International Journal of Bio-Science and Bio-Technology
Vol.5, No.6 (2013), pp.63-70
http://dx.doi.org/10.14257/ijbsbt.2013.5.6.07

Population Structure and Regeneration Potential of Sal (*Shorea robusta* gaertn. f.) and its Associates in Sal Bearing Forests of Satpura Tiger Reserve

O. P. Chaubey and Archana Sharma

Senior Scientist and Head of Forest Botany Division
State Forest Research Institute, Jabalpur - 482008 (M.P.)
E-mail: chaubey.dr@gmail.com, archanasharma.sharma6@gmail.com

Abstract

Shorea robusta is threatened these days due to sal borer attack, sal mortality, poor regeneration potential, edapho-climatic changes and various biotic interferences. No systematic attempts were made to understand dynamism of its natural regeneration and to suggest management inputs to encourage its regeneration. The present study deals with the natural regeneration of sal and its associates in Satpura Tiger Reserve, India. The results indicated that the average number of regeneration of sal seedlings per hectare worked out to be 6372 ha^{-1}, which are quite adequate. The distribution pattern of individuals of Shorea robusta trees in different girth classes was also seemed to be uninterrupted in most of the stands studied. This trend of uninterrupted distribution of sal in different growth phases with plenty of established regeneration is the healthy sign of establishment and growth of Shorea robusta crop in the past in this area. Other associates showed different growth patterns.

Keywords: *Natural regeneration, stand structure, crop composition, distribution, phyto-sociology*

1. Introduction

Sal is the most important timber species and has high production potential in the forest of Madhya Pradesh. In Satpura Tiger Reserve division, sal forest is found in 2 forest ranges, namely Pachmarhi and Park Pachmarhi. The total area under sal forest of the Satpura Tiger Reserve being 588.809 ha. According to Champion and Seth (1968) classification of forest types, the Sal forest of Satpura Tiger Reserve is mainly falling under Dry peninsular high level Sal Forest (5B/C1c(iv))**.** Topographically, most of the sal forest of this area is found in hilly, undulating and plains habitats. Sal forest of this area was also under sal borer infestation (*Hoplocerambyx pinecones*) during 1997-98.

Scattered information is available in literature on status of *Shorea robusta* regeneration in relation to soil pH (Gupta, 1953), accumulation of leaf litter in moist forests (Champion and Seth, 1968) damage by wild animals (Sirkar, 1954), effect of grazing closure (Chaubey and Jamaluddin, 1989), Shrubby growth and ground flora richness (Khan and Gupta, 1960). Srivastava (1963) studied phyto-sociological studies of *Shorea robusta* forests in U.P. with special reference to regeneration. Dabral *et.al*. (1980) studied micro-climatic variations in naturally regenerating *Shorea robusta* forest in West Dehradun. They advocated that temperature and moisture regimes of the surface soil are related with mortality of *Shorea robusta* seedlings. Jha and Pandey (1980) studied the comparative loss of soil moisture during

ISSN: 2233-7849 IJBSBT

decomposition of leaf litter in Poplar, *Eucalyptus*, Chir, Teak and *Shorea robusta* and suggested that moisture loss is least in *Shorea robusta* as compared to other species. No systematic attempts were made in India, to understand dynamism of natural regeneration of *Shorea robusta* and to suggest management inputs to encourage its regeneration, particularly in the state of Madhya Pradesh, India. The natural regeneration aspect received very little attention with particular reference to crop composition and community type. Ecology of natural regeneration of *Shorea robusta* with special reference to crop composition and community types was attempted by Khan and Gupta (1960) in Dehradun Valley. The present paper contains the status of sal regeneration and standing crop of Satpura Tiger Reserve, India.

2. Materials and Methods

In order to assess the status of sal regeneration and population structure of standing crop, total 07 compartments out of total 67 sal bearing compartments were studied in Satpura Tiger Reserve adopting standard ecological methods (Mishra, 1989; Philips, 1959). The list of compartments bearing sal forests is given in Table 1. In all, more than 10% of the total sal bearing compartments was selected systematically from the list of total compartments of the tiger reserve. The latitude and longitude of the center point of the compartment were noted with the help of GPS, and the sample plot of 0.1 ha was laid in the center of the compartment.

