International Journal of Applied and Pure Science and Agriculture
ISSN Online - 2394-5532 Impact Factor : 4.446 by SJIF ISSN Print - 2394-823X

"CHARACTERIZATION OF ACID SOIL AND LIME REQUIREMENT OF BISHNUPUR DISTRICT, MANIPUR"

Indira sarangthem[1], pebam bidyananda[2], l. Devarishi sharma[3] and nivedita oinam[4]
[1]Professor, Department of Soil Science & Agricultural Chemistry, College of Agriculture, Central Agricultural University, Imphal 795004
[2,3,4] Department of Soil Science & Agricultural Chemistry, College of Agriculture, Central Agricultural University, Imphal 795004

Abstract

Soil acidity has been recognized as an important agricultural problem, which adversely affects the crop production, directly or indirectly. The fertility status of such acid soils is very poor and the crop grown on such problematic soils have lower yield. Problem of soil acidity is acute in hilly states like Manipur, where the common problems are low pH, low CEC (due to dominance of 1:1 type of clay) and low base saturation (16 - 67 %). Therefore, the present research entitled "Characterization of acid soils and lime requirement of Bishnupur district, Manipur" was undertaken with forty eight soil samples; twenty four samples each from Bishnupur block (viz., Toubul, Khoijuman, Kwasiphai and Kabowakching) and Moirang block (Phubala, Tronglaobi, Keirenphabi and Ethai) of Bishnupur district of Manipur during 2011. The soils were found to be of heavy in texture and ranged from clay loam to clay while the pH ranged between 4.44 to 6.42 which were considered as strongly acidic to slightly acidic. The cation exchange capacity of the studied samples varied from 7.80 to 17.80 Cmol (p^+) kg^{-1} soil and organic carbon contents were high and ranged between 0.75 and 2.16 per cent. Exchangeable bases (Ca^{++} and Mg^{++}) ranged from 3.30 to 6.10 Cmol (p^+) kg^{-1} and 1.50 to 4.00 Cmol (p^+) kg^{-1}, respectively. Total Potential Acidity ranged from 3.80 to 7.00 Cmol (p^+) kg^{-1}, Extractable Acidity from 0.07 to 0.35 Cmol (p^+) kg^{-1} and pH Dependent Acidity from 3.67 to 6.87 Cmol (p^+) kg^{-1}. However, there is closer correlation value between total potential acidity and pH dependent acidity, thus pH dependent acidity has dominant influence than exchange acidity. Most of the soils of Bishnupur District, Manipur is under strongly acidic to slightly acidic range, thus high doses of lime amendments is required for desirable crop production. Therefore, it is needed to adopt suitable remedial counter measures other than liming.

Key Words: Exchangeable Al^{+++}, extractable Al^{+++}, total potential acidity, exchange acidity, pH dependent acidity, lime requirement.

I. INTRODUCTION

A soil having dominance of hydrogen (H^+) ion and aluminium (Al^{3+}) ion relatively to hydroxyl (OH^-) ion is called an acid soil. Soil acidity is common in all regions where precipitation is high enough to leach appreciable quantities of exchangeable base forming cations (Ca, Mg) from the soil layers. Several forms of acidity account for the total acidity and lime requirement of an acid soil. Forms of acidity present in soils are viz active acidity, exchangeable acidity, total acidity, pH dependent acidity.

In India, acid soils constitute nearly one-third of the area under cultivation. Acid soils are widely distributed in the Himalayan regions, Eastern, North-Eastern and in Southern states under varying climatic conditions. Out of the total geographical area of 328 Mha in India, 187.7 Mha is subjected to degradation of various kinds producing less than 20 % of its potential capacity. Approximately, 100

Mha of land suffers from soil acidity out of which 51 Mha is under forest and 49 Mha under cultivation, of which 25.9 Mha has pH < 5.6 and 23.07 Mha has the pH value ranging between 5.6 and 6.5 (Motiramani 1971; Sarkar 2002). The acid soils are located in Kerala, Karnataka, Assam, Manipur, Tripura, Mizoram, some district of West Bengal, Bihar and Orissa.

