Scopus Indexed Journal

Bioscene

ISSN: 1539-2422 (P) 2055-1583 (O)

www.explorebioscene.com

Analysis of Physico-Chemical Characters of Soil, Along Disturbance Gradient in Jeypore Reserve Forest of Assam, North East India.

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Abstract

Disturbance plays an important role in vegetation and soil characteristics of a forest. It causes loss of diversity, habitat, leading to changes in vegetation structure. The changes on vegetation may lead to changes in soil physical and chemical parameters and finally the ecosystem loss in productivity. Present study was carried out during the year 2011-2015 in Jeypore Reserve Forest of North East India for enumeration of vegetation structure and soil characteristics. Study sites were categorized into three broad categories along disturbance gradient as Pristine Stand (PS), Semi Degraded Stand (SDS) and Degraded Stand (DS). Soil samples were collected (16 replications) from each sampling sites of each category and undergone experiments for physico-chemical parameters. Soil Organic Carbon (OC), available N, Available K, and available P decreases with the increase of disturbance. No significant correlation was observed among physical and chemical parameters in Pristine stand, where as in Semi degraded stand bulk density shows significant positive correlation with moisture content and organic carbon shows significant positive correlation with available phosphorus at 0.05 level. Significant positive correlation was also observed among bulk density and moisture content at 0.05 level and with OC and available P in degraded stand at 0.01 level.

Keywords: Degraded stand, gradient, Jeypore Reserve Forest, pristine stand, semi degraded stand, vegetation.

Introduction

Soil is the uppermost layer of the earth's crust responsible for many vital functions of our lives sustenance in the planet. It may be defined as the uppermost layer of earth, serves as a natural medium for growth and development of plants. It is the natural body of plants animal, mineral, and organic constituents differentiated into horizons of variable depth, which differ from the material below in morphology, physical makeup, chemical properties

and composition, and biological characteristics (Waugh 1995). Soil consists of soil organic matter, minerals, water and air in various proportions. Composition and properties of soil is controlled by different environmental factors like slope, aspect, climate, landscape, topography and vegetation (Chen et al 1997 and Tsui et al 2004).

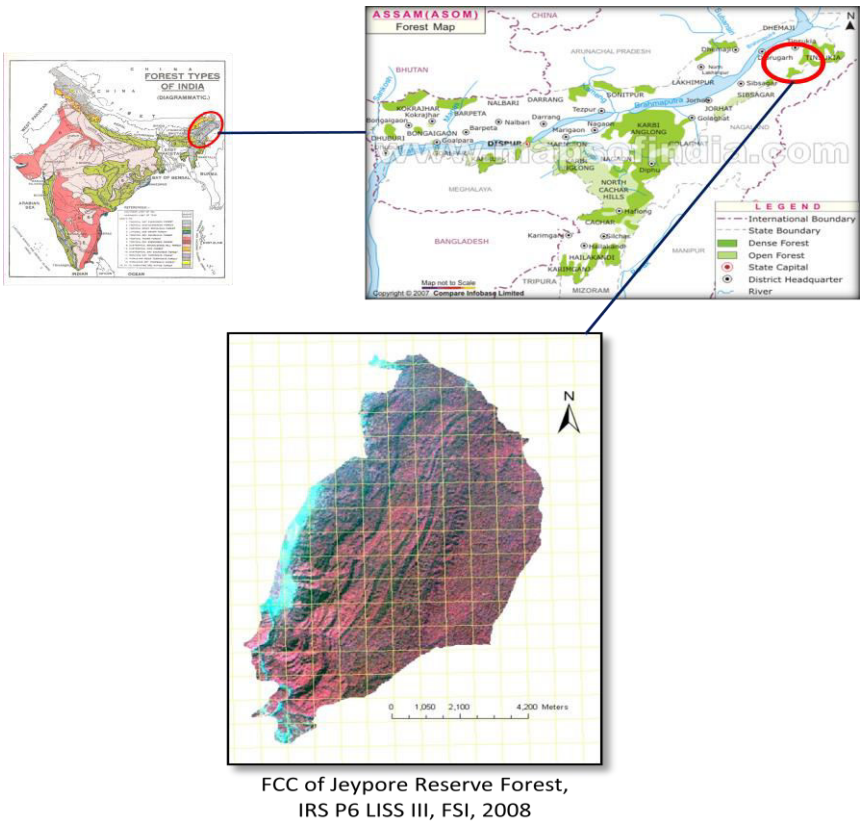
Vegetation of an area is solely depends on soil quality. The edaphic factors have the significant influence for vegetation heterogeneity in the natural forest (Shrestha et al 1979). Surface soil plays a crucial role for vegetation distribution. The nutrient status of soil varies considerably in the forest ecosystems depending upon the rate of deposition and decomposition of organic materials like leaves, twigs, fruits etc, (Nath & Sarmah 2008). The dominant species present in the particular forest can regulate the soil physico-chemical characters and soil micro-organisms too.

