent the population structure of forest (Saxena *et al.* 1984, Khan *et al.* 1987). Undisturbed old-growth forests with sustainable regeneration are found to have a reverse J- shaped size class distribution (West *et al.*1981, Parker and Peet 1984). A bell shaped size class distribution has been attributed to disturbed forest where regeneration is hampered and discontinuous (Parker and Peet 1984, Saxena *et al*. 1984). We aimed to study the population structure of *Shorea robusta* and effects of edaphic factors on regeneration of *Shorea robusta* in Tropical forest in Palpa district.

MATERIALS AND METHOD

Study area. : The present study was carried out on Thulo ban forest (a Government managed forest), in Dobhan VDC (27º34' to 27º57'N; 83º22'-84º 22'E) of Palpa district between 200-700 m asl. Its area was approximately 35 hector. The site was steepy so it was not visited frequently by local people. The study area was natural forest where, *Shorea robusta*, *Terminalia alata*, *Lagerstroemia parviflora* were dominant species.

Sampling: The fieldwork was carried out during June and October 2005. The study area was divided into total eight sites. The first four quadrats were laid randomly at 250-300 m. Similarly, other quadrats in each site were studied randomly at every 50 m intervals. The requisite size of quadrats for tree was 10 m ×10 m as determined by species area curve method following Mishra (1968). For seedlings and saplings, each quadrat of 10 m ×10 m were divided into 4 subplots from the center of the quadrat and two sub plots of opposite corner were studied.

Altogether 32 plots for trees and 64 plots for seedlings and saplings were studied. In each plot number and size of individuals were recorded. Circumference at breast height (cbh) of each tree was measured at 1.37 m above the ground level by using measuring tape and converted it into diameter at breast height (dbh). Individuals were grouped into tree (dbh>10cm), sapling (dbh < 10cm, height > 30cm and seedling (height < 30cm) (Sundriyal and Sharma, 1996). Tree species were divided into different size classes based on dbh of 10 cm intervals and the size class diagram was developed to analyze regeneration pattern. Soil samples were collected in two seasons from four

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Table 1: Density and basal area of individual tree species in sal dominated forest.

SN	Name of the species	D(ha^{-1})	BA (m^2/ha)	Frequency (%)	IVI
1	*Albizia lebbeck*	15.62	0.43	12.5	5.81
2.	*Bauhinia variegata*	9.38	0.63	9.38	4.51
3.	*Bombax ceiba*	12.5	0.83	12.5	6.0
4.	*Bridelia retusa*	34.38	1.05	21.88	11.7
5.	*Callicarpa arborea*	56.25	1.84	15.62	14.7
6.	*Cassia fistula*	12.5	0.34	12.5	5.23
7.	*Desmodium oojeinense*	28.13	0.93	25	11.31
8.	*Diploknema butyraceae*	12.5	1.3	12.5	6.73
9.	*Ficus semicordata*	3.13	0.15	3.13	1.4
10.	*Grewia optiva*	12.5	1.85	12.5	7.0
11.	*Hymenodictyon excelsum*	3.13	0.17	3.13	1.44
12.	*Kydia calycina*	3.13	0.13	28.13	1.38
13.	*Lagerstroemia parviflora*	43.75	1.3	9.38	14.9
14.	*Mallotus philippinensis*	9.38	0.14	9.38	3.73
15.	*Phyllanthus emblica*	9.38	0.33	9.38	5.25
16.	*Semecarpus anacardium*	40.62	2.0	31.25	16.26
17.	*Shorea robusta*	209.37	31.42	87.5	99.93
18.	*Sterculia villosa*	3.13	0.06	3.13	1.25
19.	*Stereospermum chelonoides*	9.38	0.12	9.38	3.72
20.	*Syzygium operculata*	18.75	1.15	9.38	5.33
21.	*Syzygium cumini*	18.75	1.9	15.63	9.31
22.	*Terminalia alata*	78.13	13.6	56.25	45.65
23.	*Terminalia chebula*	25	0.96	18.75	9.46
24.	*Vernonia saligna*	3.13	0.4	3.13	1.81
25.	*Wendlandia exserta*	18.75	0.51	6.25	4.25
26.	*Wendlandia puberula*	3.13	0.03	3.13	1.95
Total		684.44	63.86	434.44	300.0

corners and centre of the 10×10 m plot following Saxena (1989). The collected soil samples were mixed homogenously and packed in airtight plastic bags, for analysis. Soil moisture and pH were measured in laboratory of Central Department of Botany, Tribhuvan University, Kathmandu. The physico-chemical parameters (organic matter, nitrogen, phosphorus and potassium) of soil were examined at soil section of Nepal Agricultural Research Council (NARC), Khumaltar, Lalitpur, SPSS (2002, 11.5 version) was used for statistical (correlation and regression) analysis.

