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Assessment of micronutrient status of some soils of Tengakhat block of Dibrugarh district, Assam, India

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Abstract
A study was conducted to assess the micronutrient status in the soils of seven different villages of Tengakhat block of Dibrugarh district, Assam, India. GPS based 140 numbers of surface soil samples (0-15 cm depth), comprising of 20 composite soil samples from each site, were collected. The pH of the all soils of study area was found acidic and majority (37%) of the samples lie in the strongly acidic (5.1 to 5.5) range. Electrical conductivity was normal (<1.0 ds/m) and soil organic carbon content varied from low to high (0.34 to 1.09) with average value of 0.68. The available soil micronutrients as iron, manganese, copper, zinc and boron status was found 18.98 to 107.59 mg/kg, 6.98 to 42.99 mg/kg, 0.88 to 4.92 mg/kg, 0.21 to 1.86 mg/kg and 0.21 to 0.87 mg/kg respectively with mean value of 73.97 mg/kg, 22.78 mg/kg, 2.57 mg/kg, 0.82 mg/kg and 0.50 mg/kg respectively. All the soils of the study sites contain high amount of available iron, manganese and copper. Majority of the soil samples contain sufficient amount of zinc (67%) and boron (54%).

Keywords: Micronutrient, iron, manganese, copper, zinc, boron

Introduction

Adequate amount of essential nutrients play an important role in increasing crop production (Fageria, 2005) [14]. Essential nutrients are classified as macro (primary, secondary) and micro nutrients. Micronutrients are required by plants in trace quantities but they are as essential as macro nutrients for proper growth, development and quality produce (Li *et al.*, 2007) [29] of plants and are associated with enzymes and coenzymes (Kumar *et al.*, 2016) [25]. The threshold limits for deficient, sufficient and toxic level of micronutrients are also very narrow (Mathew *et al.*, 2016) [31]. Intensive cultivation of high yielding varieties of crop with heavy use of synthetic fertilizers (Saha *et al.,* 2019) [42] only may deteriorate the native micronutrient status of soil (Sidhu and Sharma, 2010 [44]; Shukla, *et al.*, 2016) [49]. Productivity, stability and sustainability of soil leading to poor crop production may occur due to micronutrient deficiency (Bell and Dell, 2008) [6]. Soil physico-chemical factors like pH, electrical conductivity (EC), soil organic matter, sand particles (Kingsley *et al.*, 2019) [23] etc. govern the micronutrient (Zn, Cu, Fe, Mn, B and Mo) dynamics and transformation in soil (Dhaliwal *et al.,* 2019) [13]. Soil parent material and pedogenesis processes also influence the micronutrient content in soil (Silva *et al*, 2019) [45]. Minerals present in soil and weathering processes also assess the micronutrient content in soil and their availability to plants (Kumar and Babel, 2011) [26]. Presence of major nutrients in soil may have positive or negative effect on uptake of micronutrients by plants (Fageria, 2001) [15]. Over fertilization with phosphate fertilizer or high phosphorus content in soil may decrease the uptake of Zinc or other micronutrients by plants (Dadhich and Somani, 2007; [10] Kizilgoz and Sakin, 2010) [24]. Micronutrient deficiency generally lead to crop failure (Meliyo *et al.*, 2015) [33], hence advanced crop and soil management practices including micronutrient application (Garcia-Ocampo, 2012 [16]; Kabata-Pendias and Pendias, 2001) [19] is essential for enhancing crop yield. Micronutrient enhances the macronutrient use efficiency of crop but injudicious continuous application of micronutrient may also cause toxic and hazardous effect of plant (Sarkar *et al.*, 2010) [43].

In Assam state, India, agriculture is the main means of livelihood for most of the population (Upadhyai and Nayak, 2017) [50]. Tengakhat block is located in the eastern part of Dibrugarh district, Assam, India. Rice and tea are two main crops grown in this area. Since tea is a commercial crop, it requires large amount of nutrients and farmers of this area use large amount of chemical fertilizers injudiciously to enhance production which may cause deleterious effect on both soil and environment (Rahman and Zhang, 2018) [39]. Micronutrient concentration in soil affect the quality of tea (Kacar, 1984) [20]. To satisfy the demand of increasing rice production to feed the huge population of Assam, soil should be fertile with sufficient amount of nutrients including micronutrients to enhance rice productivity. Prior knowledge of distribution of micronutrients in the soil is very much important for amelioration as well as to enhance soil fertility and crop production. Study on micronutrient status of soils of Tengakhat, Assam block is very scanty. Therefore, present study is undertaken to assess the micronutrient status of soil for sustainable crop production by maintaining soil health.