Study area: The Jeypore reserve forest is the last patch of biodiversity-rich rainforest of Assam (27^0 05'N to 27^0 28'N and 95^0 20'E to 95^0 38'E), spread on both sides of the river Buridihing in the district of Dibrugarh and Tinsukia. It is continuing to the Lohit, Changlang and Tirap districts of Arunachal Pradesh and to the easternmost part of Nagaland. It was once spread over both north and south banks of Brahmaputra towards the foothills of Himalaya. The altitude ranging from 122m to 475m above mean sea level. The climate is tropical monsoonal which is characterized by high humidity and rainfall of 2226–2372mm. The monsoon period last from June to September, where heaviest rainfall received in July. There is a relatively dry period from November to February. Average temperature ranges from 8°C to 39°C.

In North-east India several workers like Singh & Das (1992), Prasad et al (1985) and Devi (1997), Singh et al (1995) worked on physico-chemical parameters of soil. In Assam also many workers such as Barooah & Barua (1964), Bora & Das (1972), Bera et al (2008), Nath et al (2008) and Nath T. N. (2015) had worked on physico-chemical characters of soil in various places. However, very little work hitherto has been done on Jeypore Reserve Forest in such aspects. So present study has been undertaken to bring into light the type and quality of the soil of forest along disturbance gradient.

2. Material and Methods

In the present study extensive field work has been made in the study area in



FCC of Jeypore Reserve Forest,
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Fig. Map of the study site

different seasons (monsoon, post monsoon, winter and pre monsoon) to access the diversity of plants. The present study is undertaken following grid pattern method. After preliminary survey of the forest, six forest areas viz., Nagfan, Hapjan, Nahorjan, Dillighat, Akashiganga and Baliasuti. It was divided into three categories, based on disturbance gradient as degraded stand (DS), semi degraded stand (SDS) and pristine stand (PS). For analysis of Physico-chemical properties of soil samples were collected from various sampling plots, of Jeypore Reserve Forest throughout the season viz., monsoon (June - August), post monsoon (September - November), winter (December- February) and pre-monsoon (March-May). For each sampling plot, soil sample were collected from 0-15 cm, 16-30 cm, 31-60 cm and 61-100 cm (4 replications from each depth, total

16 samples per sampling plots) drawn randomly and was thoroughly mixed to get a representative sample for further analysis following standard methodology. Estimation of soil parameters like organic carbon (OC %) by Walkley and Black (1934) method, moisture content (MC %) by Gravimetric method (Andersion and Ingram (1993), soil texture by Hydrometric method (Boruah and Borthakur, 1997), soil pH by 1:2 Soil water suspension glass electrode method (Jackson, 1967), available nitrogen (N) by alkaline potassium permanganate method (Subbiah and Asiza,1956), available potassium (K) by ammonium acetate (Jackson, 1967), available phosphorus (P) by the method described by Olesons et al (1954).

3. Results and discussion

Physical-chemical parameters of soil in the study area showed a wide range of variation in various seasons as well as in different soil depth.

Bulk density (BD)

Bulk density (BD) in different study stands were recorded an average of 1.01 ± 0.009 in pristine stand (PS) followed by 1.01 ± 0.008 in semi degraded stand (SDS) and 1.02 ± 0.02 in degraded stand (DS). It was observed that, BD increases with the increase of soil depth and disturbance in all three types stand. Depth wise variation was distinct, but stand wise variation was not distinct. In monsoon season bulk density shows higher value and in pre monsoon season, shows lower value. BD was positively correlated with moisture content, available N, available P and negatively correlated with available K and organic carbon in PS. In SDS it showed significant positive correlation with moisture content and simple negative correlation with available K, organic carbon (OC), available P and positively correlated with available N. It showed significant positive correlation with moisture content (MC) at 0.05 level and simple positive correlations with OC, available N, whereas negative correlation was observed with available K and available P in DS. According to Swarnam et al (2004) increase in bulk density with depth was attributed to lower organic matter, more compaction and less aggregation in soils of entisols and inceptisols whereas higher bulk density values could be due to their coarse texture and low organic matter content

Table 1. Summary of physico-chemical characteristics of soil of Jeypore Reserve Forest.