Lime requirement of an acid soils may be defined as the amount of liming material that must be added to raise the pH to some prescribed value. There are various kinds of liming materials that are use for the correction of soil acidity. Some of them are viz oxides of limes, hydroxides of lime, carbonates of lime, slag and other liming material.The extent of occurrence of acid soils in North Eastern is reported to be 80 % of ASR (Misra, 2004). In acid soil regions (ASR) precipitation exceeds the evapo-transpiration and hence leaching is predominant causing loss of bases from the soil. When the process of weathering is drastic, the sub-soil and in many cases, the whole profile becomes acidic. In these soils, the concentration of H^+ ions exceeds that of OH^- ions.

Soil acidity has been recognized as an important agricultural problem, which adversely affects the crop production, directly or indirectly. In the valley districts of Manipur where intensive agriculture is practiced, soil acidity have become a major problem. However, informations regarding forms of acidity in acid soils are lacking. Keeping in view of the nature of soil acidity existing in Manipur, the present research entitle “CHARACTERIZATION OF ACID SOILS AND LIME REQUIREMENT IN BISHNUPUR DISTRICT, MANIPUR” was therefore proposed under the following objectives - To estimate the correlation between soil properties and lime requirement & correlation between forms of acidity and lime requirement.

II. MATERIALS AND METHODS

For the present investigation, forty eight soil samples from Bishnupur district of Manipur, covering all blocks i.e., Moirang and Bishnupur in which 4 villages per block and 6 respondent farmers per village, were selected. The study covered in 4 villages equally in each Block. From each selected village 6 farmers were selected with the help of SIMPLE RANDOM SAMPLING.

Collection & Preparation of soil sample

Soil samples were collected from forty eight paddy growing fields after harvesting of the crop *i.e.*, January 2011. From each site, samples were collected at a depth of 0-20 cm from each field. The soil samples were thoroughly air dried in shade and crushed with a wooden roller on a wooden plank and sieved through 2 mm sieve. The sieved samples were stored in labelled transparent polythene bags for future use for various determinations.

Analytical methods

Soil samples were air-dried, ground and passed through 2 mm sieve, and subjected to analysis of Particle size analysis using Bouyoucos hydrometer method (Bouyoucos, 1927), Soil reaction (pH) (Gupta 2006), Organic carbon (OC) Walkley and Black rapid titration method (Jackson 1973), Cation exchange capacity (CEC) with standard alkali as described by Jackson (1973), Exchangeable (Ca^{++} and Mg^{++}) in neutral normal ammonium acetate and titrated against EDTA (versenate) solution as described by Gupta (2006), Total Potential Acidity by $BaCl_2$-triethanolamine buffered at pH 8 + 0.02 as described by Peech *et al.* (1962), Exchange Acidity by I M KCl extract as described by McLean (1965), pH Dependent Acidity was calculated as difference between Total Potential Acidity and Exchange Acidity as described by Hesse (1971), Lime Requirement by new Woodruff Buffer Method as described by Jackson (1973), Exchangeable Aluminium by 1 M KCl at pH 4.8 as described by Hesse (1973), Extractable Aluminium by 1 M NH_4OAc at pH 4.8 as described by Hesse (1973).Correlation co-efficient (r) studies between various soil physico-chemical properties and micronutrient; was calculated given by Fisher and Yates (1982).

III. RESULTS & DISCUSSIONS

Different forms of acidities

Total Potential Acidity (TPA)

Total potential acidity of the studied soil sample are presented in table 1. Result revealed that total potential acidity is moderately high ranging from 3.8 to 7.0 Cmol (p^+) kg^{-1} soil. The highest total potential acidity with a value of 7.0 Cmol (p^+) kg^{-1} was found in soils of Ethai, respondent farmer no.2 and lowest in soils of Toubul, respondent farmer no. 4. Data also revealed that high total potential acidity is due to high content of organic matter and clay reported by Nayak et *al*. (1996).

