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Distribution of different forms of soil acidity in Imphal East district of Manipur

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Abstract
Soil acidity is an important agricultural problem leading to severe toxicity of iron, aluminium and manganese, in many crops, coupled with deficiency of phosphorus and low microbial activity that led to poor yield of crops. Thus, an attempt has been made to study the distribution of different forms of soil acidity. Ten surface soil samples (0-20 cm) were collected from Imphal east district of Manipur to study the distribution of different forms of soil acidity. The investigated soil samples were moderately to slightly acidic. The soils were rich in organic carbon and the CEC of the soils is low to medium. The different forms of soil acidity in Imphal west district of Manipur are in the following order TPA>PhDA>TA>Ext-Al^{3+}>NEA>EA>E- Al^{3+}>E-H^{+}.

Keywords: Soil acidity, forms of acidity, Imphal West district

Introduction
Manipur, one of the seven sisters of the North-Eastern Region of India, is an isolated hill-girt state stretching between 92°59′ to 94°46′ E longitudes and 23°50′ to 25°42′ N latitudes. It has a geographical area of 22,327 sq. km., which constitutes 0.7 percent of the total land area of the country. Soil acidity poses a great problem for crop production in Manipur state where about 90 per cent of soils are strongly acidic, 70 per cent of soils are moderately acidic, 3.7 per cent of soils are slightly acidic. Management of acid soils needs to identify the extent and severity of the problem. Soil acidity is an important agricultural problem leading to severe toxicity of iron, aluminium and manganese, in many crops, coupled with deficiency of phosphorus and low microbial activity that led to poor yield of crops (Reza *et al*., 2012) [9]. Therefore, knowledge on different forms of acidity may provide firsthand information on acid soils for their better management. Thus, an attempt has been made to study the distribution of different forms of soil acidity.

Materials and Methods
Ten surface soil samples (0-20 cm) were collected from Imphal east district of Manipur to study the distribution of different forms of soil acidity. The processed soil samples (< 2 mm size fractions) were analysed to study important physicochemical properties and forms of acidity following the standard procedure. The pH of the soils were estimated by using soil suspension (1:2.5) (Jackson 1973) [5]; organic carbon by the method of Walkley and Black; cation exchange capacity (CEC) by ammonium saturation method (Jackson 1973) [5]; clay content by hydrometer method Buoyoucous, 1962. The exchange acidity and Exchangeable Al^{3+} of soils was measured following the method of Baruah and Barthakur (1997) [2]. The Non Exchangeable Al was estimated indirectly as: Non Exchangeable Al= extractable Al– Exchange acidity. The pH dependent acidity was estimated by the following equation: pH dependent acidity = Total potential acidity – Exchange acidity. Total soil acidity was measured by shaking the soil 1M sodium acetate (NaOAc) solution adjusted at pH 8.2 (Baruah and Barthakur (1997) [2]. Total potential acidity of soil was measured by leaching the soil with solution containing 0.5N $BaCl^{2}$- 0.05N tri-ethanol amine (TEA) buffered at pH 8.0+- 0.02 at a soil, solution ratio of 1:10 (Peech *et al*., 1962) [8].

Results and Discussion
Physicochemical properties of soils

Results and discussion
Soil physic-chemical properties
Some physico-chemical characteristics of the soils are presented in table 1. All the investigated soil samples were moderately to slightly acidic varying from 4.91 to 5.72. The soils were rich in organic carbon varying from 9.9 to 26.5 g kg^{-1}. The CEC of the soils is low to medium 11.33 to 21.27 cmol (p+)kg^{-1}.

Table 1: Physico-chemical properties of soil

Soil no.	pH	EC	OC (%)	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)	CEC (cmol/kg)	SAND (%)	SILT (%)	CLAY (%)
1.	5.35	0.16	1.13	310.47	15.28	117.25	11.37	35.50	22.85	41.65
2.	5.05	0.18	1.71	313.61	26.68	167.05	14.77	31.56	23.40	45.05
3.	5.16	0.14	1.75	326.14	12.49	164.05	12.20	22.75	21.40	55.85
4.	5.04	0.15	0.99	310.63	20.02	156.40	14.70	28.95	24.09	46.96
5.	5.12	0.11	1.48	307.35	20.41	169.35	15.66	9.60	35.00	55.40
6.	5.72	0.13	1.06	275.80	21.54	188.60	13.60	34.45	21.25	44.30
7.	5.01	0.26	1.98	426.50	12.56	113.10	20.40	17.17	34.93	47.90
8.	5.19	0.24	2.65	251.15	16.10	128.05	21.27	28.10	20.30	51.60
9.	4.91	0.16	2.51	320.20	14.90	123.02	11.33	22.20	34.20	43.60
10.	5.27	0.17	1.58	315.59	18.57	150.98	13.64	27.41	25.68	46.91
Mean	5.18	0.17	1.68	315.74	17.85	147.79	14.89	25.77	26.31	47.92

Nature of Soil Acidity

Exchange Acidity (EA)

The data on exchange acidity are represented in table 2.