Parameters/Stand type	**Pristine stand**	**Semi degraded stand**	**Degraded stand**
Physical properties			
Bulk Density	1.01 ± 0.009	1.01 ± 0.008	1.02 ± 0.021

Moisture content		19.54 ± 0.36	18.75 ± 0.41	17.70 ± 0.43
Soil Texture	Sand (%)	56.83 ± 0.39	64.52 ± 0.51	73.56 ± 0.57
	Silt (%)	13.45 ± 0.13	11.29 ± 0.09	8.74 ± 0.11
	Clay (%)	29.72 ± 0.29	24.19 ± 31	17.7 ± 0.29
Chemical properties				
P^H		4.7 ± 0.05	5.54 ± 0.09	5.93 ± 0.10
K (kg ha^{-1})		102.21 ± 2.16	94.47 ± 1.34	81.81 ± 0.85
Soil OC (%)		0.75 ± 0.03	0.60 ± 0.02	0.47 ± 0.01
Soil N (kg ha^{-1})		530.09 ± 1.53	477.40 ± 1.94	294.39 ± 1.14
Soil P (kg ha^{-1})		21.17 ± 0.41	17.08 ± 0.19	11.07 ± 0.24

Moisture Content (MC)

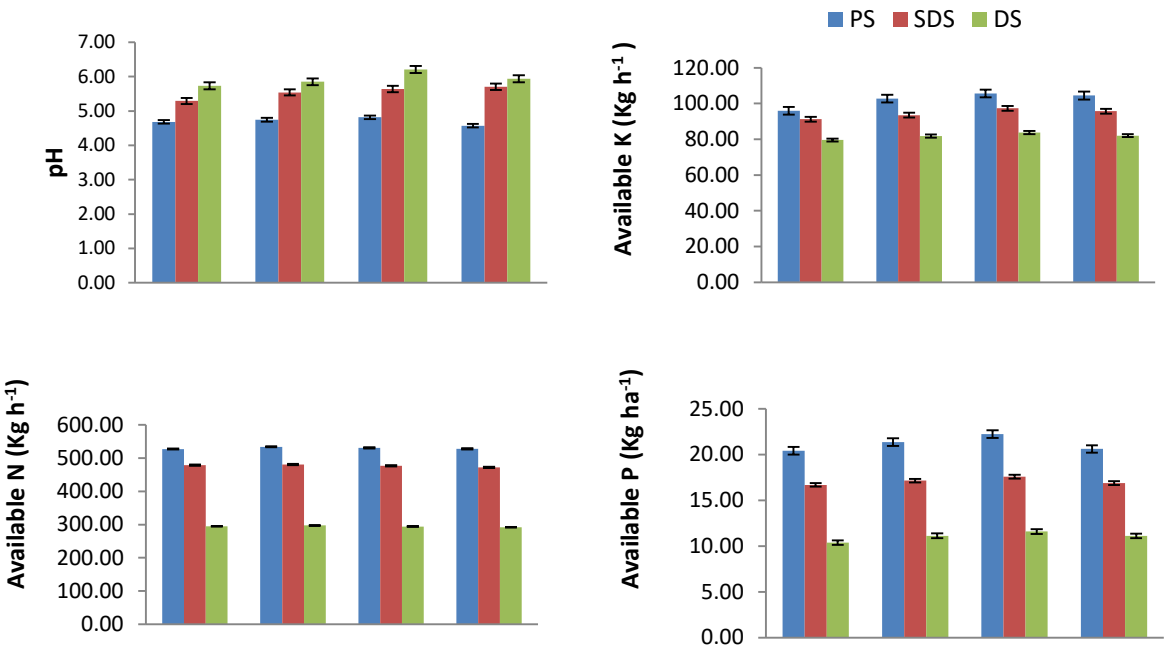
Moisture content (MC) showed moderate variation in different forest stands and soil depth as well. The mean MC was recorded 19.54 % ± 0.36 in PS followed by 18.75 % ± 0.41 in SDS and 17.70 ± 0.43 in DS. It was observed that moisture content decreases with the increase of soil depth and disturbance. It may be due to maximum exposure of sunlight in disturbed area as soil experience maximum sun light. There may be another factor like the water of various types of soil retention capacity. It shows negative correlation with available K, OC, available N and available P in PS. Similarly in SDS moisture content showed negative correlation with available K, OC, available P and positively correlated with available N. It experienced positive correlation with OC and available N where as negative correlation with available K and available P in DS.