In order to represent the population structure of each species and to determine the distribution pattern of density of different tree species following GBH classes were established (Ralhan *et al.*, 1982).

Class	Range in gbh/cbh (cm)
A	0-10 (Seedlings)
B	> 10-20 (Saplings)
C	> 20-40
D	> 40-60
E	> 60-80
F	> 80-100
G	> 100-120
H	> 120-140
I	> 140-160
J	> 160-180
K	> 180-200 and above

The total number of individuals belonging to above girth classes was computed for each species. The database is useful for determining the trend of establishment and growth of each species. The number of individuals in each girth class, for each species, was divided by the total number of individuals in all girth classes of that species. The resultant value was multiplied by 100 to yield per cent density for each girth class for different species.

Table 1. Details of Sal Bearing of Compartments of Satpura Tiger Reserve

S. N.	Range	Name of beat	Comptt. No.	Area(ha)
1	Pachmarhi	Bari Aam	P-244, P269, P270	968.82
		Barghati	P246, P247, P-291, P-292, P-293, P-294, P-295	1831.61
		Pathar	P-249, P-250, P-296	1906.88
		Mahadeo	P-252, P-298, P-300 P-301	1120.39
		Nandia	P-251, P-271, P-272	1869.65
		Patharkanta	P-273, P-274, P-275	1155.38
		Churni	P-276, P-277, P-278	1108.85
		Churnipathar	P-248, P-279, P-280	1874.14
		Fiferi	P-287	353.70
2	Park Pachmarhi	Shalangali	P-301, P-302, P-303, P-304, P-305	1039.08
		Dhupgarh	P-306, P-307, P-308	966.79
		Tinkheda	487	1427.31
		Ghodanar	484, 486	1780.19
		Reechhgarh	P-309, P-310, P-311, P-312, P-313	1001.60
		Pagaradhana	P-238, P-240	665.31
		Binora	P-252, P-253, P-254, P-255	1186.82
		Rorighat	P-256, P-257, P-258	1099.93
		Kajari	P-259, P-260, P-261	1083.34
		Badkchhar	P-262, P-263, P-239	1335.45
		Ambamai	P-264, P-265, P-266, P-267	1370.27
		Neemdhan	481, 482	1530.50
			Total	**26676.01**

3. Results

3.1. Population Structure of Standing Crop

The status of standing crop of sal and its associates, pertaining to crop composition, average density of standing trees per ha, average percent composition of sal and its associates in different girth classes of Satpura Tiger Reserve is described in Table 2. The growth phase of sal showed uninterrupted trend of regeneration from saplings to mature stage. This is the good indication of establishment and development of sal. From the population structure of various tree species, following common patterns could be recognized. One pattern of population structure was represented by species showing individuals in lower and middle girth classes with the absence of trees in higher girth classes. These species are namely *Albizia odoratissima, Buchanania lanzan, Casearia graveolens, Chloroxylon swietenia, Diospyros melanoxylon, Holarrhena pubescens, Manilkara haxandra, Miliusa tomentosa, Semecarpus anacardium* and *Terminalia chebula*. Species like *Emblica officinalis* having most of the individual in lower girth class (sapling stage) with the absence of individuals in higher girth classes. Some species such as *Lannea coromandelica* and *Lagerstroemia parviflora* showed interrupted trend or gap phase in population structure. There is another pattern of population structure which consists of individual in middle girth class with absence of individuals in lower and higher girth classes. The species belonging to this category were *Gardenia latifolia, Grewia tiliaefolia, Pterocarpus marsupium, Schleichera oleosa* and *Ziziphus rugosus.*

Table 2. Population Structure of Different Trees Species in Various Girth Classes with Percent Density in Satpura Tiger Reserve (STR)

