International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
DOI: 10.22192/ijarbs Coden: IJARQG (USA) Volume 7, Issue 6 -2020

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2020.07.06.016

Physico-chemical Properties of Soil of Jaldapara National Park in West Bengal, India

Chandra Ghosh[1], Mainak Mukherjee[2] & Kishor Biswas[3*]

[1]Department of Tea Science, University of North Bengal, Darjeeling - 734013, West Bengal, India.
E-mail: *chandraghosh19@nbu.ac.in*
[2]Soil Analysis Laboratory, Department of Tea Science, University of North Bengal, Darjeeling, West Bengal
[3]Department of Botany, Darjeeling Govt. College, Lebong Cart Road, Darjeeling, West Bengal
*Corresponding author: *kbiswas83@gmail.com*

Abstract

Present paper deals with the physico-chemical properties of the soil of Jaldapara National Park (JNP) of West Bengal. Soil Samples (0 - 30cm) from 30 Forest Beats of 09 Ranges of JNP were collected and analyzed using standard methodology to characterize the properties of soil mainly the soil Moisture content, pH, Organic Carbon content, Organic matter, total Nitrogen content, available Potassium as Potash content, available Phosphorus as Phosphate content and available Sulpher as Sulphate content. Soil was mostly found to be acidic [pH value ranges from 7.97 – 4.21 and 7.50 - 4.26 in top and sub soil respectively] having variable amount of Moisture content [top: 3.41 – 28 %, sub: 4.52 - 30 %], Soil Organic Carbon [Top: 0.034 - 6.102% & Sub: 0.446 - 3.642 %], total Nitrogen content [0.037 - 0.525%], Potash content [10 – 35ppm], Phosphate content [2-32 ppm] and Sulphate content [2-74 ppm]. Widely varied edaphic factors of different forest Compartments, Beats and Ranges of JNP keep parity with its diverse micro habitats and the diversified floral and faunal elements prevailing over there. The study also suggest for further and detailed investigation of soil physico-chemical properties for future reference.

Keywords: Jaldapara National Park, Soil, Physico-chemical, Pedology, Edaphic

Introduction

Jaldapara National Park (JNP) is one of the prestigious National Parks of West Bengal and is the second largest natural home for the great Indian one-horned Rhinoceros (*Rhinoceros unicornis* L.) in India after Kaziranga in Assam. In 2014, the Jaldapara Wildlife Sanctuary was elevated in its rank as Jaldapara National Park (JNP). It is situated in the newly demarcated Alipurduar district of the state West Bengal and is located between 25°58′ N to 27°45′ N Latitude and between 89°08′ E to 89°55′ E Longitude. This unique trouser-shaped park is situated at the foot of Darjeeling part of the Eastern Himalaya with the present area of 216.51 sq. km. (Pandit 1996; Anonymous 1997; Das *et al* 2003; Ghosh & Das 2005, 2007). The Park is flat and elevates from 61 – 130 m. amsl. except Titi beat which is quite hilly with an elevation ranging from 152 – 610 m. amsl. (Anonymous 2007).

For administrative purposes, JNP has been divided into 09 Forest Ranges, 30 Forest Beats and 100 Compartments (Ghosh, C. 2018). Its topographical situation and environmental factors made the park a beautiful natural habitat not only for Rhinos but also for an amazing variety of wild flora and fauna. The entire area is situated in the tropical region and experiences both, high temperature and precipitation. However, during summer (May – September) the day temperature varies between 27° C to 38° C and during winter (i.e. during November to February) the day temperature varies from 10° C to 20° C. The main source of precipitation is rainfall. Due to the location of the Park in a high precipitation tropical region, the atmospheric humidity generally remains considerably high almost round the year. It varies from 80 – 95% during June to September and from 75 – 80% during October to May.

Its unique climatic condition resulted in diverse and much varied vegetation patterns. The basic vegetation structure of this region is mixed deciduous forest (Champion & Seth 1968). Recent workers (Banerjee 1993; Das *et al.* 2003, Pandit *et al.* 2004; Ghosh & Das 2005, 2007; Ghosh, C. 2018) recognized the formation of following types of vegetation in JNP, namely Riverine Forests, Sal Forests, Wet Mixed Forests, Semi-evergreen Forests, Evergreen Forests, Riverine Grasslands, Savannah Grasslands, Open low lying Herbland, Hydrophytic vegetation, *etc*.

Ground water table in the area is much suitable for different types of vegetation. The most important perennial river 'Torsa' provides sufficient moisture to the park area. It is an unpredictable river and changes its course frequently, flooding wide areas. Malangi is the second important perennial river passing through the park. There are a number of other perennial and seasonal water sources also (Pandit 1996; Anonymous 1997; WII 1997). The direction of flow of water is from north to south. Heavy rains in Duars lead to devastating flood which also affected the park so many times. This intense and much branched network of small rivers and rivulets forms a mosaic of pedological and microclimatic facets throughout the JNP.

