

Physicochemical Characteristics of the Soil on the Growth of Sal Forest in Jharkhand

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Abstract:- The physicochemical characterization of soil on the growth of selected Sal forest in Hazaribag, Chatra, Koderma, and Ranchi districts of Jharkhand in India has been carried out. The paper describes the different basic factors which support the growth of Sal-dominated forest found in these areas. The soil sampling was done using a quadrat method based on the principle of systematic sampling. Ten samples each were collected from Hazaribag, Chatra, Koderma, and Ranchi Sal forests of Jharkhand for the study of soil properties. The soil samples were collected from eight different quadrats in order to determine soil quality index viz. soil texture, MC, WHC, OC, OM, pH, N, P, Na, K, and Ca. The soil pH was found to be slightly acidic having a range of 5.40– 5.99. Moisture content, water-holding capacity, organic carbon, organic matter, and available nitrogen of soil samples were found to be in the range of 3.70–11.30%, 35.27–57.59%, 0.46–0.97%, 1.36–3.54%, 207–314 Kg/ha, respectively. P, Na, K was found to be in the range of 2.96-7.19 Kg/ha, 2.73-5.34, 154.56- 471.38 Kg/ha and Ca in mg/kg was found to be 1712- 3144 respectively.

Keywords: Sal-dominated forest, Soil properties, Systematic sampling, Quadrat method

I. INTRODUCTION

Sal (*Shorea robusta*) is a tropical tree species native to South Asia from India, Nepal, Bangladesh, and Myanmar covering more than 12 million hectares of forest area [1]. The general distribution of Sal forest is due to climate, geological, and soil conditions [2]. On the basis of edaphic conditions and microclimates, the phenology of the Sal forest ranges from deciduous to evergreen and extends from tropical to subtropical. Sal tree is a species of tree belonging to the *Dipterocarpaceae* family and it is used for various purposes in addition to timber and fuel [3], Sal produces fodder [4], leaves for plates [5], seeds for oil [6], feed, resin or latex from hardwood and tannin and gum from the bark. Hora [7] found that Jharkhand is very rich in floristic diversity due to its geological area which is a link between Satpura Hill Ranges and Eastern Himalayas that allowed species exchange between these ranges. The state is covered with a variety of different habitats in which the Sal forest is predominant among all. Champion and Seth [8] classified the Sal forests of Jharkhand mainly into two types: (i) Moist Peninsular and (ii) Dry Peninsular Sal Forest. Braun-Blanquet et al [9] observed that Sal is associated with various other species, and the companion species differ to some extent in different localities according to the local climate. Structurally and floristically, tropical moist deciduous forests are more complex than dry deciduous forests.

Tropical moist deciduous forests are mainly distributed in the states of Jharkhand, Chhattisgarh, and West Odisha of India. The Jharkhand state has a large area of Sal forest and these forests are originally spread out over thousands of square miles, especially in the districts of Hazaribag, Chatra, Koderma, and Ranchi. These forests contain very dense and rich growth of Sal trees spread all over these areas [10-12]. Among the natural factors, the most important variation is altitude, climate, vegetation covers, and microbial activities [13]. Vegetation plays an important role in the formation of soil. For example, the main source of soil organic matter is plant tissue (aboveground litter and belowground root detritus), which influences physicochemical characteristics of soil such as water holding capacity (WHC), soil pH, nutrients availability, and texture [14]. Recently several workers [15-25] have worked on the growth of the Sal forest in Jharkhand and other areas of the Indian subcontinent. There is a need for assessment of soil properties which has expanded because of growing public interest in determining the consequences of management practices on the quality of soil relative to the sustainability of forest ecosystem functions in addition to plant productivity. This is the natural forest having large socio-economic value and thus, a scientific forest management system is necessary for this forest. The Sal forests have always relied on the knowledge of the chemical and physical properties of soils to assess the capacity of sites to support productive forests. This prompted the present author to undertake the physicochemical properties of forest soil vary in space and time depending on a variety of natural factors. This work incorporates in order to document the physicochemical characteristics (soil organic matter, soil moisture content, soil pH, electrical conductivity, soil organic carbon, available nitrogen, and available phosphorus) of soil with the growth of Sal forest in Jharkhand State.

II. MATERIAL AND METHODS

Four representative samples were collected at different locations of the forest covering 1×1 m length from the center of quadrat in four study sites at a depth of 10-15 cm using a soil digger at each location from Hazaribag, Chatra, Koderma and Ranchi district of Jharkhand areas Fig. 1 and description of study sites in Tab.1.

