Int. J. Agriworld, Vol. 7[2] August 2026
©2020 SVPSS, India
Online ISSN: 2582-7537
Journal's URL:http://www.svpss.in/ijaw
DOI: https://doi.org/10.51470/IJAW.2026.07.02.57
Received 13.07.2026 Revised 01.08.2026 Accepted 11.08.2026
ORIGINAL ARTICLE OPEN ACCESS

Assessment of Chemical Properties of Soils of Dhalai District, Tripura, India

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Abstract

The findings provide useful information for site-specific soil fertility management and appropriate nutrient application, which can help improve crop productivity and support sustainable agriculture in the region. To assess the chemical properties of soils in Dhalai District, Tripura. Soil samples were collected from nine selected sites at depths of 0–15, 15–30, and 30–45 cm and analyzed for major soil chemical properties. The soil pH ranged from 4.03 to 5.29, indicating predominantly acidic conditions, while EC varied from 0.06 to 0.12 dS m^{-1}. Soil organic carbon ranged from 0.60 to 1.80%. Available NPK ranged from 201.65–591.60, 31.18–54.44, and 48.53–296.40 kg ha^{-1}, respectively. Sulphur, Ca, and Mg contents varied from 0.86–2.90 ppm, 3.60–9.80, and 1.00–3.80 cmol (p^{+}) kg^{-1}, respectively. Soil pH and sulphur showed little variation with depth, whereas EC and nutrient contents varied considerably with depth and sampling site.

Keywords: *Chemical properties, pH, EC, Nitrogen, Phosphorus, Potassium, etc.*

Introduction

Soil chemical properties play an important role in determining soil fertility, nutrient availability, crop productivity, and overall soil health. Soil pH influences nutrient release and microbial activity, while electrical conductivity indicates soil salinity and helps in effective water and nutrient management (Sousa *et al.,* 2017; Rhodes *et al.,* 2020). Soil organic carbon is an important indicator of soil quality and is positively related to crop productivity (Bennett *et al.,* 2018). Among the essential nutrients, nitrogen, phosphorus, and potassium are crucial for plant growth and yield, whereas sulphur, calcium, and magnesium contribute to protein synthesis, physiological processes, and plant development (Cantarella, 2017; Prajapati *et al.,* 2020; Cakmak *et al.,* 2018). Therefore, assessment of soil chemical properties is essential for evaluating soil fertility and developing appropriate nutrient management practices for sustainable crop production.

Soil is the most vital natural resource and the basis for all terrestrial life. The chemical properties of soil are the most important factors that determine soil fertility, nutrient availability and crop productivity. Tripura state is located in the North-Eastern Hill (NEH) region of India. It has humid subtropical climate with high rainfall (2000-2500 mm). Due to high rainfall and undulating topography, most soils of Tripura are acidic in nature. The leaching of basic cations is the main cause of soil acidity in this region. (Chaudhari *et al.,* 2013 & Datta *et al.,* 2016) Dhalai district is the largest district of Tripura, covering an area of 2,523 sq km. It lies between 23° 25' to 24° 10' N latitude and 91° 45' to 92° 10'E longitude. The district comprises four blocks - Manu, Ambassa, Salema and Chawmanu. Agriculture is the main occupation, with 75% population dependent on agriculture. Major crops are rice, maize, oil palm, rubber and litchi. The traditional slash and burn (Jhum) cultivation is still practiced, which degrades soil fertility. Characterization of soils in terms of their chemical properties is essential for scientific land use planning, fertilizer recommendation and sustainable crop production. The chemical properties like soil pH, Electrical Conductivity (EC), Organic Carbon (OC), available N, P, K and Cation Exchange Capacity (CEC) indicate the fertility status of soil (Lodh *et al.,* 2014).

MATERIALS AND METHODS

Soil Sampling

Soil samples were collected from agricultural fields of 9 different villages, which fall under three community development blocks viz., Manu, Ambassa, Salema. Each village represented three profile depths viz., 0-15 cm, 15-30 cm, and 30-45 cm. Twenty-seven samples were collected in total. All the samples were collected using khurpi by a random selection. The samples were air-dried and all the unwanted materials were removed. Large clods were crushed by hand and a wooden mallet and then ground using wooden mortar and pestle. Grinding was followed by sieving for which a 2.0 mm sieve was used. Sieved soil samples were stored in air-tight plastic bags and tagged for estimation of physical properties.