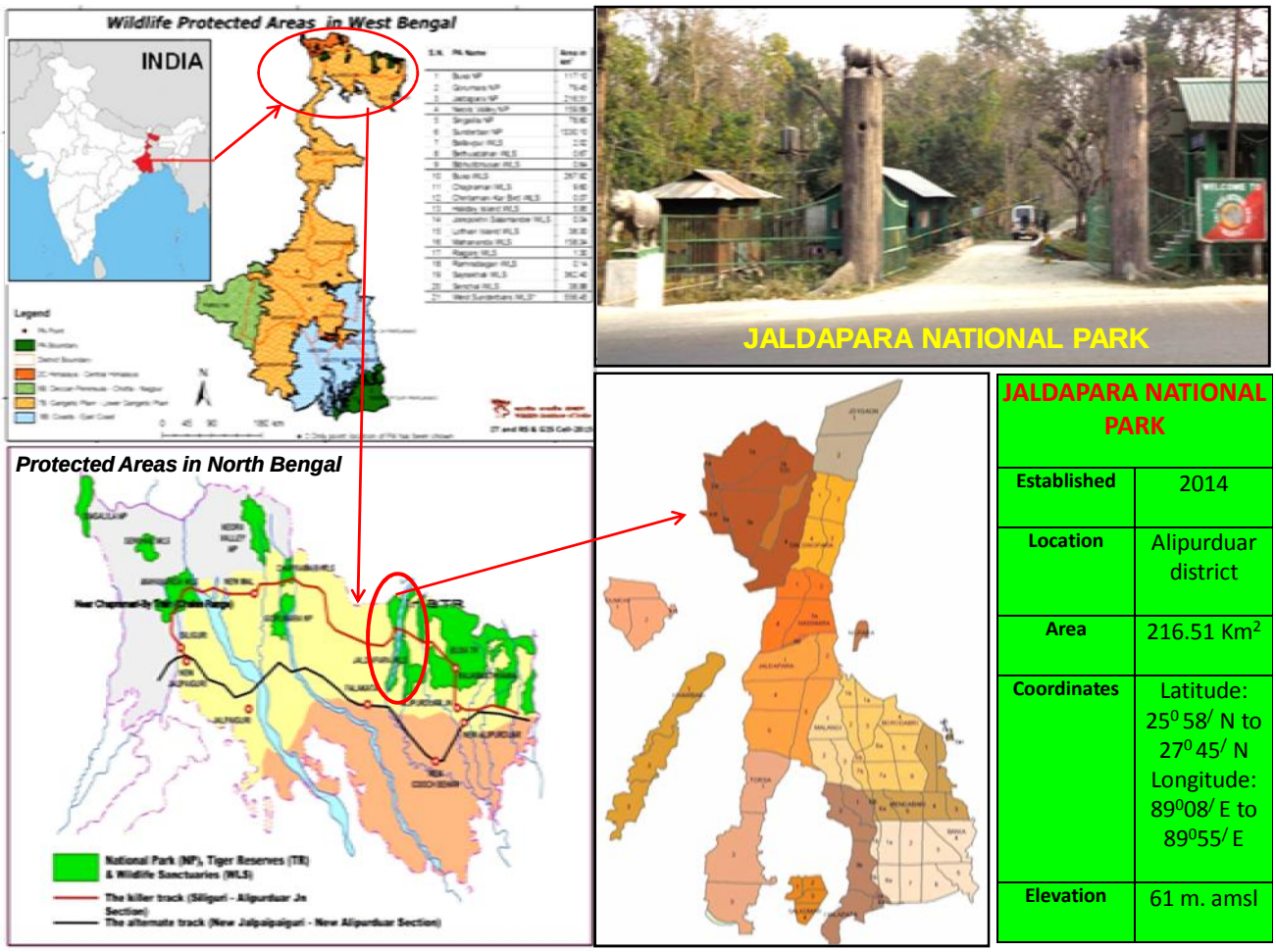
Different types of geological formations found inside the JNP which are Alluvial formation, Terai formation, Bhabar formation and Terrain *etc*. (Anonymous 1997; WII 1997; Anonymous 2007). In the Southern part of JNP, soil composed of mainly silt and clay with minimum amount of gravel and boulders whereas in Northern part, soil constituted of loose gravel, boulders and river deposits that are highly variable in composition, texture and porosity. Some part of JNP has more clay.

Previous workers Chakraborty & Chakraborty (1957) studied the soil properties of North Bengal. Mukhopadhaya (1983) worked on distribution of Manganese in some soil of this area whereas Mondal *et al.* (2002) traced the forms of soil phosphorus in Terai zone. Recent workers inventoried soil resources of Jalpaiguri district (Anonymous, 2011), studied physico-chemical properties of soil under different tea growing regions of West Bengal (Ray & Mukhopadhyaya, 2012; Misra *et al*, 2018), soil of Gorumara National Park (Ghosh, S.B., 2012) and transformation of some major nutrients in tea garden soils of North Bengal (Khanda *et al*, 2018). Thus very limited information is available on the soil properties of North Bengal region and no such data is available on Jaldapara National Park. Keeping this in mind the present study was attempted to gather preliminary data on physico-chemical properties of soil Jaldapara National Park.

Materials and Methods

A total 31 composite soil samples were collected from two layer of 0 – 15 cm and 15 – 30 cm depth from 30 forest beats of 09 forest ranges of Jaldapara National Park along with the habitat of *Hibiscus fragrans* Roxburgh (Malvaceae) [an endangered plant recorded from Jaldapara beat under Jaldapara east range of JNP (Ghosh *et al.* 2013)] using methodology prescribed by Misra *et al.* (2009) during the period from November 2016 to April 2018 and brought to the Soil Analysis Laboratory of Department of Tea Science, University of North Bengal.