Soil Texture

Soil type of Jeypore Reserve Forest was recorded as sandy loam and sandy clay type. The same type soil was observed in all study sites with mild variation of structure. Higher percentage of sand with moderate percentage of clay and low percentage of silt was the characteristic feature of the soil. In PS, sand contributes 56.83 % with clay 29.72% and 13.45 silt. In SDS, sand contributing 64.52 % with 24.19 % clay and 11.29% silt. Sand concentration was found maximum of 73.56% in degraded stand with 17.7% clay and 8.74% of silt. Study result shows, increase of sand percentage with the increase of soil depth. However, clay percentage decreases with the increase of disturbance. Silt percentage also decreases with the increase of disturbance.

Soil pH

In the present study in PS soil p^H showed marked variations in different forest stands and soil depth. The mean pH of the study sites were recorded 4.70 ± 0.52 in PS followed by 5.54 ± 0.09 in SDS and 5.93 ± 0.10 in DS. From the study it was observed that surface layer soil was more acidic than sub surface layer soil. Acidity decreases with increase of soil depth. However acidity declines with the increase of disturbance. In winter season higher pH was observed than rainy season. It may be due to maximum microbial activity resulting high decomposition rate in rainy season which produced carbon dioxides, other organic and inorganic acids in maximum amount. The variable pH also indicates suitability of a wide range of plant species in the forest. Miles (1986) stated that acidification of soil depends on the type of species, the environmental condition, developmental stages and on plantation management. In pristine stand, pH was positively correlated with Bulk density, moisture content, available K, organic carbon, available N and available P but no significant correlation was observed among them during the study. In SDS, pH showed negative correlation with BD, MC, available N while, positively correlated with OC, available K and available P. It showed negative correlation with bulk density, moisture content, organic carbon, available N, while positively correlated with available K and available P in DS.



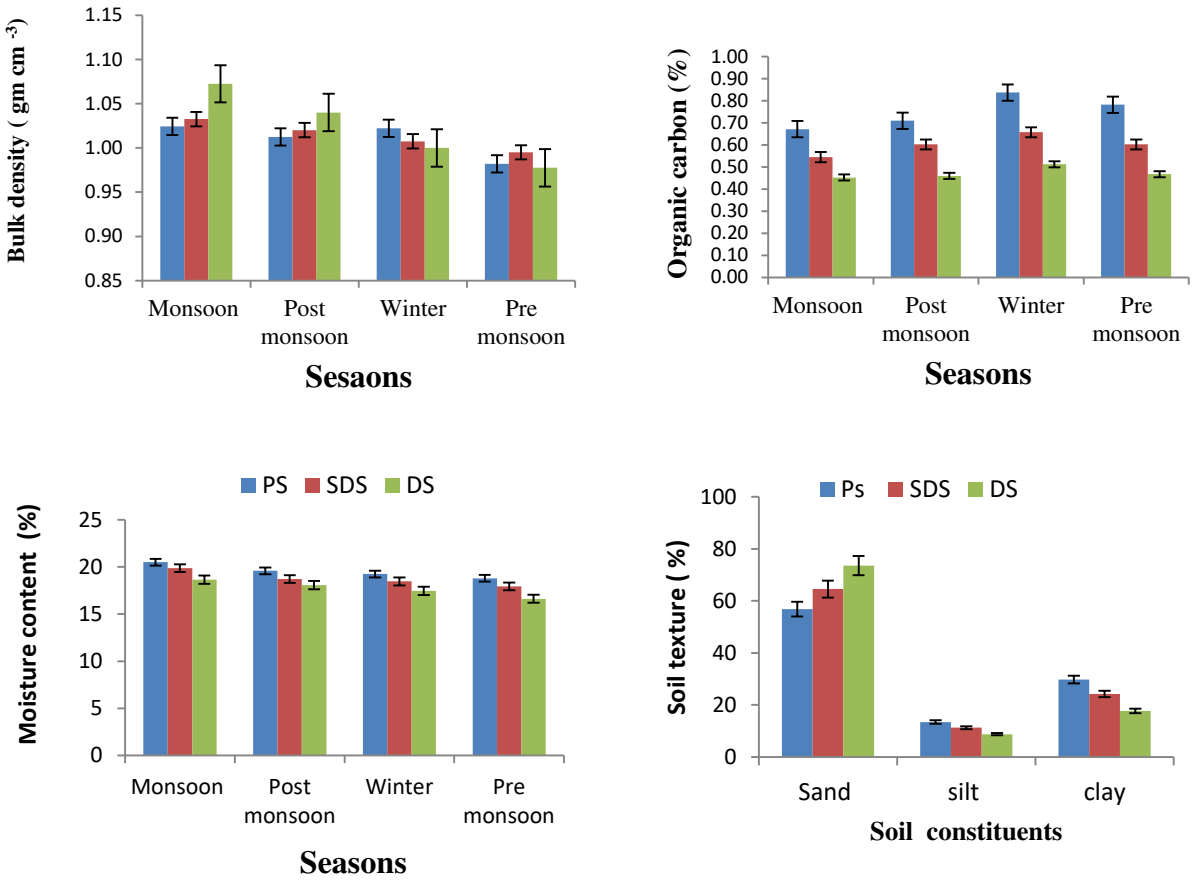


Fig: Variation of soil parameters in various seasons along disturbance gradient.

