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# Soil characteristics in the forest patches of Jungle Mahal in WB, India

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## Abstract

*Jungle Mahal is popular for its numerous forest patches and elephant corridor and is embarrassing to both the villagers and forest department regarding man-elephant conflict in and around the forest areas of south-east part of West Bengal. The forest area of the Jungle Mahal (composed of four districts and part of two districts) once is in depleting status, which is now reviving as reported by the Forest Survey of India in 2019. The probable reasons for this increasing scenario of Jungle Mahalare the impact of climate change, change of soil chemical parameters and local people's direct participation with the forest department for forest restoration. As the study of the impact of climate change is still continuing, a pilot survey has been taken up to review the physico-chemical parameters of soil in the selected areas of Joypur and Beliatore Forest Ranges of Bankura, Lodhasuli and Mayur Jharna Elephant Reserve in Jhargram, Arabari in Paschim Medinipur, Bundowan and Garh Panchakot of Purulia, Garh Jangal and Aduria forest in Paschim Bardhaman and 11 Mile forest in the Birbhum district.Result obtained from the soil chemical analysis of the sampled soils up to rooting depth of 30 cm show status quofor the forest stands of Jungle Mahal of West Bengal.*

**Keywords:** Jungle Mahal, Alfisol, NPK, organic Carbon, EC, red soil, acidic soil.

## Introduction

Jungle Mahal (literally meaning of Jungle Mahal is Jungle estates) was formed by the rulers of the British East India Company in 1805 as a district comprising of 23 Parganas and Mahals in the Bengal Province of the British India in terms of Regulation XVIII of 1805. After 28 years of its existence officially, the British rulers abolished the district in 1833 by the implementation of Regulation XIII of 1833 due to several inconveniences was caused for its vague jurisdiction for managing administration and collection of revenue. There is not any district in the name of Jungle Mahal in West Bengal since then, but the name of Jungle Mahal is still popular to the people of West Bengal. At present, forest areas of Purulia, Bankura, Paschim Medinipur and Jhargram districts and part of Paschim Bardhaman and Birbhum districts form Jungle Mahal in the south-west part of West Bengal (Figure-1), though the major portions of the forest areas of the then Jungle Mahal of eighteenth century are now reclaimed and converted into agricultural land. A few forest patches are still in existence under the jurisdiction of the forest department and they are classified as Reserved Forests and Protected Forests according to their importance of wildlife conservation[1]. Topographically the area is characterized with alluvial plain in the east with maximum elevation of 150m and covered with red soil in the west with maximum elevation of 200m[2]. The area is basically hot and humid with a small duration of cold weather and rainy days. Temperature ranges between $6^0$C in the winter and about $44^0$C during hot summer days[3]. Annual average rainfall ranges from 900 to 1500mm and percentage of relative humidity varies between 49%, minimum on the month of April and 85%, maximum during the month of August.

## Soil characteristics

Forest soils of Jungle Mahalat its east side are characterized with Alfisol with slight admixture of red soil. Alfisol, a typical forest soil, composed of aluminum and iron as main components. The prefix 'Alf' of Alfisol is derived from aluminum (Al) and iron (Fe). Alfisol offers relatively native fertility to the forest vegetation through moderate leaching of clay minerals and soil nutrients from the surface layer to subsoil that enable food and fiber production of plants[4,5]. Abundant occurrence of calcium, magnesium and potassium in the soil turns Alfisol saturated into at least 35% base composition that lead to high productivity and keep fertile than other humid-climate soil. Alfisol is associated with semiarid to moist areas of relatively cooler, drier climates and younger landscapes of forest cover where rapid leaching, weathering and removal of bases are generally not occurred[6,7]. These physico-chemical properties along with presence of inherently fertile parent materials of Alfisol assist luxuriant growth of the floral assemblages in the forest.