Different Physico-chemical properties of the soil were analyzed using standard methods – Soil P^H using glass electrode P^H meter (Jackson 1973), Soil Moisture content by gravimetric method (Piper 1966; Allen *et al.* 1974), Organic Carbon and Organic matter by wet digestion method (Walkley & Black, 1934; Walkley, 1947), total Nitrogen content by Kjeldahl method (Kjeldahl, 1883), available Potassium as Potash using neutral normal ammonium acetate (Jackson, 1958), available Phosphorus as Phosphate by Bray's method-I (Bray & Kurtz, 1945) and available Sulpher as Sulphate by colorimetric method (Anderson & Ingram, 1993; Ensminger, 1954). Final data was analyzed using MS excel to trace the correlation among the physic-chemical properties of soil and to justify its significance.



JALDAPARA NATIONAL PARK	
Established	2014
Location	Alipurduar district
Area	216.51 Km^2
Coordinates	Latitude: 25^0 58/ N to 27^0 45/ N Longitude: $89^0$08/ E to $89^0$55/ E
Elevation	61 m. amsl

Figure 1: Study Area

Results and Discussion

Soil of Jaldapara National Park was found to be strongly acidic to moderately alkaline in reaction and the pH value ranges from 4.2 –7.97 in top layer (0-15cm) and 4.26 – 7.50 in sub soil (15-30cm). Acidity of top soil was recorded to be highest in Mendabari Beat (pH 4.21) of Chilapata range and was followed by C. C. Line Beat (pH 4.22) of Kodalbasti Range and Bania Beat (pH 4.39) of Chilapata Range respectively whereas highest and lowest pH values of sub soil (15-30cm) were recorded from Chilapata Beat under Jaldapara East Range and C. C. Line Beat of Kodalbasti Range respectively. Alkaline soils were recorded from Malangi, Chilapata and Jaldapara Beat (**Figure 2**).

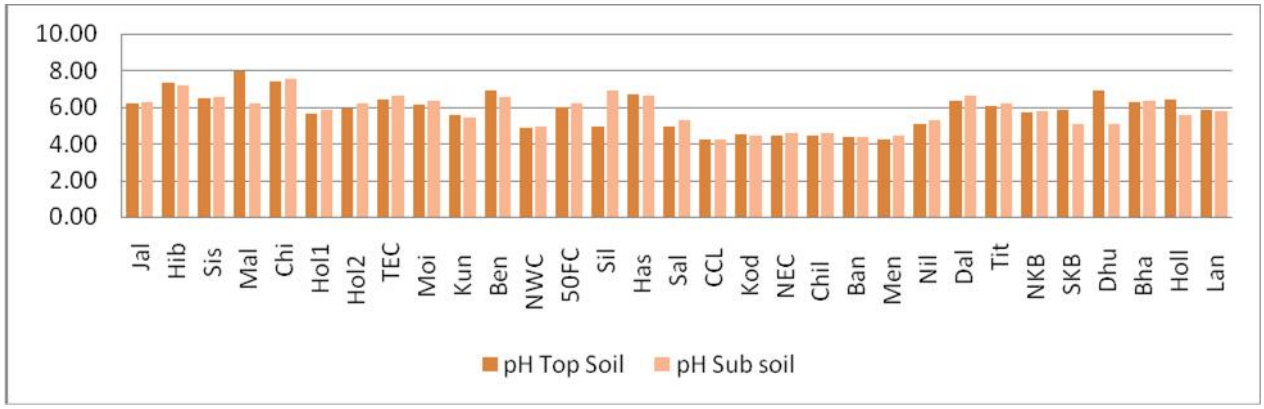


Figure 2: p^H in top and sub soil of different forest beats in JNP

Moisture contents of top and sub soil of different areas of Jaldapara NP were found to be highly variable. In top soil moisture content varies from 3.41 – 28 % whereas it ranges from 4.52 to 30 % in sub soil. Moisture content was recorded to be very high in top soil of CC Line beat in Kodalbasti range, Jaldapara East range (28 %) and was followed by Mendabari beat (26%) and Bania beat (25 %) Under Chilapata range, Nilpara beat (24.16 %) under Nilpara Range. Soil moisture content was lowest in North Khairbari beat (3.41%) under Madarihat range and was followed by Jaldapara (6%) under East range, Hollapara (7.15%) under Hollapara range, Kunjanagar in West range (10.92%) etc. Sub soil with highest moisture content was recorded in East Range (30%) then in CC Line beat (27%) under Kodalbasti range, Bania (26%) in Chilapata range, Salkumar (24%) in South range, Mendabari (23%) in Chilapata range etc. But North Khairbari beat under Madarihat range represented most dried sub soil having moisture content of 4.52% and was followed by Hollapara (5.4%) in Hollapara range, Jaldapara in East and NWC in North ranges (both 6%), Hollong in West range and South Khairbari in Madarihat ranges (both 9.64%) [**Figure 3**].