Materials and Methods

Soil samples were collected from the study sites *i.e.*, seven different villages *viz.*, Tingrai Nepali (27°20'40"N latitude to 95°13'48"E longitude), Tinikuria (27°24'13"N latitude to 95°11'52"E longitude), Kapahua (27°21'27"N latitude to 95°10'41"E longitude), Abhoipuria (27°23'11"N latitude to 95°11'04"E longitude), Kheremia (27°21'35"N latitude to 95°15'55"E longitude), Bosajan (27°20'47"N latitude to 95°15'28"E longitude) and Tamulikhat (27°22'32"N latitude to 95°09'21"E longitude) of Tengakhat block of Dibrugarh district, Assam, India. The study site lies in the Upper Brahmaputra Valley Zone of Assam. Warm and humid climate with annual average precipitation of 2781 mm, 135 rainy days, winter temperature of 11 °C to 23.2 °C and summer temperature of 23.7 °C to 31 °C is the climatic characteristics of the study site (Source: Inventory of Soil Resources of Dibrugarh District, Assam, using Remote Sensing and GIS Technique). GPS based a total of 140 numbers of surface soil samples (0-15 cm depth) were collected from the seven villages (20 numbers of samples from each village) with the help of soil auger and composite soil samples were prepared. Collected composite soil samples were air dried at room temperature, ground and passed through 2 mm sieve and analysed for physico-chemical properties of soil *i.e.*, soil pH, electrical conductivity (EC), organic carbon and soil micronutrients *viz.*, available iron, manganese, zinc, copper and boron using standard analytical methods. Soil pH and electrical conductivity of the processed soil samples in 1:2.5 soil:water suspension were analysed by potentiometric method using glass electrode pH meter and Systronics Digital Electrical Conductivity meter respectively (Jackson, 1973) [18]. Walkley and Black's (1934) [52] titrimetric determination or wet digestion method was used to determine organic carbon content of the composite soil samples. Available micronutrient cations, *i.e.*, iron, manganese, copper and zinc were determined by DTPA (Diethylene Triamine Penta Acetic Acid) method by using Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978) [30] and available boron content in the soil samples was analysed by Hot water method given by Berger and Truog (1939) [7].