RESULTS

Vegetation composition

Sal was the dominant tree species in study site. Altogether 26 tree species were recorded. *Shorea robusta* has the highest importance value index (99.93) (Table 1). Frequency of *Shorea robusta* was 87.5% *Terminalia alata* was co dominant species in this forest. Total tree density in the forest ranged from 3.13 pl/ha to 209.37 pl/ha (Table 1). The total basal area of all tree species was 63.86m^2 ha^{-1}. In the case of sapling, the total density was 3437.5 pl/ha in which *Shorea robusta* was found higher (2250 pl/ha) (Table 2).

Soil analysis: Soil of the forest under study was slightly acidic in nature. The average soil pH of study site was 5.3.Moisture content of soil ranged between 16.3 to 41.5%. Total organic matter in soil ranged between 2.6 to 2.8%. Similarly, nitrogen content, available phosphorus and potassium content in the soil was found between 0.13 to 0.14%, 6.8 to 20.76 kg/ha and 152.03 to 259.73 kg/ha respectively.

Table 2: Frequency, density and abundance of saplings at study site.

SN	Name of the species	D (ha^{-1})	Frequency
1	*Albizia lebbeck*	12.5	3.12
2.	*Bauhinia variegata*	337.5	25
3.	*Bombax ceiba*	12.5	3.12
4.	*Bridelia retrusa*	62.5	9.38
5.	*Cassia fistula*	37.5	6.25
6.	*Desmodium oojeinense*	125.0	15.62
8.	*Ficus hispida*	62.5	6.25
9.	*Ficus semicordata*	12.5	3.12
10.	*Lagerstroemia parviflora*	187.5	34.38
11.	*Phyllanthus emblica*	62.5	9.38
12.	*Premna integrifolia*	37.5	9.38
13.	*Semecarpus anacardium*	125.0	18.75
14.	*Shorea robusta*	2250	84.38
15.	*Syzygium cumini*	25.0	6.25
16.	*Terminalia alata*	37.5	9.38
17.	*Wrightia alata*	50.0	9.38
Total		3437.5	253.13

Regeneration and size class distribution

Size class diagram of *Shorea robusta* showed reverse J-shaped structure (Fig 1).Only seven size classes were found

Table 3: Correlation of seedling and sapling density with soil parameters (OM= Organic matter, N=Nitrogen, P= Phosphorus, K= Potassium, MOIST= Moisture, SEEDLI= Seedling, SAPLI= Sapling).

Correlations	pH	OM	N	P	K	MOIST	SEEDLI	SAPLI
SEEDLI	-0.587	0.299	0.282	-0.548	-0.053	-0.394		
SAPLI	-0.436	0.429	0.399	-0.526	0.192	-0.154	0.958**	

** Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.01 level (2- tailed)

of which density of smallest diameter classes were highest. Larger trees of *Shorea robusta* with DBH more than 80 cm were not found.