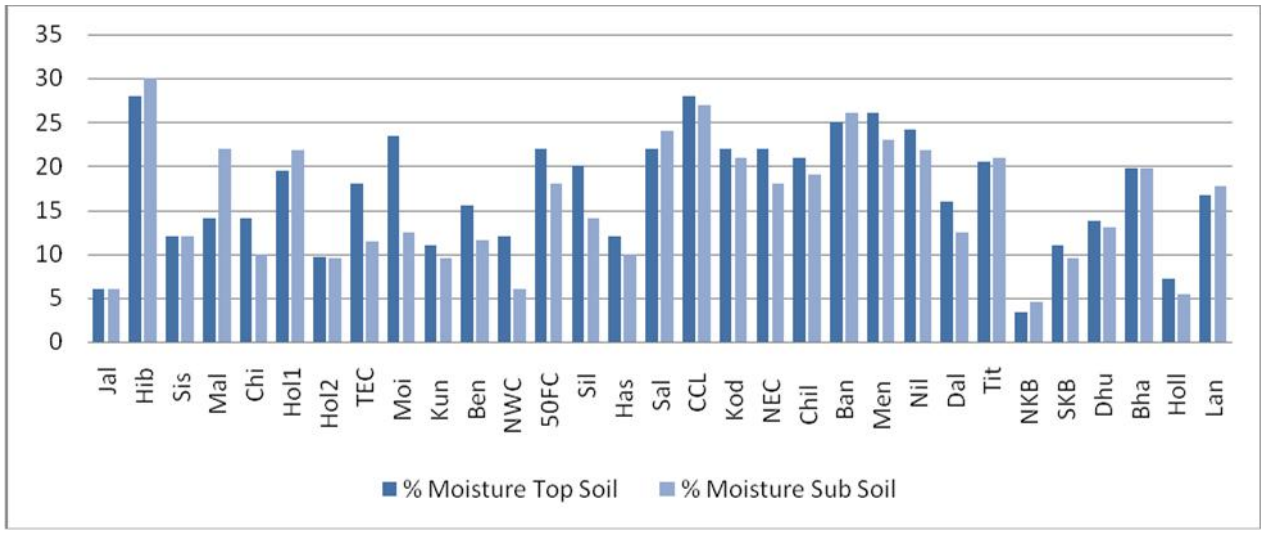


Figure 3: Soil Moisture content (%) in top and sub soil of different beats of JNP

Soil Organic Carbon in the top layer ranges from 0.034 to 6.102 % and highest Organic Carbon content (6.102%) was recorded from Bania beat of Chilapata range followed by Bengadaki beat (5.6%) under Jaldapara West range, C C Line beat (4.389%) under Kodalbasti range *etc*. (**Figure 4**). On the other hand lowest value was found to be 0.434% in Jaldapara beat under Jaldapara East range and was followed by Kunjanagar (0.559%) under Jaldapara West range, Hasimara (0.579%) under Jaldapara North range and others. Organic Carbon content of sub soil of different beats and ranges varied from 3.642% in C.C Line beat under Kodalbasti range to 0.446% in South Khairbari beat of Madarihat range.

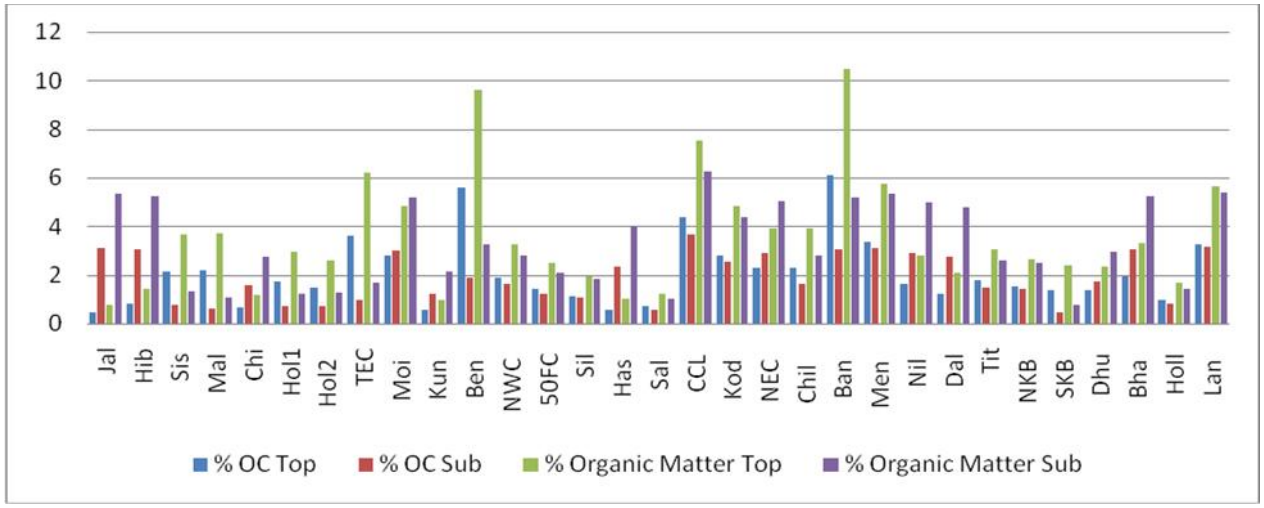


Figure 4: Organic Carbon (%) and Organic Matter (%) in different beats of JNP

Soil Organic Matter ranges from 0.746 – 10.495% and 0.767 –6.264% in top soil and sub soil respectively **(Figure 4).** Bania beat under Chilapata range showed highest value of Organic Matter in top soil of 10.495 % and was followed by Bengdaki beat (9.632%) in Jaldapara West range, C C Line beat (7.749%) in Kodalbasti range, TEC beat (6.216%) in Jaldapara West range and others. Jaldapara beat under Jaldapara East range was poorest in organic contents having the recorded value of 0.746% and some other areas showing lower Organic Matter was Kunjanagar beat (0.961%) under Jaldapara West range, Hasimara beat (0.996%) under Jaldapara North range etc.