The soil samples stored in polythene bags for physicochemical analysis in the laboratory. These soil samples were mixed thoroughly. The soil samples were air dried in shade in the field as well as in the laboratory and debris of plants, stone, and objects other than soil were removed. About 200 g of fine dried soils (passed through the sieve of mesh size 0.5 mm) were stored in an airtight polythene bag until laboratory analysis. There were

altogether 10 soil samples from the study site representing different conditions. For each soil sample soil texture, pH, organic carbon, organic matter, available nitrogen, available

phosphorus, available potassium, sodium, calcium analyzed and was estimated using the standard method.

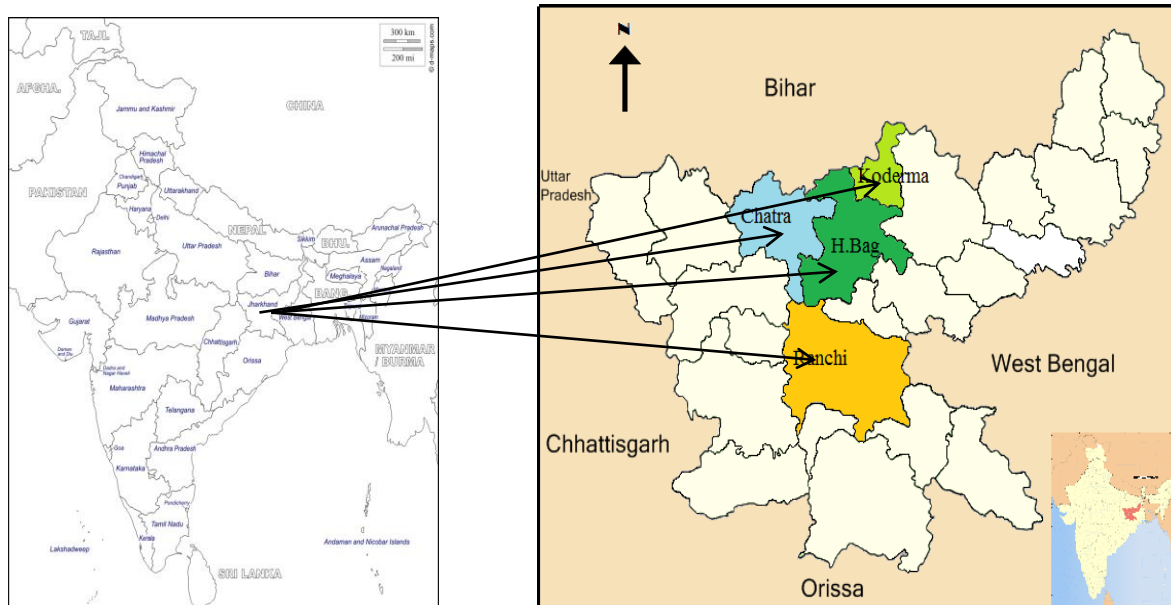


Fig. 1: Study area of Jharkhand

Features	Study Sites			
Block	Padma	Simaria	Koderma	Ormanjhi
District	Hazaribag	Chatra	Koderma	Ranchi
Latitude	24.173283	23.9998	24.469006	23.53395619
Longitude	85.400108	85.1329	85.56884	85.49406152

Table1. Description of study site

III. RESULTS AND DISCUSSION

The descriptive statistics of soil physicochemical properties under Sal forest in Hazaribag, Chatra, Koderma, and Ranchi Forest have been summarized in Table2.

Soil Properties	Hazaribag			Chatra			Koderma			Ranchi		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
Temp (°C)	39.20	6.9	24.4	38.1	9.4	23.75	37.40	9.6	23.5	36.10	9.5	22.8
Humidity (%)	98.30	10.8	67.6	83.91	28	55.96	84.28	30.83	57.56	87.16	31.57	59.37
Moisture Content (%)	11.30	4.60	7.95	9.30	3.70	6.50	8.77	4.26	6.25	7.34	5.82	6.58
Water Holding Capacity (%)	53.77	45.22	49.50	57.59	35.27	46.43	47.33	39.86	43.60	54.59	48.36	51.48
pH	5.60	5.40	5.50	5.99	5.79	5.89	5.91	5.89	5.90	5.80	5.60	5.70
Organic Carbon (%)	0.85	0.65	0.75	0.59	0.47	0.53	0.68	0.46	0.57	0.97	0.77	0.87
Organic Matter (%)	2.42	1.36	1.89	3.54	2.57	3.01	3.30	1.75	2.52	2.96	2.03	2.50
Available Nitrogen (Kg/ha)	287.04	275.46	281.25	217.00	207.00	212.00	243.47	231.67	237.57	314.00	295.00	304.50
Available Phosphorous(Kg/ha)	7.28	7.10	7.19	3.06	2.86	2.96	6.81	6.65	6.73	3.69	3.59	3.60
Sodium(mg/L)	5.13	3.52	4.33	5.27	2.84	4.05	4.78	2.73	3.76	5.34	3.93	4.63
Available Potassium(Kg/ha)	471.38	455.98	463.68	158.16	150.96	154.56	214.03	204.23	209.13	211.26	198.60	204.96
Calcium(mg/kg)	3144.00	1712.00	2428.00	2967.00	1844.00	2406.00	2933	2367.00	2650.00	2735.00	2134.00	2435.00
Electrical conductivity	0.10	0.08	0.09	0.13	0.11	0.12	0.20	0.18	0.19	0.15	0.13	0.14