Exchange Acidity (EA)

Data on exchange acidity (table 1) of the studied soil samples indicated that exchange acidity value is low compare to total potential acidity ranging from 0.07 to 0.35 Cmol (p^+) kg^{-1} soil. Exchange acidity was found highest in soils of Phubala, respondent farmer no. 4 with a value of 0.35 Cmol (p^+) kg^{-1} and lowest with a value of 0.07 0 Cmol (p^+) kg^{-1} in soils of Toubul, respondent farmer 2. Data result shows that exchange acidity have relatively low contribution towards total acidity. Similar findings were observed by Sharma et *al*. (1990), Das *et al.* (1991) and Kumar *et al*.(1995).

pH Dependent Acidity (pHDA)

Data on pH dependent acidity presented in table 1 revealed that pH dependent acidity contributes significantly towards total potential acidity which was similarly reported by Bandyopadhyay and Chattopadhyay (1997).

The value of pH dependent acidity ranges from 3.67 to 6.87 Cmol (p^+) kg^{-1} soil. Highest value of pH dependent acidity was found in soils of Ethai, respondent farmer no. 2 which was 6.87 Cmol (p^+) kg^{-1} and lowest value of 3.67 Cmol (p^+) kg^{-1} in soils of Toubul, respondent farmer no. 4. Data also revealed that high pH dependent acidity is due to high content of organic cabon. Similar finding were observed by Nayak et *al*. (1996) and Gangopadhyay et *al*. (2008).

Table 1: Different forms of acidities

Sample	Farmer	TPA [C mol (p^+) kg^{-1}]	EA [C mol (p^+) kg^{-1}]	pH DA [C mol (p^+) kg^{-1}]
Toubul				
	I	4.40	0.14	4.26
	Ii	4.60	0.12	4.48
	Iii	4.40	0.09	4.31
	iv	3.80	0.13	3.67
	v	4.00	0.11	3.89
	vi	4.20	0.12	4.08
Mean		**4.23**	**0.12**	**4.12**
Khoijuman				
	I	5.40	0.09	5.31
	Ii	5.20	0.07	5.13
	Iii	5.00	0.09	4.91
	iv	4.40	0.11	4.29
	v	4.80	0.08	4.72
	vi	4.20	0.10	4.10
Mean		**4.83**	**0.09**	**4.74**
Kwasiphai				

	I	5.40	0.10	5.30
	Ii	5.00	0.13	4.87
	Iii	4.40	0.09	4.31
	iv	4.60	0.12	4.48
	v	4.40	0.11	4.29
	vi	4.80	0.08	4.72
Mean		**4.77**	**0.11**	**4.66**
Kabowakching				
	I	5.80	0.18	5.62
	Ii	6.00	0.17	5.83
	Iii	6.20	0.14	6.06
	iv	5.40	0.19	5.21
	v	5.60	0.15	5.45
	vi	5.80	0.16	5.64
Mean		**5.80**	**0.17**	**5.64**
Phubala				
	I	6.60	0.18	6.42
	Ii	6.20	0.32	5.88
	Iii	6.80	0.22	6.58
	iv	6.20	0.35	5.85
	v	6.00	0.24	5.76
	vi	6.40	0.26	6.14
Mean		**6.37**	**0.28**	**6.11**
Tronglaobi				
	I	6.40	0.22	6.18
	Ii	6.20	0.15	6.05
	Iii	5.60	0.26	5.34
	iv	5.80	0.20	5.60
	v	5.40	0.17	5.23
	vi	6.00	0.24	5.76
Mean		**5.90**	**0.21**	**5.69**
Keirenphabi				
	I	5.80	0.16	5.64
	Ii	5.40	0.11	5.29
	Iii	5.60	0.18	5.42
	iv	5.00	0.15	4.85
	v	5.20	0.17	5.03
	vi	5.80	0.12	5.56
Mean		**5.47**	**0.15**	**5.30**
Ethai				
	I	6.60	0.12	6.48

	Ii	7.00	0.13	6.87
	Iii	6.40	0.12	6.23
	iv	5.60	0.17	5.45
	v	6.00	0.15	5.86
	vi	5.80	0.14	5.66
Mean		**6.23**	**0.14**	**6.09**

Lime requirement (LR)

Data on lime requirement are presented in table 2. Result revealed that that the studied sample have fairly high lime requirement with a value ranging from 6.8 to 15.88 t ha^{-1}. Highest lime requirement was found in soils of Kabowakching, respondent farmer no.2 with a value of 15.88 t ha^{-1} and lowest value of 6.8 t ha^{-1} in soils of Toubul, respondent farmer no. 4. Similar finding of the lime requirement value were reported by Ghosh *et al*. (2005) and *Patton et al.* (2007). The result also indicated that lime requirement value was high in areas where clay content was high. This might be due to direct positive correlation between clay content and lime requirement which was reported by Patton *et al*. (2007).