Total Nitrogen content in top and sub soil ranges from 0.037 to 0.525% and 0.038 to 0.313% respectively (**Figure 5**). Top soil with highest Nitrogen content was found in Bania beat (0.525%) under Chilapata range and was followed by Bengdaki beat (0.482%) under West range, CC line beat (0.0377%) under Kodallbasti range, TEC beat (0.311%) under West range and others. On the other hand Jaldapara beat in East range was recorded for lowest Nitrogen Content in its top soil measuring 0.037% only. Sub soil of CC line beat of Kodalbasti range was recorded for highest amount of Nitrogen Content (0.313%) in its sub layer and lowest amount of Nitrogen content (0.038%) was recorded in South Khairbari beat and was followed by Salkumar beat (0.050%), Malangi beat (0.054%) and Hollong beat (0.062%).

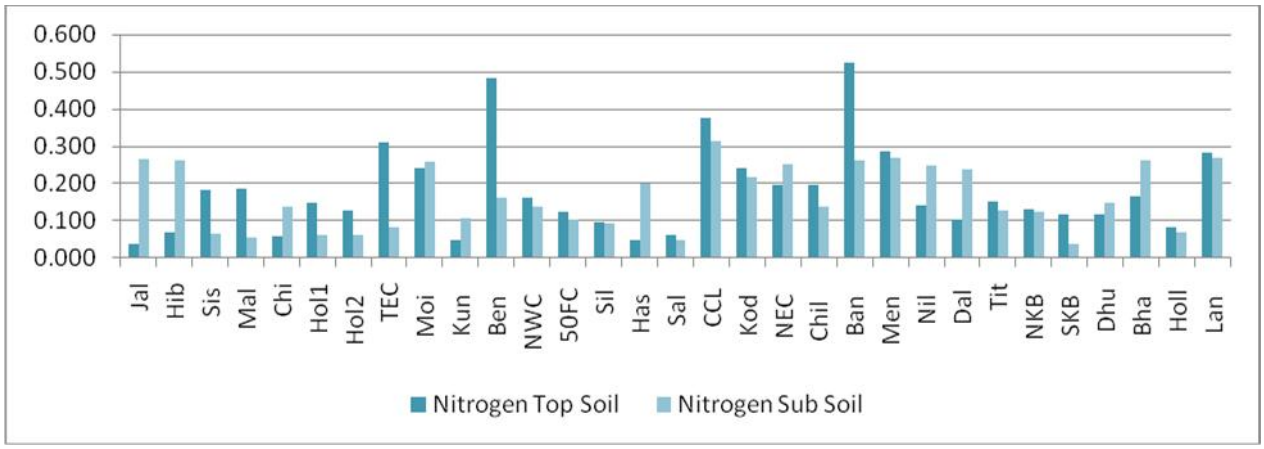


Figure 5: Total Nitrogen content (%) in top and sub soil of different beats of JNP

Available Potash contents in the top layer of soil was measured to be highest for NEC beat under Kodalbasti range, T.E.C. beat under West range, Chilapata beat under Chilapata range with the same estimated value of 35 ppm whereas the lowest value was recorded as 11 ppm in Nilpara beat under Nilpara range (**Figure 6**). CC Line (33ppm) and Kodalbasti (32ppm) – these two beats under Kodalbasti range were also with the estimated Potash value near highest one. On the other hand South Khairbari in Madarihat range and Nilpara beats in Nilpara range were also very poor in Potash content in their top layer of soil having estimated values of 14ppm and 11ppm in the same order. Sub soil contained highest amount of potash in Dhumchi beat and measured to be 35ppm under Madarihat range and was followed by Moiradanga beat (33ppm) under West range, Mendabari beats (32ppm) under Chilapata range etc. Lowest amount of Potassium content was recorded in sub soil of Nilpara beat under Nilpara range and it was measured to be 10ppm. Lowest value of potash was also recorded in Bengabari beat (12ppm) under West range.

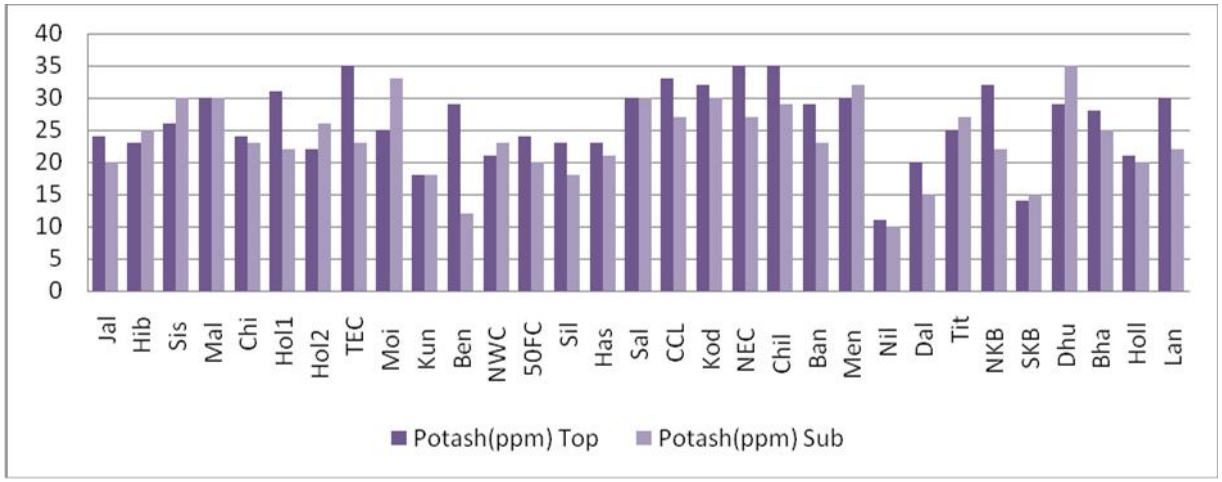


Figure 6: Available Potassium as Potash (ppm) in different beats of JNP

Both the top and sub soil of different beats and ranges in Jaldapara NP showed variable amount of Phosphate contents (**Figure 7**). Phosphate contents in top soil ranges from 2 ppm in Salkumar beat under South range to 27ppm in Jaldapara beat under East range whereas in sub soil it ranges from 2 ppm in NWC beat under North range to 32 ppm in South Khairbari beat in Madarihat range.