Table 2: The descriptive statistics of soil physicochemical properties of Sal forest areas in Jharkhand

From the above Table 2 following physicochemical properties have been studied for the optimum growth of Sal forest in Hazaribag:

- **Soil textures:** The soil texture in the study areas were all sandy loam types with lower electrical conductivity, which were suitable for the growth of Sal trees. This sandy loam texture was very common in the study sites of Hazaribag, Chatra, Koderma, and Ranchi Sal forest which supports dense Sal trees in the forest. The supply of water to plants increases as the soil texture becomes finer. Soil texture also affects the nutrient supply to the plants of these Sal forests.
- **Moisture content:** The moisture content of Hazaribag Sal forest was found to be in the range of 4.60 to 11.30% with an average value of 7.95%, and the moisture content of Chatra Sal forest was found to be in the range of 3.70 to 9.30% with an average value 6.5%, the moisture content of Koderma Sal forest was found to be in the range of 4.26 to 8.77% with an average value 6.25% the moisture content of Ranchi Sal forest was found to be in the range of 5.82 to 7.34% with average value 6.58%. The average value of moisture content of Hazaribag Sal forest was higher at 7.95% while Koderma Sal forest was lower at 6.25%. Hazaribag Sal forest has a large variation in moisture content because Hazaribag has a very dense Sal forest which reduces the temperature of the soil and increases the rainfall.
- **Water holding capacity:** The water holding capacity of Hazaribag Sal forest was found to be 45.22 to 53.77% with an average value of 49.50%, Chatra Sal forest was found to be 35.27 to 57.59% with an average value of 46.43%, Koderma Sal forest was found to be 39.86 to 47.33% with an average value of 43.60 and Ranchi Sal forest was found to be 48.36% with average value 51.48 to 54.59%. The water holding capacity of Ranchi Sal forest is high due to more clay loam soil than the other three Sal forests of Jharkhand.
- **pH:** The pH of Soil found in the Hazaribag Sal forest is slightly acidic because the soil pH varied from 5.40 to 5.60 with a mean of 5.50 reports that most of the soil was acidic. The pH range in the Chatra Sal forest was also acidic and it was also found in the range of 5.79 to 5.99 with a mean of 5.89. The pH range in the Koderma Sal forest was also acidic and it was also found in the range of 5.89 to 5.91 with a mean of 5.90. The pH range in the Ranchi Sal forest was also acidic and it was also found in the range of 5.60 to 5.80 with a mean of 5.70. It shows that the soil of the Koderma Sal forest was more acidic than all other Sal forests of Jharkhand. This may be due to local environmental factors such as rainfall and vegetation composition.
- **Organic carbon:** Organic carbon content of Hazaribag Sal forest ranged from 0.65 to 0.85% with an average of 0.75%, Chatra Sal forest ranged from 0.47 to 0.59% with an average of 0.53%, Koderma Sal forest ranged from 0.46 to 0.68% with an average of 0.57% while Ranchi Sal forest has ranged from 0.77 to 0.97% with an average of 0.87%, indicated that Ranchi Sal forest has good soil fertility. It is a known fact that higher soil organic matter occurs more commonly in cooler than warmer climates.
- **Organic matter:** Organic matter in the Hazaribag Sal forest area was found to be varying from 1.36- 2.42% with a mean value of 1.89%, and Chatra Sal forest was found to be in the range of 2.57- 3.54% with a mean value of 3.01%, Koderma Sal forest was found to be in the range of 1.75- 3.30% with a mean value of 2.52% and Ranchi Sal forest was found to be in the range of 2.03- 2.96% with a mean value of 2.50%. It shows that Chatra Sal forest has better organic matter. Organic matter content increases with the maturation of the forest.
- **Available Nitrogen:** The available nitrogen content ranging from 275.46 to 287.04 Kg/ha with an average of 281.25 Kg/ha was found in Hazaribag Sal forest while it ranged from 207 to 217 Kg/ha with an average of 212 Kg/ha in Chatra Sal forest, 231.67 to 243.47 Kg/ha with an average of 237.57 Kg/ha in Koderma Sal forest, 295 to 314 Kg/ha with an average of 304.5 Kg/ha in Ranchi Sal forest which was higher than the values found in other three Sal forest in Jharkhand. The low nitrogen content in soil at our study site may have been due to the continuous loss through leaching and run-off. In the floodplains, sandy loam soil is deficient in nitrogen.
- **Available Phosphorus:** The available phosphorus is one of the most important micronutrient essential for plant growth. From our four study forests, the forest of Hazaribag contained available phosphorus ranging from 7.10 to 7.28 Kg/ha with an average range of 7.19 Kg/ha, Chatra Sal forest contained available phosphorus 2.86 to 3.06 Kg/ha with an average range of 2.96 Kg/ha, Koderma Sal forest contained available phosphorus 6.65 to 6.81 Kg/ha with an average range of 6.73 Kg/ha and Ranchi Sal forest contained available phosphorus 3.59 to 3.69 Kg/ha with an average range of 3.6 Kg/ha.
- **Sodium:** Sodium content of Hazaribag Sal forest was found to be 3.52 to 5.13 mg/L with an average value of 4.33 mg/L. On the other hand, sodium content in Chatra Sal forest was found to be 2.84 to 5.27 mg/L with an average value of 4.05 mg/L. Koderma Sal forest was found to be 4.78 to 2.73 mg/L with an average value of 3.76 mg/L and Ranchi Sal forest was found to be 5.34 to 3.93 mg/L with an average value of 4.63 mg/L. The sodium content in the Ranchi Sal forest was high due to very dense and long Sal trees found in these areas.
- **Available Potassium:** Available potassium content was found in the range of 455.98 to 471.38 Kg/ha with the average value of 463.68 Kg/ha of Hazaribag Sal forest, available potassium content was found in the range of 150.96 to 158.16 Kg/ha with the average value 154.56 Kg/ha of Chatra Sal forest, available potassium content was found in the range of 204.23 to 214.03 Kg/ha with the average value 209.13 Kg/ha of Koderma Sal forest while in the case of Ranchi Sal forest , available potassium content is found to be in the range of 198.60 to 211.26 Kg/ha with the average value 204.96 Kg/ha. Available potassium content is also high in the Hazaribag Sal forest than in the other three Sal forests. Available potassium content has a very important role in the seed germination of the Sal plant. The study sites of the Hazaribag Sal forest had a good flourish of Sal regeneration, probably due to the presence of a higher proportion of available potassium