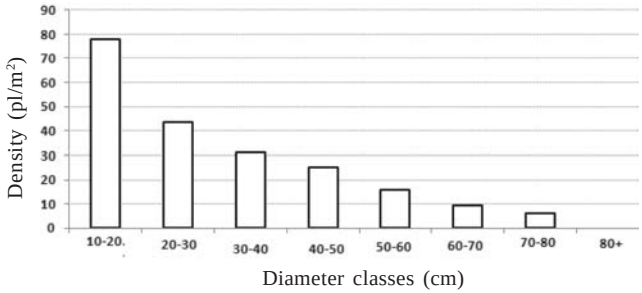

Fig 1: Density of different diameter classes (cm) of *Shorea robusta.*

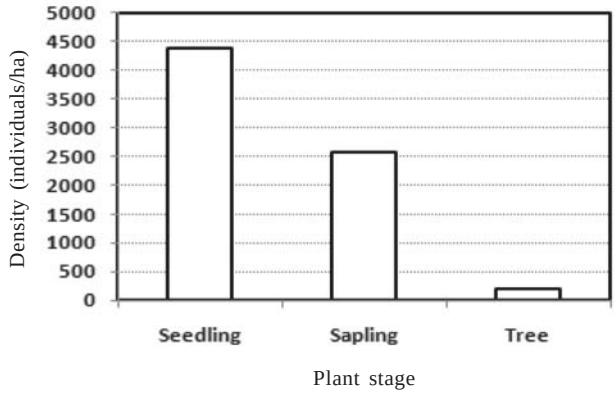

Fig 2: Density of seedling, sapling and tree of *Shorea robusta.*

DISCUSSION

The diameter distribution of the *Shorea robusta* trees shows the reverse J-shaped curve (Fig1.) which is the indication of the sustainable regeneration (Vetaas, 2000). Density of the trees with smaller girth size is higher than that of the larger girth size. So the forest is in the state of good regeneration. Density of sal in Thuloban forest was higher than values reported from other parts of Nepal (Shrestha, 2005; Pant, 1997 and Duwadee *et al.*, 2006) but lower than value reported by Kandel (2007). In Nepal sustainable regeneration of *Shorea robusta* has been reported from both Terai (Rautiainen, 1996; Giri *et al.*, 1999 and Kandel, 2007) and the hills (Rai *et al*., 1999). However, regeneration was not sustainable in natural dense forest with a high density of larger trees (Rai *et al*., 1999). *S. robusta* has been facing a serious threat to its existence in the tropical and sub tropical belts of India due to infestation by sal borer (*Hoplocesambyx spinicornis*) and also to moisture stress caused by the combined effects of intensive grazing repeated fire, lopping and indiscriminate harvesting (Negi *et al*, 2002).Tree canopy of Thuloban forest was formed by *Shorea robusta* and *Terminalia alata* but sal had very high density and relative density (88.31) than *Terminalia alata*. The total plant densities of tropical forest varies from 550 to 1100 pl/ ha (Saxena, 1979). So the result of present study also lies in general trend of tropical forest.

There was 4375seedling and 2562.5 sapling and 209.37adults $ha^{-1}$of *Shorea robusta* (Fig. 2) in study site. It indicates the better regeneration of sal. The number of seedlings of other timber species was much lower than the number of sal seedlings. Hence sal regeneration is good.

Rautiainen (1994) stated that the number of *Shorea robusta* seedlings (6000 to 10000) in the Terai forest which shows more suitability of *S. robusta* plant such area. The present value of finding was lower than 13166 individual per hectare reported by Aryal *et al.* (1999) in Royal Bardia National Park and 11099 in natural forest at Chitrepani due to different climatic condition and edaphic factors. The establishment of seedling probably reflects soil or litter properties. Regarding the correlation coefficient seedling density of *S. robusta* showed the significant positive correlation (p=0.01) that of sapling density. However, the effect of soil nutrients and physical parameters is not significant (Table 3).For the better regeneration of any species seed germination and seedling establishment is very important. Germination of seed mostly depends upon various environmental factors like temperature, soil moisture, light intensity and viability of seeds. If seed gets sufficient light, moisture and temperature then it germinates to seedling. In the study area the total seedlings that germinate from the seed did not develop into saplings which were indicated by the highest density of seedlings than saplings. The reason may be all seedlings can not tolerate harse environmental condition and compete with other herbaceous flora. On the other hand lopping of other forest component has a negative effect on regeneration. Seedlings growing under the shrub canopy are easily destroyed by lopping of these shrubs.

Large number of fallen logs and lopping of tree is observed in the field visits. People nearby the study area generally preferred timber of *Shorea robusta* for construction of buildings and other furniture. High human and other biotic pressure as well as natural disturbance has been reported to be detrimental for population structure and forest regeneration (Singh and Singh, 1992).

CONCLUSION

The study area was natural forest where, *Shorea robusta and Terminalia alata* were dominated tree species. The highest value of IVI among trees and sapling was found for *S. robusta.* Density diameter distribution of *Shorea robusta* shows continuous regeneration. Seedling and sapling density also indicates good regeneration of *Shorea robusta.* There was no significant relation of sapling and seedling density of *Shorea robusta* with soil parameter.

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