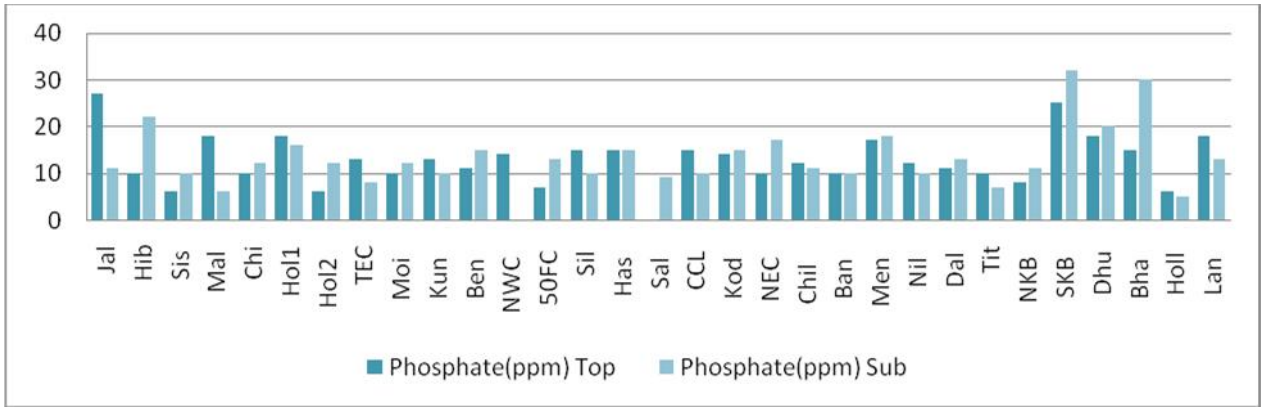


Figure 7: Available Phosphorus as Phosphate (ppm) in different beats of JNP

Sulphate contents of top and sub soil were also quite variable and ranges from 2 – 52 ppm and 2 – 74 ppm respectively. Highest amount of Sulphate was recorded to be 52 ppm in top soil layer in Mendabari beat in Chilapata range and was followed by Bengdaki, Kunjanagar, (both 35ppm) under west range and CC Line (34 ppm) in Kodalbasti range respectively. Top soil of Sissamara in East range, 50ft Camp in North range and NEC beat in Kodalbasti range were devoid of available sulphate content. Jaldapara and Chilapata beats both are under East Range also very poor in it (2 ppm) [**Figure** 8]. Highest amount of sulphate was estimated to be 74 ppm in sub soil of Bania beat under Chilapata range and was followed by Jaldapara beat (49ppm) under East range, Bengdaki beat (45ppm) under West range etc. Sub soil of Hollapara beat in Hollapara range and CC line beat in Kodalbasti range were devoid of available sulphate content. Salkumar beat in South range was found to had 7 ppm of sulphate contents in its sub soil and was followed by 10 ppm in Sissamari beat in east range.

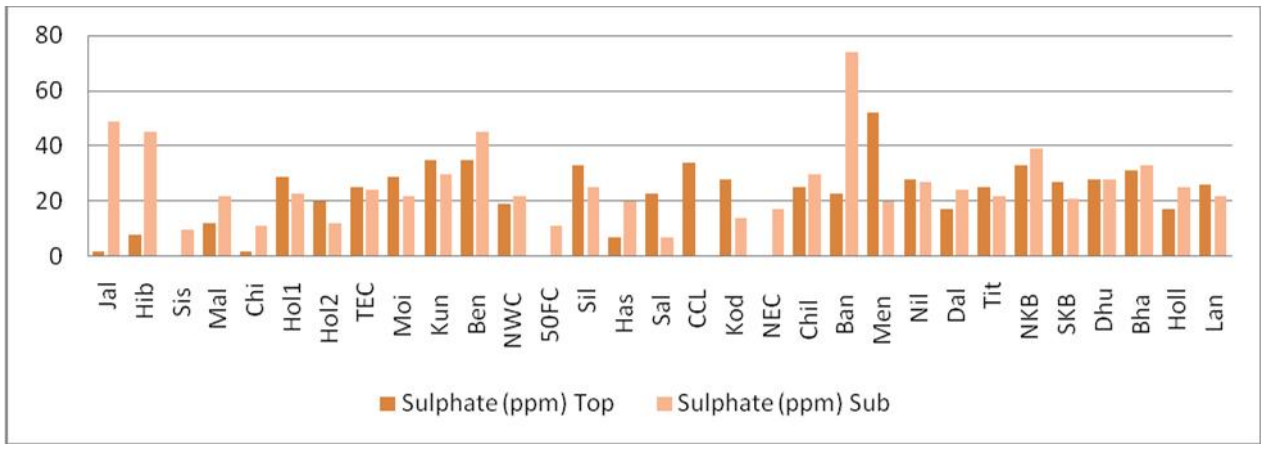


Figure 8: Available Sulpher as Sulphate (ppm) in top and sub Soil of different beats in JNP

Soil moisture content had a significant positive correlation (**Table 1**) with Organic Carbon (r=0.414*), Organic Matter (r=0.414*) and available Nitrogen (r = 0.414*); significant negative correlation with p^H (r=-0.410*) in top soil layer whereas in sub soil moisture content showed significant positive correlation with Organic Carbon (r=0.361*), Organic Matter (r=0.361*) and available Nitrogen (r = 0.361*) only (**Table 2**). Available Sulphate were negatively correlated with pH (r=-432*) and positively correlated with Organic Carbon content, Organic matter and total Nitrogen (r= 0.389* in each cases) (**Table 1**).