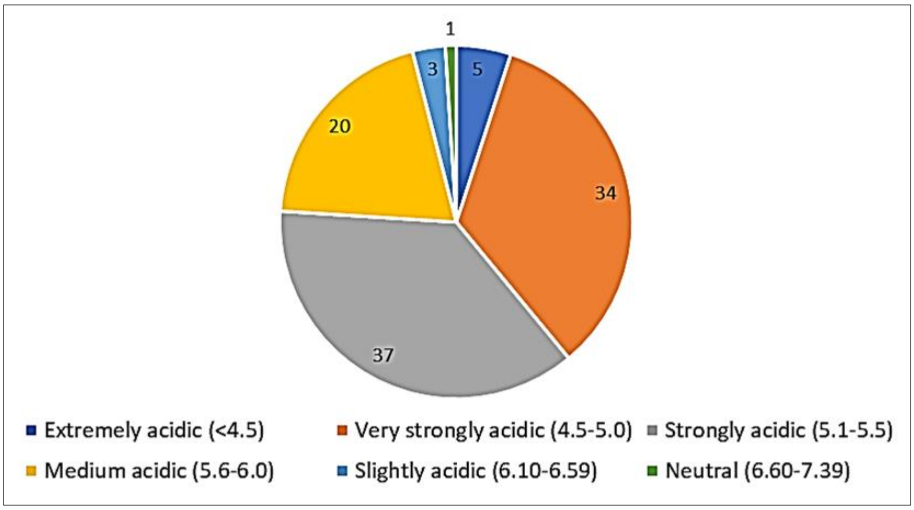
Results and Discussion

Physico-chemical properties of soil

In this study, a total of hundred and forty numbers of collected surface soil samples were analyzed and investigated. The pH of the study site soils varied from extremely acidic to neutral range (3.98 to 6.85) with mean value of 5.24 (Table 1). From the study it was also observed that pH the soils of all the villages are in the acidic range and majority (37%) of the samples lie in the very strongly acidic range (Fig. 1). Similar result was also reported by Nath (2013) [35]; Barooah *et al.*, (2020) [2]. The acidity of the soil might be due to leaching of basic cations from the surface soil because of characteristic high rainfall (>2000 mm/year) prevailing in the study area (Chakravarty *et al.*, 1987) [9]. Organic matter decomposition by soil microorganisms and release of organic acids like -COOH and -OH (Lalrinfela *et al.*, 2016) [28] and long-term fertilization (Nath, 2013) [35] may also be the causes of soil acidity. The results of the study area revealed that electrical conductivity of all the villages of the study area was found in the normal range (<1.0 ds/m) (Table 1). Inherent factors like soil minerals and texture, climate and excessive rainfall of the area might be the causes of low electrical conductivity of the study area (Roy and Landey, 1962 [41]; Singh and Mishra, 2012) [48]. Results show that organic carbon content of the soil varied from low to high (0.34 to 1.09%) with average value of 0.68% (Table 1). It was found that organic carbon content was medium (0.50 to 0.75%) in majority of the soil samples (39% samples), high in 34% of the soils and low in remaining 27% of soils of the study area (Figure 2). In terrestrial ecosystems and agroecosystems, soil organic matter plays an important role (Mensik *et al.*, 2018) [34] as it is the reservoir of plant nutrients including micronutrients. Addition of organic manure as well as good vegetative growth may increase the organic matter content in the soil (Patil and Ananth Narayana, 1990) [38].

Table 1: Range and mean values of physico-chemical properties of soil of the study area

Village	No. of samples	pH		EC (dsm^{-1})		Org. C (%)	
		Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
Tingrai Nepali	20	4.15-6.85	5.57 ± 0.69	0.04-0.47	0.14 ± 0.09	0.38-1.02	0.63 ± 0.18
Tinikuria	20	4.56-6.03	5.16 ± 0.09	0.06-0.20	0.11 ± 0.04	0.34-1.04	0.71 ± 0.20
Kapahua	20	4.55-6.23	5.31 ± 1.07	0.07-0.40	0.16 ± 0.07	0.43-1.03	0.73 ± 0.18
Abhoipuria	20	3.98-6.09	5.12 ± 0.52	0.05-0.43	0.18 ± 0.08	0.43-0.98	0.68 ± 0.17
Kheremia	20	4.48-5.82	5.18 ± 0.36	0.05-0.32	0.16 ± 0.07	0.40-1.09	0.67 ± 0.19
Bosajan	20	4.59-6.12	5.20 ± 0.44	0.06-0.32	0.16 ± 0.08	0.43-0.98	0.67 ± 0.16
Tamulikhat	20	4.44-5.90	5.16 ± 0.39	0.07-0.43	0.20 ± 0.08	0.47-1.01	0.68 ± 0.20
Pooled soil samples		3.98-6.85	5.24 ± 0.51	0.04-0.47	0.16 ± 0.08	0.34-1.09	0.68 ± 0.18



***Source*:** USDA, 1998

Fig 1: Soil acidity class of different villages of study site

Micronutrient contents in soil

Iron

The available iron content in the study site ranged from 18.98 to 107.59 mg/kg with an average value of 73.97 mg/kg (Table 2). On the basis of critical limit of 4.5 mg/kg of soil (Lindsay and Norvell, 1978 [30]; Anonymous, 1990) [1], all the samples (100% samples) of the study area possessed a very high amount of iron (Figure 2). Similar result was reported by Patel *et al.*, 2015 [37], Khadka *et al.* (2017) [22]; Dameshwar *et al.* (2018) [11]. The low pH or acidity of study site soils leading to higher solubility could be resulted in higher availability of Fe content (Pandiaraj *et al.*, 2017) [36]. This is supported by the findings of Medhe *et al.*, (2012) [32]. Presence of primary and secondary iron minerals like hematite, olivine, siderite, goethite, magnetite *etc.*, (Das, 2000) [12] and granite gneiss parent material (Katti *et al.*, 2020) [21] might be the reason of high availability of iron.