The exchange acidity ranges from 0.89- 2.14 [cmol(p^+)kg^{-1}] with a mean value of 1.42 [cmol(p^+)kg^{-1}]. Exchange acidity is the sum total of H^+ and Al^{3+} retained on the soil exchange complex. Unlike other forms of acidity, exchange acidity of all soils is less. The reason may be possibly due to the depositions of fresh alluvium from hill slopes. Similar result were also reported by (Nayak *et al.* 1996) [7]

Exchangeable Aluminium(E-Al^{3+})

The data on exchangeable Aluminium (E-Al^{3+}) of surface soil are represented in (table 2)

The exchangeable Aluminium (E-Al^{3+}) ranges from 0.60-1.82 [cmol(p^+)kg^{-1}] with a mean value of 1.06 cmol(p^+)kg^{-1}]. Data result shows that exchange acidity have relatively low contribution towards total acidity. Similar findings were observed by Sharma *et al*. (1990) [10], Das *et al.* (1991) [4] and Kumar *et al*. (1995) [6].

Exchange Hydrogen(E-H^+)

The data on Exchange Hydrogen(E-H^+) of surface soil are represented in (table 2)

The Exchange Hydrogen(E-H^+) of soil ranges from 0.22-0.53 [cmol(p^+)kg^{-1}] with a mean value of 0.36 cmol(p^+)kg^{-1}].Data result shows that exchange hydrogen have relatively low contribution towards total acidity. Similar findings were observed by Sharma *et al*. (1990) [10], Das *et al.* (1991) [4] and Kumar *et al*. (1995) [6].

Total Acidity (TA)

The data on Total Acidity (TA) of surface soil are represented in table 2.The Total Acidity (TA) ranges from 2.50-4.75[cmol(p^+)kg^{-1}] with a mean value of 3.54 cmol(p^+)kg^{-1} and 3.60[cmol(p^+)kg^{-1}.

Total Potential Acidity (TPA)

The data on Total Potential Acidity (TPA) of the soil are represented in (table 2). The Total Potential Acidity (TPA) ranges from 10.64-22.24 [cmol(p^+)kg^{-1}] with a mean value of 16.48 cmol(p^+)kg^{-1}.Result revealed that total potential acidity is moderately high. The Total potential acidity comprises all the acidity components. The Total potential acidity of all soils are considerably high. The result might be possibly due to high content of organic matter, clay and free iron oxides. The result was also reported by Nayak *et al*. (1996) [7].

Extractable Aluminium (Ext-Al)

The data on Extractable Aluminium (Ext-Al) of surface soil are represented in (table 2). The Extractable Aluminium (Ext-Al) of soil ranges from 2.00-3.80 [cmol(p^+)kg^{-1}] with a mean value of 2.91 [cmol(p^+)kg^{-1}] respectively.

Non-Exchangeable Aluminium (NEA)

The data on Non-Exchangeable Aluminium (NEA) of surface soil are represented in (table 2). The Non-Exchangeable Aluminium (NEA) ranges from 1.11-1.87 cmol(p^+)kg^{-1} with a mean value of 1.49 cmol(p^+)kg^{-1}.

pH Dependent Acidity (pHDA)

The data on pH Dependent Acidity (pHDA) of surface soil are represented in (table 2)

The pH Dependent Acidity (pHDA) ranges from 9.75-20.77 [cmol(p^+)kg^{-1}] with a mean value of 15.10 [cmol(p^+)kg^{-1}]. Data on pH dependent acidity presented in table 2 revealed that pH dependent acidity contributes significantly towards total potential acidity which was similarly reported by Bandyopadhyay and Chattopadhyay (1997) [1].

Table 2: Different forms of acidity

Soil no.	EA cmol(p^+)kg^{-1}	E-Al cmol(p^+)kg^{-1}	E-H cmol(p^+)kg^{-1}	TA cmol(p^+)kg^{-1}	TPA cmol(p^+)kg^{-1}	Ext-Al cmol(p^+)kg^{-1}	NEA cmol(p^+)kg^{-1}	PHDA cmol(p^+)kg^{-1}
1.	1.12	0.90	0.22	3.15	11.24	2.55	1.43	10.12
2.	2.00	1.48	0.53	4.11	19.04	3.15	1.15	17.04
3.	1.35	0.93	0.43	3.48	16.74	2.75	1.40	15.39
4.	0.97	0.60	0.38	2.50	11.74	2.70	1.73	10.77
5.	1.55	1.15	0.40	3.75	17.74	3.42	1.87	16.19
6.	0.89	0.67	0.23	2.65	10.64	2.00	1.11	9.75
7.	1.45	1.10	0.36	3.20	20.74	2.65	1.20	19.29
8.	1.47	1.13	0.34	4.75	22.24	3.15	1.68	20.77
9.	2.14	1.82	0.32	4.41	19.73	3.80	1.66	17.59
10.	1.25	0.82	0.43	3.35	15.04	2.90	1.65	13.79
Mean	1.42	1.06	0.36	3.53	16.49	2.91	1.49	15.07

Conclusion

Most of the studied soils were moderately to highly acidic in nature because of intense leaching and having high organic matter content. The different forms of soil acidity in Imphal west district of Manipur are in the following order TPA>PhDA>TA>Ext-Al^{3+}>NEA>EA>E- Al^{3+}>E-H^{+}.

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