Table 1: Correlation matrix among Physico-chemical properties in top layer soil

Variables	Moisture (%)	pH	Organic Carbon (%)	Organic Matter (%)	Total Nitrogen (%)	Potash (ppm)	Phosphate (ppm)	Sulphate (ppm)
Moisture (%)	1							
pH	-0.410*	1						
Organic Carbon (%)	0.414*	-0.305	1					
Organic Matter (%)	0.414*	-0.305	1	1				
Total Nitrogen (%)	0.414*	-0.305	1	1	1			
Potash (ppm)	0.250	-0.200	0.471**	0.471**	0.471**	1		
Phosphate (ppm)	-0.139	0.039	-0.018	-0.016	-0.016	-0.073	1	
Sulphate (ppm)	0.230	-0.432*	0.389*	0.389*	0.389*	0.119	0.160	1

*Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

Table 2: Correlation matrix among Physic-chemical properties of sub soil

Variables	Moisture (%)	pH	Organic Carbon (%)	Organic Matter (%)	Total Nitrogen (%)	Potash (ppm)	Phosphate (ppm)	Sulphate (ppm)
Moisture (%)	1							
pH	-0.277	1						
Organic Carbon (%)	0.361*	-0.216	1					
Organic Matter (%)	0.361*	-0.216	1	1				
Total Nitrogen (%)	0.361*	-0.216	1	1	1			
Potash (ppm)	0.296	-0.254	0.043	0.043	0.043	1		
Phosphate (ppm)	0.164	0.013	0.200	0.200	0.200	-0.025	1	
Sulphate (ppm)	0.017	0.003	0.282	0.282	0.282	-0.277	0.090	1

*Correlation is significant at the 0.05 level (2-tailed).

[Abbreviations used for different beats: Jaldapara (Jal), Habitat *Hibiscus* (Hib), Sissamara (Sis),Malangi (Mal), Chilapata (Chi), Hollong (Hol1), Hollong (Hol2), T.E.C. (TEC), Moiradanga (Moi), Kunjanagar (Kun), Bengdaki (Ben), N.W.C. (NWC), 50ft Camp (50ft), Siltorsa (Sil), Hasimara (Has), Salkumar (Sal),CC Line (CC), Kodalbasti (Kod), N.E.C. (NEC), Chilapata (Chi), Bania (Ban), Mendabari (Men), Nilpara (Nil), Dalsingpara (Dal), Titi (Tit), North Khairbari (KhaN), South Khairbari (KhaiS), Dhumchi (Dhu), Bhagatjote (Bha), Hollapara (Holl), Lankapara (Lan)**]**

Conclusion

Soil not only provides the nutrients and water but is also regarded as one of the important parameters controlling flora and vegetations. From the foregoing result and discussion it can be concluded that the present paper revealed the varied physico-chemical properties of soil of different forest beats and ranges of JNP which are responsible for its diversified flora, fauna, habitat and microclimatic condition. It's much varied pedological properties like strongly acidic to mildly alkaline, dried to much humid damp soil having very low to higher amounts of nutrients and organic contents keep its parity with multifarious microclimatic conditions due to diverse vegetation patterns and widely and intensely distributed rivers and rivulets.

The present survey also recommend further detailed investigation into the soil physico-chemical properties for better understanding the ongoing pedological process in different pockets of habitats in JNP to understand the factors leading to the degradation of habitat, characteristic vegetation patterns, its dynamics and ultimately for conserving the important habitat of Jaldapara National Park (JNP) in its best form to its wider flora and fauna.

Acknowledgments

Authors are grateful to University Grants Commission for granting UGC Teachers' Research Award on the project "Floristic Exploration and Conservation of Endemic and Endangered Species in Jaldapara National Park in West Bengal, India" from 2016-2018 and also thankful to all Forest Personnel of Jaldapara National Park for their constant support and guidance throughout the project period.

References

Allen, S.E., Grimshaw, H.M., Parkinson, J. and Quarmby, C., 1974. Analysis of Ecological Meterial. Blackwell Scientific Publications, Oxford.

Anderson, J.M. and Ingram, J.S.I., 1993. Tropical Soil Biology and Fertility – A Hand book of Methods. CAB Internation, U.K.

Anonymous, 1997. Management plan of Jaldapara Wildlife Sanctuary West Bengal. Wildlife Circle, Department of Forests, Govt. of West Bengal.

Anonymous, 2007. Management plan of Jaldapara Wildlife Sanctuary West Bengal. Wildlife Circle, Department of Forests, Govt. of West Bengal.

Anonymous, 2011. Inventory of Soil Resources of Jalpaiguri Districts, West Bengal using Remote Sensing and GIS Techniques. Soil and Land Use Survey of India, New Delhi

Banerjee, L.K., 1993. Plant resources of Jaldapara Rhino Sanctuary. Botanical Survey of India, Calcutta.