The forest soils of western part are predominantly red soil derived from disintegration of rocks and stones of Chhotonagpur plateau region. The common forest soils are yellowish in colour on the upper layer and reddish in depth of 30cm with non-calcareous and low concentration of soil nutrients[8-10]. Soils are relatively low in pH value indicating slight to moderate acidic nature of red soils. Available iron,

manganese and copper are high with respect to low percentage or almost deficient occurrence of available boron, molybdenum, and zinc in the soils of the forest floors where soils are generally cemented by iron and aluminum oxides. Overall, the soils are characterized with low pH, high exchangeable acidity, and low base exchange capacity. Concentration of soil nutrients like NPK (nitrogen, phosphorus and potassium) and organic carbon content depends on the elevations, derived parent materials that control the pattern of vegetation in the forest stands of the west part of Jungle Mahal. NPK availability as plant nutrients to the forest stands exhibits low in availability in the soils, characteristics of lateritic soils. Physico-chemical properties of soil and soil organisms present in the forest floor as independent or dependent variables have decisive influence on forest vegetation[11-14]. Denser the forest, more soil-health potential is gained through improvement of soil characteristics by litter fall on the forest floor[15].

Texturally, soil exhibits medium to coarse grain size distribution that contains high amount of acid-soluble ferric oxide. Average soil texture varies a little for the soil samples of different parts of Jungle Mahal. In an average, coarse sand ranged from 2 – 20%, fine sand 14-22%, very fine sand 11–24%, silt 21–39%, and clay 14-34% constitute the forest soils of the Jungle Mahal.

Forest plants usually uptake available nutrients, ready for absorption and assimilation, derived from weathering and biomass decomposition. Weathering contributes calcium, magnesium, potassium, and sodium (base cations) along with iron, aluminum, and manganese (acid cations) to the forest soils. Trees are very much selective in choosing elements for absorption from among these elements. Forest plants absorbs NPK and manganese, whereas aluminum, chlorine and sodium are in their list of discrimination[16,17]. For decomposition process, microorganisms, agents for decomposition of forest biomass, classified as four major groups–bacteria, fungi, *Actinomycetes* and algae, cause microbial decomposition and contribute microbial biomass[18].


**Figure-1:** Map of the Jungle Mahallocated at the south-west part of West Bengal, India.

Forest lands have higher soil carbon content than the agricultural land due to production of detritus from leaves, bark, fruit, flower, seeds, flosses, and others from the plants. The soil carbon content becomes low with the conversion of forest land into agricultural land for decomposition of soil organic matter through oxidation process. Decomposition of litter fall such as leaves, bark, flosses, seeds, flowers, and fruits produce organic carbon and extract available nutrients to the forest vegetation. Amount of organic carbon in forest floor of Sal (*Shorea robusta*) forests is relatively lower (1.07%) as the Sal leaves are frequently collected by the local people particularly the tribal community for its different uses and low rate of decomposability of Sal (*Shorea robusta*) tree leaves and their loss in the runoff water during rainy days[19]. The plantation forests enrich soils in organic carbon and thus improved the forest floor with increasing amount of organic carbon. Calcium, Magnesium, Phosphorus and Nitrogen with maximum quantity returns to the soils of the forest floor of Sal forests through leaf litter. Mixing of maximum content of such Calcium with soil depends upon the nature of tree species in the forests and the amount is determined with the content of calcium present in the tree leaves. Sal forests have higher content of exchangeable calcium and lower content of exchangeable magnesium in the plantation site with mixed vegetation[20].

## Materials and methods

Soil samples from a rooting depth of 30cm were collected from 36 points selecting randomly distributed 36 pedons from six districts within the periphery of Jungle Mahal. Pedons were selected in the experimental stations to study the characteristics of soil as 'pedon' in the forest land surface is considered as the smallest unit[21]. As the concentration of soil nutrients and other chemical properties are rather higher up to the depth of 30cm and changes of soil chemical properties at soil depths are insignificant in the forest landscapes, all soil samples were collected at the depth of 30cm from the top surface layer. Soil samples from the study area are collected and soil chemical parameters are analyzed following the standard methods for interpreting their correlation with the growing stock vegetation of the forests (Table-1).

## Results and discussion

**Data analysis:** Organic carbon of forest soils of Jungle Mahal varies from 0.21 to 0.96%. The soil organic carbon shows higher value in Beliatore forest and this happens for aggregation of more litter at forest floor as the soil carbon content and forest floral assemblage density is directly correlated.