Statistical Analysis

The data recorded during the course of an investigation was subjected to statistical analysis by the method of analysis of variance (ANOVA) technique (Fisher, 1960). The type of ANOVA adopted for the experiment was a two-factor analysis without replication. The implemented design of an experiment in the analysis done was Completely Randomized Design (CRD).

RESULTS AND DISCUSSION

Soil pH

Table 1 depicted the statistical soil pH; no significant difference was found in soil pH due to depth. A significant difference was found in soil pH due to villages. The soil pH of different villages varied between 4.03 to 5.29. The maximum mean soil pH of 5.03 was found at V4 – Balaram village and the minimum mean soil pH 4.07 was found at V6 – Lalcheri village. Similar findings have also been reported earlier by Choudhary *et al.,* (2016) and Reza *et al.,* (2010).

Soil EC (dS m^{-1})

Table 1 depicted the statistical soil EC (dS m-1). A significant difference was found in electrical conductivity in soils due to depths and due to villages. The soil EC at three depths of different villages varied between 0.06 to 0.12 dS m-1. The maximum mean soil EC of 0.10 dS m-1 was found at V6 –Lal chhari village and the minimum mean soil EC of 0.07 dS m-1 was found at V2-Kathalcherra, V3- Damcherra and V7 – Halam para village. Soils of the study area were found to be non-saline/ acidic in nature. Hence, all the soils under the study area are safe for all types of crop production with respect to the soluble salt content. Similar findings have also been reported earlier by Datta *et al.,* (2008).

Organic carbon (%)

Table 1 depicted the statistical soil organic carbon content (%). No significant difference was found in organic carbon content in soils due to villages. Significant difference found in villages. Soil organic carbon content in soils of different villages varied between 0.6 to 1.8 %. The highest mean soil organic carbon content was found at V6- Lalchhari (1.70 %) and lowest mean soil organic carbon content was found at V7 –Halam para (0.98 %). Soil organic carbon status was found to be medium to high which enables the soil for higher crop production. Similar findings have also been reported by Choudhary *et al.,* (2016), Reza *et al.,* (2010).

Table 1: Evaluation of Chemical Properties of Soils at Different Sites in Dhalai District, Tripura

Blocks/Sites	pH	EC	OC	N	P	K	Ca	Mg
	Manu							
Karaticherra (V1)	4.99	0.08	1.17	387.53	49.45	199.22	4.87	2.00
Kathalcherra (V2)	4.38	0.07	1.38	383.85	46.54	79.74	5.20	1.47
Damcherra (V3)	4.476	0.07	1.35	319.50	45.08	69.86	5.60	2.67
	Ambassa							
Balaram (V4)	5.03	0.08	1.37	375.66	36.15	116.75	7.13	1.80
Bagmara (V5)	4.58	0.09	1.30	476.43	39.42	56.59	6.67	1.67
Lalchhari (V6)	4.07	0.10	1.70	267.09	27.36	99.20	6.84	1.67
	Salema							
Halam Para (V7)	4.41	0.07	0.98	253.27	42.74	74.58	6.53	2.53
Kachucherra (V8)	4.70	0.08	1.45	401.74	37.14	135.93	5.13	1.53
North Kachucherra (V9)	4.78	0.08	1.30	300.04	49.66	117.64	9.53	2.07

Available Nitrogen (kg ha^{-1})

Table 1 depicted the statistical available nitrogen in soils (Kg ha^{-} 1). A significant difference was found in available nitrogen in soils due to depth and between villages. Availability of nitrogen content in soils of different villages varied from 201.65 to 591.60 Kg ha^{-} 1. The highest mean available nitrogen was found at V5 – Bagmara (476.43 Kg ha^{-} 1) and lowest mean available nitrogen was found at V7 – Halam parai (253.27 kg ha^{-1}). The available nitrogen

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status in the entire study area was found to be low to medium. The reason may be attributed to the fact that nitrogen content is positively correlated with organic matter content which decreases with depth. Similar findings have also been reported by Reza *et al.,* (2010), Rahman and Nath (2018).