S. N.	Species	Trees per ha in different girth classes (cm) / Percent Density									
		>10-20	> 20 - 40	>40- 60	>60-80	>80-100	>100-120	> 120 - 140	> 140 - 160	> 160 - 180	>180 - 200 and above
		B	C	D	E	F	G	H	I	J	K
1	*Albizia odoratissima* (L.f.) Benth.	5.00 (33)	10.00 (67)	-	-	-	-	-	-	-	-
2	*Anogeissus latifolia* (Roxb.ex DC.) Wall.ex Bedd.	-	10.00 (100)	-	-	-	-	-	-	-	-
3	*Bauhinia vahlii* Wight. & Arn.	-	-	-	10.00 (100)	-	-	-	-	-	-
4	*Buchanania lanzan* Spreng.	23.33 (45)	23.33 (45)	5.00 (10)	-	-	-	-	-	-	-
5	*Casearia graveolens* Dalz.	5.00 (20)	20.00 (80)	-	-	-	-	-	-	-	-
6	*Chloroxylon swietenia* DC.	35.00 (37)	50.00 (53)	10.00 (11)	-	-	-	-	-	-	-
7	*Diospyros melanoxylon* Roxb.	30.00 (55)	25.00 (45)	-	-	-	-	-	-	-	-
8	*Emblica officinalis* Gaertn	10.00 (100)	-	-	-	-	-	-	-	-	-
9	*Flacourtia indica*(Burm. f.) Merr.	-	10.00 (50)	10.00 (50)	-	-	-	-	-	-	-
10	*Gardenia latifolia* Schlecht. ex Hook.f.	-	10.00 (100)	-	-	-	-	-	-	-	-
11	*Grewia tiliaefolia* Vahl.	-	20.00 (100)	-	-	-	-	-	-	-	-
12	*Holarrhena pubescens* Wall. ex G.Don	40.00 (67)	10.00 (17)	10.00 (17)	-	-	-	-	-	-	-
13	*Lagerstroemia parviflora* Roxb.	10.00 (37)	6.67 (25)	6.67 (25)	-	-	-	3.33 (12)	-	-	-
14	*Lannea coromandelica* (Houtt.)Merr.	10.00 (50)	-	-	-	10.00 (50)	-	-	-	-	-
15	*Litsea glutinosa* (Lour.) Robbinson in Philipp. J. Sci. Bot.	30.00 (100)	-	-	-	-	-	-	-	-	-
16	*Madhuca indica* J.F. Gimelin	10.00 (33)	2.50 (8)	-	5.00 (17)	5.00 (17)	-	2.50 (8)	2.50 (8)	2.50 (8)	-

S. N.	Species	Trees per ha in different girth classes (cm) / Percent Density									
		>10-20	> 20 - 40	>40- 60	>60-80	>80-100	>100-120	> 120 - 140	> 140 - 160	> 160 - 180	>180 - 200 and above
		B	C	D	E	F	G	H	I	J	K
17	*Manilkara haxandra* (Roxb.) Dub.	5.00 (8)	35.00 (58)	20.00 (33)	-	-	-	-	-	-	-
18	*Miliusa tomentosa* (Roxb.)Sinclair	10.00 (29)	20.00 (57)	5.00 (14)	-	-	-	-	-	-	-
19	*Pterocarpus marsupium* Roxb.	-	10.00 (100)	-	-	-	-	-	-	-	-
20	*Schleichera oleosa* (Lour.) Oken.	-	20.00 (100)	-	-	-	-	-	-	-	-
21	*Semecarpus anacardium* L.f.	5.00 (33)	5.00 (33)	5.00 (33)	-	-	-	-	-	-	-
22	*Shorea robusta* Gaertn. f.	160.0 (20)	311.43 (40)	151.43 (19)	100.00 (13)	35.71 (5)	14.29 (2)	4.29 (1)	4.29 (1)	-	-
23	*Syzygium cumini* (L.) skeels	-	10.00 (25)	5.00 (13)	5.00 (13)	5.00 (13)	15.00 (38)	-	-	-	-
24	*Terminalia chebula* Retz.	20.00 (67)	10.00 (33)	-	-	-	-	-	-	-	-
25	*Terminalia tomentosa* (Roxb.ex DC.)	10.00 (25)	10.00 (25)	10.00 (25)	5.00 (13)	5.00 (13)	-	-	-	-	-
26	*Ziziphus rugosus* Lamk.	-	10.00 (100)	-	-	-	-	-	-	-	-

Note: *The values in parentheses are the percent plant density in various girth classes*

3.2. Regeneration Status of sal and its Associates

Perusal of the compartment wise details summarized in Table 3, reveals that the regeneration of sal (seedlings per ha) varied from 694 to 20444. The average number of regeneration per hectare worked out to be 6372, which is quite adequate as per the standard norms described in code of working plans and by Champion and Seth (1968). Besides the adequate regeneration of sal, the distribution pattern of individuals of sal trees in different girth classes was also seemed to be uninterrupted in most of the stands studied (Table 2). This trend of uninterrupted distribution of sal in different growth phases with plenty of established regeneration is the healthy sign of establishment and growth of sal crop in the past in this area. No indication of any disease/borer infestation was found in the study area. The presence of healthy sal trees in all age groups suggests the sustainable development of the sal crop in this area.