Electrical Conductivity (EC) varies from 81.64 to 188.22µS of the forest soils of Jungle Mahal. Composition and nature of humus present in the forest soils controls the EC having higher content of Calcium cation ($Ca^{++}$) in Sal forests. Presence of calcium cation in the soil increases base saturation, exchangeable cations and EC in the soils covered with trees in the forests. Maximum EC in the forest soils was reported in the plantation sites with imported species like *Eucalyptus* and *Acacia* rather than the forest areas covered with indigenous species like *Shorea robusta, Buchanania lanzan, Lagerstroemia parviflora,* and *Madhuca indica* etc[22].

Soil pH varies from 4.81 to 6.6 indicating acidic nature of soil and low base exchange capacity. Soil pH, acidic in nature for all the samples, has major impact over nutrient availability and fertility of soil[23]. Soil pH is recorded higher in the forests covered with Sal trees (*Shorea robusta*), though litter fall and its decomposition contribute weak acids to the forest floor.

**Table-1:** Mean values of soil physico-chemical parameters for the samples collected at selected pedons of the Forests of Jungle Mahal.

| Name of the districts | Name of the forests | Soil pH | Electrical Conductivity(µS) | Organic Carbon (%) | Nitrogen Kg/ha | Phosphorus Kg/ha | Potassium Kg/ha |
|---|---|---|---|---|---|---|---|
| Purulia | Bundowan Garh | 4.81 | 108.33 | 0.64 | 8.2 | 53.97 | 234 |
| | Panchakot | 4.93 | 98.42 | 0.61 | 7.4 | 51.19 | 230.4 |
| Jhargram | Lodhasuli Mayur | 5.32 | 93.57 | 0.68 | 19 | 64.11 | 212.3 |
| | Jharna | 6.3 | 118.77 | 0.66 | 15 | 62.39 | 208.8 |
| Birbhum | 11 Mile | 4.98 | 104.62 | 0.28 | 22.4 | 36 | 181 |
| Paschim Medinipur | Arabari | 6.1 | 92.99 | 0.73 | 25.3 | 68.25 | 202.4 |
| Bankura | Joypur | 6.3 | 86.75 | 0.81 | 36.1 | 72.82 | 215.8 |
| | Beliatore | 6.6 | 81.64 | 0.96 | 39.9 | 74.2 | 218.75 |
| Paschim Bardhaman | Garh Jangal | 5.9 | 138.9 | 0.21 | 12 | 38 | 197.11 |
| | Aduria Forest | 6.2 | 188.22 | 0.62 | 18.77 | 46 | 192.61 |

Available nitrogen content of all samples varies from 7.4 to 39.9 Kg/ha in the forest floors of Jungle Mahal as red soil is reported to be poor in available nutrients like NPK (nitrogen, phosphorus, and potassium). Available nitrogen is generally considered as the most important factor limiting the growth of the trees. Content of available nitrogen in the mineral horizons of forest soils are recorded higher than the amount accumulated in the organic horizons and the rate of accumulation of available nitrogen differs from one forest to another forest stand due to presence of different tree species composition and different physico-chemical properties of forest soils[24]. Available nutrients are generally higher in the vegetation-covered forest areas than the available nitrogen, phosphorus, and potassium in open spaces.

Available phosphorus in the forest soils of Jungle Mahal varies from 36 to 74.2Kg/ha. Phosphorus cannot alone improve forest-health, but it works well in combination with nitrogen for the forest stands. Available phosphorus accelerates growth of trees and thus is significantly correlated with the forest growth. In Perhumid climatic conditions, forest soils contain low amount of available phosphorus[23,24]. Available potassium in the study area ranges from 181 to 234Kg/ha and it exhibits high content of potassium in the forest soils of the Jungle Mahal.

## Conclusion

The results of the chemical analysis of the soils sampled in the different forest patches of the Jungle Mahal comes out to be constant as usual for the nutrient concentration and physico-chemical parameters which are characteristics for the red soil and Alfisol of the forest stands. Data obtained from the soil chemical analysis for nutrient concentration and other chemical parameters reveals that the nutrient uptake by the forest vegetation from the microbial biomass decomposition and mineralization thereon of the forest floors, are almost equal to the return of the same by means of litterfall at constant and usual rate by the trees in the forest stands situated at different topographical areas within the Jungle Mahal in the state of West Bengal.

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