- **Calcium:** The Hazaribag Sal forest contained Calcium in the range of 1712 to 3144 mg/kg with an average value of 2428 mg/kg, Chatra Sal forest contained Calcium in the range of 1844 to 2967 mg/kg with the average value of 2406 mg/kg, Koderma Sal forest contained Calcium in the range of 2367 to 2933 mg/kg with the average value of 2650 mg/kg while Ranchi Sal forest contained Calcium in the ranges of 2134 to 2735 mg/kg with the average value of 2435 mg/kg. The Koderma Sal forest contained more Calcium than the other three Sal forests due to the greater amount of rock and stone found in these study sites.
- **Electrical Conductivity:** The electrical conductivity of Hazaribag Sal forest was found in the range between 0.08 to 0.10 with an average value of 0.09, the Chatra Sal forest has a electrical conductivity in the range of 0.11 to 0.13 with the average value 0.12. The electrical conductivity of Koderma Sal forest was found in the range between 0.18 to 0.20 with an average value of 0.19 while the Ranchi Sal forest has a electrical conductivity in the range of 0.13 to 0.15 with the average value 0.14. The electrical conductivity is high in the study site of Koderma Sal forest than that of other three Sal forest in Jharkhand.
- **Conclusion:** Sal forest is an important forest of Jharkhand. The Sal tree has great importance not only for human beings it also important for wild animals and for different types of birds found in these areas. The whole properties of Sal trees like roots, stems, branches, leaves, flowers, and foods are used for different purposes by the local people. The study found that there are various factors like moisture, water holding capacity, organic carbon, Organic matter, soil N, P, Na, K, and Ca which support the Sal forest found in these areas. These factors not only provide the strength of the Sal forest, it also provides the natural regeneration in huge amounts. Altogether, the comparative study of four different Sal forests has the same sandy loam type soil texture and are little acidic in nature. Soil Nutrient including Organic matter content, soil N, P, Na, K, and Ca plays an important role in the growth of Sal trees and their regeneration. The electrical conductivity of all the Sal forest is a little low but other factors support the growth and regeneration of Sal plants and other species. Research in this field contributes to planning, conserving, and decision-making in natural forest management and development programs. The information can also be used for research, education and training.

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