Manganese

Available manganese content of soils of the study area ranges from 6.98 to 42.99 mg/kg with the mean value of 22.78 mg/kg (Table 2). According to Lindsay and Norvell's (1978) [30] rating, 100% of the samples of the study area of all the villages lie in the very high category (Figure 2). Similar result was found by Riyabati and Sarangthem (2017) [40]; Khadka *et al.*, (2017) [22], Vijaya *et al* (2000) [51]. Higher available manganese may be present in the study site soil due to granite gneiss parent material (Gurumurthy *et al*, 2019 [17], Katti *et al.*, 2020) [21].

Copper

From the Table 2, it is observed that available copper content of the study area soils ranges from 0.88 to 4.92 mg/kg with the mean value of 2.57 mg/kg. Considering the critical limit of 0.20 mg/kg as suggested by Lindsay and Norvell's (1978) [30], all the samples of the seven different villages were found to be high in available copper content (Figure 2). Kumar *et al.* (2013) [27] and Dameshwar *et al.* (2018) [11] also observed similar results. Higher copper content in soil might be due to higher organic carbon content of the soil as chelating agent like copper may be firmly held by soil organic matter (Pandiaraj *et al.* 2017) [36].

Zinc

Available zinc content of the study area ranges from low to high *i.e.*, 0.21 to 1.86 mg/kg with an average value of 0.82 mg/kg (Table 2). As per the rating suggested by Baruah and Barthakur (1997) [5], most of the soil samples (56%) of the study area found in medium (0.3 to 2.3 mg/kg) range, 33% samples in low range (<0.3 mg/kg) and remaining samples (11%) in high (>0.3 mg/kg) category (Figure 2). Similar result was reported by Singh *et al.*, (2019) [47]. It was also observed from Table 3, that 67% of the analyzed soil samples are sufficient (>0.6 mg/kg) in available zinc content and 33% samples lied under deficient (<0.6 mg/kg) category. Barooah *et al.*, (2020) [3] found similar result in Assam soil. Soil pH is mainly responsible for alteration of zinc distribution in any soil (Sims, 1986) [46]. Sufficient amount of zinc in the study sites may be due to low pH of the soil.

Boron

In the study sites, available boron content varied from 0.21 to 0.87 mg/kg with average amount of 0.50 mg/kg (Table 2). On the basis of Berger and Truog's (1939) [7] rating, majority of the soil samples (50%) of the study area found in medium (0.50 to 0.75 mg/kg) range, followed by 46% of the samples in low (<0.3 mg/kg) and only 4% samples found in high (>0.75 mg/kg) category (Figure 2). Maximum number of soil samples (54%) of the study area remain in the sufficient range (>0.5 mg/kg) and remaining 46% samples were found under deficient or low (<0.5 mg/kg) category of available boron (Table 3). Similar result was reported by Baruah *et al.* (2011) [4], Chaitanya *et al.* (2014) [8]. The low and medium range of available boron content of the study area might be due to low pH soil of the study area induce water solubility of boron followed by leaching below the root zone of plants (Chaitanya *et al.*, 2014) [8] due to heavy rainfall of the area.

Table 2: Status of micro nutrients (Fe, Mn, Cu, Zn and B) in the soils of the study area

Village	Available Fe (mg/kg)		Available Mn (mg/kg)		Available Cu (mg/kg)		Available Zn (mg/kg)		Available B (mg/kg)	
	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
Tingrai Nepali (20)	18.98 - 70.81	50.16 ± 12.53	11.50 - 33.48	20.91 ± 5.71	1.04 - 2.81	1.79 ± 0.56	0.25 - 1.86	0..66 ± 0.38	0.25 - 0.87	0.48 ± 0.17
Tinikuria (20)	21.09 - 101.38	76.43 ± 16.06	14.06 - 42.99	25.90 ± 9.56	0.98 - 4.21	2.47 ± 0.85	0.21 - 1.13	0.70 ± 0.25	0.32 - 0.80	0.52 ± 0.12
Kapahua (20)	28.76 - 103.26	83.08 ± 21.44	11.56 - 42.10	25.20 ± 8.14	0.94 - 4.92	3.12 ± 0.99	0.41 - 1.34	0.90 ± 0.26	0.22 - 0.70	0.47 ± 0.12