Among other associates of sal, maximum established regeneration was found in *Diospyros melanoxylon* followed by *Miliusa tomentosa, Bauhinia vahlii, Gardenia latifolia, Buchanania lanzan, Chloroxylon swietenia, Pterocarpus marsupium, Bauhinia racemosa, Holoptelea integrifolia, Litsea glutinosa, Terminalia tomentosa, Aegle marmelos, Terminalia chebula, Cassia fistula, Emblica officinalis, Terminalia belerica, Syzygium cumini, Anogeissus latifolia* and *Careya arborea* (Table-4).

Table 3. Population Structure in Terms of Plant Density of sal Crop in Different Girth Classes (growth phases) in Different Compartments Studied in Satpura Tiger Reserve

S. No.	Com-part-ment No. / Site quality	Plant density per ha in different girth classes (cm)										
		Established regeneration per ha (1-10 cm collar girth)	10-20 (sap-lings)	>20-40	>40-60	>60-80	>80-100	>100-120	>120-140	>140-160	>160-180	>180-200 and above
1.	P-252 (MP III)	6139	400	950	420	110	60			10		
2.	P-269 (MP IVa)	1083	140	220	120	50				10		
3.	P-274 (MP III)	20444	70	60	30	110	70	60	30			
4.	P-255 (MP IVa)	694	10	150	120	100	20	10				
5.	P-302 (MP III)	4194	170	350	240	160	10					
6.	P-309 (MP III)	3027	130	290	80	120	50			10		
7.	P-264 (MP IVa)	9028	200	160	50	50	40	30				
Average		6372.71										

Table 4. Average Established Regeneration of Different Tree Species in Satpura Tiger Reserve (STR)

S.N.	Name of Species	Av. established regeneration (plants per ha)
1	*Diospyros melanoxylon* Roxb.	1452
2	*Miliusa tomentosa* (Roxb.)Sinclair	1125
3	*Bauhinia vahlii* Wight. & Arn.	1076
4	*Gardenia latifolia* Schlecht. ex Hook.f.	833
5	*Buchanania lanzan* Spreng.	694
6	*Chloroxylon swietenia* DC.	556
7	*Pterocarpus marsupium* Roxb.	523
8	*Bauhinia racemosa* Lam.	417
9	*Holoptelea integrifolia* (Roxb.) Planch.	417
10	*Litsea glutinosa* (Lour.) Robbinson in Philipp. J. Sci. Bot.	333
11	*Terminalia tomentosa* (Roxb.ex DC.)	319
12	*Aegle marmelos* (L.) Correa	278
13	*Terminalia chebula Retz.*	278
14	*Cassia fistula* L.	181
15	*Emblica officinalis* Gaertn	69
16	*Terminalia belerica* (Gaertn.) Roxb.	69
17	*Syzygium cumini* (L.) skeels	69
18	*Anogeissus latifolia* (Roxb.ex DC.) Wall.ex Bedd.	28
19	*Careya arborea* Roxb.	28

4. Discussion

The population structures of various tree species showed four types of growth pattern. One pattern of population structure is represented by greater proportion of individuals in lower and middle girth classes, indicating frequent regeneration (Knight, 1975). Another pattern showed most of the individuals in middle girth classes with the absence of seedling and saplings. Benton and Werner (1976) stated that if such a trend continues, the population of these species is on the way to extinction. The population structure of certain species is characterized by gap phase type regeneration (interrupted). Interrupted regeneration of species may indicate that one or more climatic and/or bio-edaphic factors inhibited the regeneration completely for certain periods of time, and with the return of favorable conditions, the species was able to regenerate again. There is another pattern which consists of individuals in lower and middle girth classes but absence of seedlings. The last pattern is consisting of seedlings with absence of some intermediate classes. This requires detailed study on reproductive biology and eco-silvicultural requirements at different growth stages. The sal showed adequate regeneration with uninterrupted growth pattern in most of the stands studied, indicating healthy sign of establishment and growth of sal crop in the past.