Bray, R.H. and Kurtz, L.T., 1945. Determination of total organic and available forms of phosphorus in soil. Soil Science, 59(1): 39 – 46.

Champion, G.H. and Seth, S.K., 1968. A revised survey of the forest types of India. Govt. of India, New Delhi.

Chakravarty, P. and Chakravarti, S., 1957. Soil of West Bengal. State Agricultural Research Institute, Calcutta.

Das, A.P., Ghosh, C. and Bhowmick, D., 2003. Project Report on estimation of Palatable Biomass in Jaldapara Wildlife Sanctuary with special reference to *Rhinoceros unicornis* L., Department of Botany, University of North Bengal, India.

Ensminger, L.E., 1954. Some factors affecting the adsorption of sulphate by Albania soils. Soil Science Society of America Proceedings, 18: 259-254.

Ghosh, C. and Das, A.P., 2005. Effects of grassland expansion on the herbaceous flora of Jaldapara wildlife sanctuary. In Stress Biology, ed. U. Chakraborty & B.N. Chakraborty. Narosa Publishing House, New Delhi. Pp 186 – 191.

Ghosh, C. and Das, A.P., 2007. Rhino-Fodders in Jaldapara Wildlife Sanctuary in Duars of West Bengal, India. Our Nature, 5: 14-20.

Ghosh, C**.,** Paul, T. K. and Das, A.P., 2013. Rediscovery of *Hibiscus fragrans* Roxburgh (Malvaceae) from Jaldapara National Park in Duars of West Bengal, India. Pleione 7(2): 531 – 537.

Ghosh, C., 2018. Project Report on Floristic Exploration and Conservation of Endemic and Endangered species in Jaldapara National Park in West Bengal, India (UGC Research Award), submitted to the University Grants Commission, New Delhi.

Ghosh, S. B., 2012. Biodiversity and Wild Fodder of Gorumara National Park in West Bengal, India Fodder Plants and Habitat of Gorumara National Park. Journal of Environment and Ecology, Vol. 3(1): 18-35.

Jackson, M.L., 1958. Soil chemical analysis. Prentice-Hall, Inc., Englewood Cliffs, N.J.

Jackson M.L., 1973. Soil Chemical Analysis, Prentice Hall India Pvt. Ltd.

Khanda, A., Choudhary, N.B., Barman, U., Mukherjee, P., Pandey, C.S. and Mukhopadhayay, P.K., 2019. Transformation of some major nutrients in tea garden soils of North Bengal. International Journal of Chemical Studies. 7(1): 74-79.

Kjeldahl, J., 1883. Neue Methode zur Bestimmung des Stickstoffs in organischen Koorpern. Z. Anal. Chem. 22: 338 – 366.

Mukhopadhaya, D., Gupta, S.K. and Banerjee, S.K., 1983. Forms and Distribution of Manganese in Some Soils of Northern Region of Bengal J. Ind. Soc. Soil. Sc. 31(2).

Misra, *et al*. 2009. Soil Sampling in Tea Plantation for Fertility Evaluation: A Guideline. The Assam Review & Tea News.

Misra, T.K., Nanda, A.K., Mandal, P. and Saha, A. 2018. Physicochemical Properties of Soils under Different Tea Growing Regions of North Bengal: A study from 2006 to 2010. Int. J. Res. Chem. Environ. 8 (1): 44 - 48.

Mondal, C. K., Pal, S.K. and Roy, A. 2002. Forms of soil phosphorus in Terai Zone of West Bengal. Agropedology. 12: 127-132.

Pandit, P.K., 1996. Management plan of Jaldapara Wildlife Sanctuary (vols. I–III). Wildlife Circle, Department of Forests, Govt. of West Bengal.

Pandit, P.K., Ghosh, C. and Das, A.P., 2004. Non-timber Forest Produces from Jaldapara Wildlife Sanctuary: an Assessment. Indian Forester 130: 1169 – 1185.

Piper, C. S., 1966. Soil and Plant Analysis. Hans Publisher, Bombay.

Ray, S.K. and Mukhopadhaya, D.A., 2012. Study on Physicochemical Properties of Soil Under Different Tea Growing Regions of West Bengal. (India). International Journal of Agriculture Sciences 4(8): 325-329.

Walkley, A., 1935. An examination of methods for determining organic carbon and nitrogen in soils. J. Agric. Sci. 25: 598-609.

Walkley, A., 1947. A critical examination of a rapid method for determination of organic carbon in soils - effect of variations in digestion conditions and of inorganic soil constituents. Soil Sci. 63: 251-257.

Walkley, A. and Black, I.A., 1934. An examination of Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci. 37: 29-37.

WII, 1997. West Bengal World Bank Aides Forestry Project: Study on the Management of Rhinoceros (Final Report). Wildlife Institute of India, Dehradun.

https:// www.mapsofindia.com/

https://www. wikimapia. org

https://www.wildfact .com

http://wiienvis.nic.in/Database/WestBengal_7842.aspx

Access this Article in Online	
	Website: www.ijarbs.com
Quick Response Code	Subject: Soil Science
DOI:10.22192/ijarbs.2020.07.06.016	

How to cite this article:

Chandra Ghosh, Mainak Mukherjee & Kishor Biswas. (2020). Physico-chemical Properties of Soil of Jaldapara National Park in West Bengal, India. Int. J. Adv. Res. Biol. Sci. 7(6): 141–150.
DOI: http://dx.doi.org/10.22192/ijarbs.2020.07.06.016