Available K

Available K also showed a wide range in different forest stands and soil depth. Average value of available K was 102.21 ± 2.16 kg ha^{-1} in pristine stand, 94.47 ± 1.34 kg ha^{-1} in semi-degraded stand, and 81.81 ± 0.85 kg ha^{-1} in degraded stand. From the study it is seen that, K concentration is higher in surface soil and it gradually decreases with the increase of soil depth. It also shows decreasing trend from pristine stand to degraded stand.It showed positive correlation with OC, available N, available P, in PS whereas in SDS available K was positively correlated with OC, available P, while showed negative correlation with available N. Available K showed significant positive correlation with available P at 0.01 level while it showed simple positive correlation with OC and negative correlation with available N in DS.

Organic Carbon (OC)

Organic carbon showed moderate variation in different forest stands and soil depth. The mean OC was recorded 0.75 % ± 0.03 in pristine stand followed by 0.60 % ± 0.02 in semi degraded stand and 0.47 ± 0.01 in degraded stand. OC percentage decreases with the increase of soil depth and disturbance. It shows maximum in winter season and minimum in monsoon season. It is a very important nutrient to soil and is contributed by dead bodies of plants and animals as well as micro and macro-organisms living in the soil. Further the variations in the amount of OC may be due to the differences in litter deposition and its decomposition rate in the locality. It showed positive correlation with available N and available P in PS, while, negative correlation was observed with available N and a significant positive correlation at 0.05 level, in SDS. Positive correlation was observed with available N and available P in DS.

Available N

Available N showed a marked variation in different forest stands and soil depth. However no marked variation of N concentration was observed among various seasons. Mean available N was recorded 530.09 ± 1.53 kg ha^{-1} in PS, 477.40 ± 1.94 kg ha^{-1} in SDS, and 294.39 ± 1.14g ha^{-1} in DS. Correlation studies of available N showed positive correlation with available P in pristine stand while in SDS a negative correlation was observed with available P. Negative correlation with available P was observed during the study in DS. From the observation, it has seen that available N decreases with the increase of soil depth. It may be due to maximum exposure of surface soil with more litter and other organic matters to enrich the soil with maximum N as compared to sub soil, sufficiently. On the other hand it showed decreasing trend towards degraded stand due to low litter and another organic matter in the soil.

Available P

Available P study showed moderate variation among different forest stands and soil depth. Mean available P was recorded 21.17 ± 0.41 kg ha^{-1} in PS, 17.08 ± 0.19 kg ha^{-1} in SDS, and 11.07 ± 0.24 kg ha^{-1} was observed in DS. From the study it was observed that soil available P decreases with the increase of soil depth and decreases with the increase of disturbance. In winter season maximum available P was observed (22.26 kg ha^{-1}). The low amount of available P in pre-monsoon and monsoon season may be due to rapid use of phosphorus by large trees as well as regenerating plants. According to Donahue (1970) low amount of phosphorus was also due to the formation of iron and aluminium.

4. Conclusion

The present study gives us a concrete picture of physico-chemical characteristics of the soil of Jeypore Reserve Forest along disturbance gradient. A wide variation in the physico-chemical properties of soils in degraded stands were observed in the present study. From the present study it reveals that disturbance plays a very important role in forest structure and its health, as it interfere a lot on soils physical and chemical nature. These low values of different soil parameters of the forest can have environmental effects on the ecosystem. In addition to many other anthropogenic factors like tree felling for various purposes, uncontrolled sand and stone collection, mushrooming tea gardens in forest fringe areas etc, affects soil physico-chemical composition especially in degraded stands of the remaining vegetation of Jeypore reserve Forest. So there is an urgent need of aforestation programme in large scale especially in degraded stands so that the heritage forest can regain their uniqueness.

Acknowledgements

Authors are grateful to Indian Council of Forestry Research and Education (ICFRE), Dehradun for providing financial assistance and also thankful to Assam state forest department for allowing conducting the study. Author is also grateful to Botanical Survey of India (BSI), Shillong for helping in identification of plant specimen.

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