Abhoipuria (20)	60.85 - 107.59	81.36 ± 14.21	9.36 - 32.12	21.02 ± 7.13	1.37 - 7.20	3.08 ± 1.35	0.31 - 1.26	0.75 ± 0.26	0.37 - 0.67	0.50 ± 0.08
Kheremia (20)	49.80 - 100.09	74.94 ± 17.89	13.70 - 27.80	20.29 ± 5.07	1.43 - 4.15	2.47 ± 0.92	0.45 - 1.66	0.85 ± 0.41	0.21 - 0.87	0.51 ± 0.18
Bosajan (20)	64.43 - 103.93	92.43 ± 11.17	6.98 - 42.93	27.78 ± 8.09	1.79 - 4.90	3.73 ± 0.94	0.76 - 1.73	1.15 ± 0.27	0.37 - 0.76	0.54 ± 0.11
Tamulikhat (20)	41.94 - 72.78	59.42 ± 10.00	10.36 - 30.10	18.39 ± 5.44	0.88 - 3.64	1.50 ± 0.61	0.44 - 1.10	0.74 ± 0.20	0.32 - 0.71	0.49 ± 0.12
Range and average	18.98 - 107.59	73.97 ± 20.08	6.98 - 42.99	22.78 ± 7.74	0.88 - 4.92	2.57 ± 0.98	0.21 - 1.86	0.82 ± 0.33	0.21 - 0.87	0.50 ± 0.13

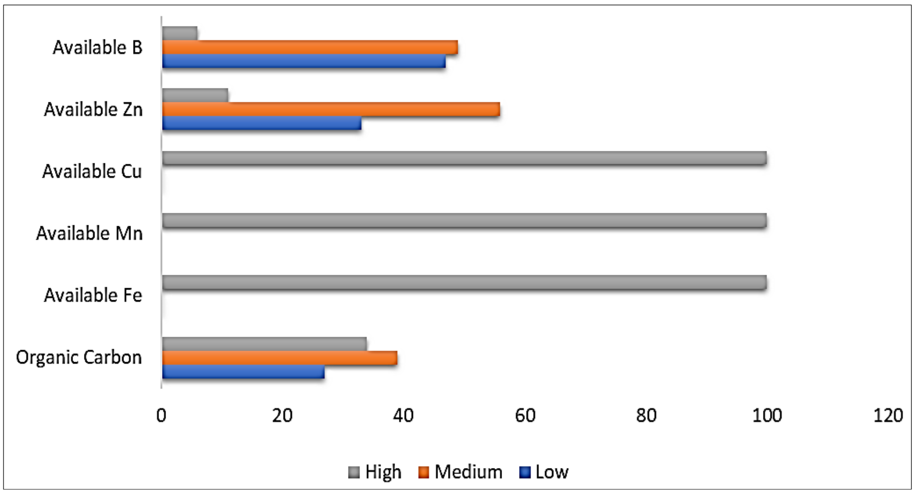


Fig 2: Percent samples under different category

Table 3: Percent samples fall under deficient and sufficient of available zinc and boron of the study area

Village	% samples of available Zn fall under		% samples of available B fall under	
	Deficient (<0.6 mg/kg)	Sufficient (>0.6 mg/kg)	Deficient (<0.5 mg/kg)	Sufficient (>0.5 mg/kg)
Tingrai Nepali (20)	70	30	55	45
Tinikuria (20)	45	55	45	55
Kapahua (20)	15	85	45	55
Abhoipuria (20)	35	65	45	55
Kheremia (20)	40	60	45	55
Bosajan (20)	-	100	35	65
Tamulikhat (20)	25	75	50	50
Total (140)	33	67	46	54

Conclusion

From the above results, it can be concluded that the soils of seven different villages of Tengakhat block of Dibrugarh district, Assam have acidic soil with normal electrical conductivity and soil organic carbon varied from low to high. Available iron, manganese and copper was found very high in all the samples. In majority of the soils, available zinc (99% samples) and boron (50% samples) content was found in medium range and sufficient amount of zinc and boron was found in 67% and 54% of the samples respectively. Since micronutrients are required by crops in trace amount and deficiency as well as excess of which hampers growth as well as yield of crop. Therefore, regular and site-specific rather soil test based micronutrient management practices, balanced organic and inorganic fertilization, suitable cropping system and adequate agronomic practices are essential to enhance sustainable soil fertility and crop production.

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