Available Phosphorus (kg ha^{-1})

The table 1 depicted the statistical available phosphorus in soils (Kg ha^{-1}). A significant difference was found in available phosphorus in soils due to depth and villages. Availability of phosphorus content in soils of different villages varied from 31.18 to 54.44 Kg ha^{-1}. The highest mean available phosphorus was found at V9- North Kachucherra (49.66 Kg ha^{-1}) and lowest mean available phosphorus was found at V6 – Lalcheri (27.36 Kg ha^{-1}). The available phosphorus status in the entire study area was found to be medium to high. Similar findings have also been reported by Yadav *et al.,* (2017).

Available Potassium (kg ha^{-1})

Table 1 depicted the statistical accumulation on available potassium (Kg ha^{-1}). A significant difference was found in available potassium in soils due to depth and between villages. Availability of potassium content in soils of different villages varied from 48.53 to 296.40 Kg ha^{-1}. The highest mean available potassium was found at V1-Karatichhera (215.68 Kg ha^{-1}) and lowest mean available potassium was found at V5- Bagmara (56.59 Kg ha^{-1}). The available potassium status in the entire study area was found to be low to high. The highest K content observed in the surface horizon and showed more or less decreasing trend with depth. This might be attributed to more intense weathering and release of liable K from organic residues. Similar findings have also been reported by Datta *et al.,* (2016), Reza *et al.,* (2010).

Available Sulphur (ppm)

Table 1 depicted the statistical accumulation on available sulphur (ppm). No significant difference was found in available sulphur in soils due to depth whereas a significant difference was found in available sulphur in soils between villages. Availability of sulphur content in soils varied from 0.86 to 2.90 ppm. The highest mean available sulphur was found at V9 – North Kachucherra (2.56 ppm) and lowest mean available sulphur was found at V7 –Halam para (1.21 ppm). Similar results were observed by Uddin *et al.,* (2012).

Available Calcium (cmol (p+) kg^{-1})

Table 1 depicted the statistical accumulation on available Calcium (cmol (p+) kg^{-1}). Significant difference was found in available calcium in soils due to depth and between villages. Available calcium content of soils varies from 3.60 to 9.80 cmol (p+) kg^{-1}. In villages the highest mean available calcium was found at V9 North Kachucherra (9.53 cmol (p+) kg^{-1}) and lowest mean available calcium was found at V1 Karaticherra (4.87 cmol (p+) kg^{-1}). Similar result was reported by Lodh *et al.,* (2014).

Available Magnesium (cmol (p+) kg^{-1})

Table 9 depicted the statistical accumulation on available Magnesium (cmol (p+) kg^{-1}). Significant difference was found in available Magnesium in soils due to depth and between villages. Available Magnesium content of soils varies from 1.00 to 3.80 cmol (p+) kg^{-1}. In villages the highest mean available Magnesium was found at V3 Damcherra (2.67 cmol (p+) kg^{-1}) and lowest mean available Magnesium was found at V2 Kathalcherra (1.47 cmol (p+) kg^{-1}). Similar result was reported by Lodh *et al.,* (2014).

Conclusion

The study showed that the soils of Dhalai District are predominantly acidic, with medium levels of available NPK and relatively high organic matter content. Deficiencies of Ca, Mg, and S were observed, which may be associated with soil erosion and waterlogging. Appropriate nutrient management, including the use of organic amendments, fertilizers, and lime where required, can help improve soil fertility. Overall, the soils are suitable for paddy, vegetables, and other crops, and proper soil management can further enhance sustainable agricultural production in the region.

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CITATION OF THIS ARTICLE

Darlong, R., Dalavi, V., Kumar, T., Swaroop, N. (2026). Assessment of Chemical Properties of Soils of Dhalai District, Tripura, India, *Int. J. Agriworld*, 7 [2]: 57-60.

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