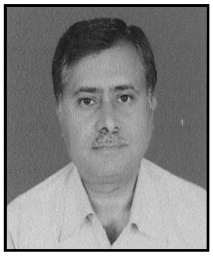
5. Conclusion

Keeping the status of standing crop and regeneration of *Shorea robusta* in particular it is concluded that though, the crop condition is quite good and regeneration is adequate, yet biotic influences, fire and other hazards should be strictly controlled for the sustainable development of population structure.

References

[1] A. H. Benton and W. E. Werner, "Field biology and ecology", McGraw-Hill, Inc., New York, **(1976)**.
[2] H. G. Champion and S. K. Seth, "General silviculture for India", Manager of Publication, Delhi-6, **(1968)**.
[3] O. P. Chaubey and Jamaluddin, "Impact of grazing closure on some ecological aspects of Shorea robusta natural forests with special reference to its regeneration in Madhya Pradesh. Biome, vol. 4, **(1989)**, pp. 29-33.
[4] B. G. Dabral, S. P. Pant and S. C. Pharasi, "Micro-climate of a regenerating Shorea robusta forest in West Dehradun", Proc. of Second Forestry Conf., Dehradun, **(1980)**, pp. 1-13.
[5] R. S. Gupta, "Studies in soils", Proc. of All India Shorea robusta Study Tour and Symp. FRI, Dehradun, **(1953)**, pp. 28-29.
[6] M. N. Jha and P. Pandey, "Loss of soil moisture as affected by decomposing leaf litter of different forest species", Indian Forester, vol. 106, no. 5, **(1980)**, pp. 352-358.
[7] M. A. W. Khan and A. C. Gupta, "Plant communities associated with Shorea robusta regeneration in Dehradun Valley", Indian Forester, vol. 86, no. 7, **(1960)**, pp. 417-422.
[8] D. J. Knight, "A phytosociological analysis of species rich tropical forest on Colorado Island", Panama. Ecol. Monograph, vol. 54, no. 259, **(1975)**.
[9] K. C. Mishra, "Manual of plant ecology", 3rd Oxford (IB) publishing Pvt. Ltd. New Delhi, **(1989)**.
[10] E. A. Philips, "Methods of vegetation study", A Holt Dry Dem it enry Holt and Co. Inc., **(1959)**, pp. 107.
[11] R. K. Ralhan, A. K. Saxena and J. S. Singh, "Analysis of forest vegetation at and around Nainital in Kumaun Himalaya", Proc. Natn. Sci. Acad, vol. 1, **(1982)**, pp. 121-137.
[12] M. M. Sirkar, Letter to the Editor. Indian Forester, vol. 80, no. 1, **(1954)**, pp. 62.
[13] P. B. L. Srivastava, "Phyto-sociological studies of Shorea robusta forests of U.P. with special reference to regeneration", Ph.D. thesis, Agra University, Agra, **(1963)**.

Authors



O. P. Chaubey, is working as Head of Forest Botany Branch in M.P. State Forest Research Institute, Jabalpur (M.P.) India. He was awarded in Ph.D. degree in Forest Ecology in 1986 from Dr. H.S. Gaur University, Sagar, (Madhya Pradesh, India). He has to his credit two books, 13 monograph of various forestry species and more than 75 research papers published in both National and International journals. He has 30 years of research experience in field of forestry. He has completed more than 22 externally funded research projects in the capacity of Principal Investigator. He has organized a number of symposia/ workshops at National and State levels. He has imparted trainings to field foresters, University scholars, NGOs and Rural Communities engaged in conservation and management of biological diversity.

Archana Sharma, is working as Head of Seed Technology Branch in M.P. State Forest Research Institute, Jabalpur. She was awarded in Ph.D. degree in Seed Science in 1993 from Dr. H.S. Gaur University, Sagar, (Madhya Pradesh, India). She has to her credit more than 50 research paper published in both National and International journals, three bulletins and fourteen brochures. She has 20 years of research experience in seed technology. She has completed more than 15 externally funded research projects in the capacity of Principal Investigator. She has organized a number of trainings and workshops at National and State levels. She has imparted trainings to field foresters, University scholars, NGOs and Rural Communities engaged in seed technology, sustainable management and harvesting of bio resources.