Correlation coefficient (r) between physico-chemical properties and lime requirement

Correlation between physico-chemical properties and lime requirement of the soil sample are presented in table 3. Correlation studies revealed that lime requirement showed a positive and significant correlation with exch. Al^{3+} (r = .840**) and extr. Al^{3+} (r = .906**) and a negative and significant correlation with pH (r = - .890**).

Table 2: Lime requirement (LR)

Sub-Division	**LR(t ha^{-1})**						
	Sample						
	I	II	III	IV	V	VI	**Mean**
Toubul	9.08	10.20	7.95	6.80	9.08	7.95	**8.51**
Khoijuman	6.80	7.95	9.08	10.20	11.35	9.08	**9.08**
Phubala	9.08	7.95	11.35	9.08	10.20	11.35	**9.84**
Tronglaobi	11.35	12.45	13.60	13.60	11.35	10.20	**12.09**
Keirenphabi	11.35	11.35	12.45	10.20	9.08	9.08	**10.59**
Ethai	12.45	11.35	9.08	10.20	12.45	11.35	**11.15**

Table 3. Correlation coefficient (r) between physico-chemical properties and lime requirement

	LR
pH	-0.890**

CEC	0.254
OC	0.661
Clay	0.703
Silt	-0.705
Sand	-0.522
Ca	-0.182
Mg	-0.495
Exch. Al	0.840**
Extr. Al	0.906**
TPA	0.705
EA	0.450
pHDA	0.713*

* r significant at 5% level
** r significant at 1% level

Correlation coefficient (r) between forms of acidities and lime requirement

Correlation between forms of acidities and lime requirement are presented in table 3. Correlation studies revealed that lime requirement showed a positive and significant correlation with pHDA (r = .713*). There is no significance correlation between LR, TPA and EA but have positive correlation. Similar results were also reported by Misra et al. (1989), Kumar et al. (1995), Nayak et al. (1996), Ghosh et al. (2005), Patton et al. (2007) and Gangopadhyay et al. (2008).

Multiple correlation and regression analysis indicated that 82 per cent variability in lime requirement of the soil were due to the simultaneous effect of various soil properties and forms of acidities in the regression. Detailed study revealed the lime requirement was influence by pH, pHDA, exch. Al^{3+} and extr. Al^{3+} (R^2 = 0.826) but their influences are not significant.

$$LR = 3.687 + 0.073\ pH + 0.004\ pHDA + 0.204\ exch.\ Al^{3+} + 0.419\ extr.\ Al^{3+} \quad (R^2 = 0.826)$$

IV. CONCLUSION

From the above finding, it can be concluded that there exists problem of moderate soil acidity. Organic carbon content was high but cation exchange capacity was low. Extractable aluminium content was higher than that of exchangeable aluminium. There was a closer correlation value between total potential acidity and pH dependent acidity and thus pH dependent acidity has dominant influence than exchange acidity. This may be one of the important reasons for decreasing the production potential of crop especially rice in Bishnupur districts of Manipur. Therefore, it is advisable to supply the required doses of lime requirement to the soil to sustain its fertility as well as productivity. Also suitable remedial counter measures other than liming may be adopted to enhance crop production.

BIBLIOGRAPHY

[1] Bouyoucos, G.J. (1927). The hydrometer as a new method for the mechanical analysis of soils. Soil Sci., 23: 225-230.
[2] Fisher, Yates. (1982). Statistical tables for Biological, Agricultural and Medical Research, Longman.
[3] Gangopadhyay, S.K., Bhattacharya, T. and Dipak, S. (2008). Nature of acidity in some soils of south Tripura. Agropedology., 18(1): 12-20.

[4] Gupta, P.K. (2006a). Estimation of available nutrients. Plant, Water and Fertilizer Analysis, published by Agro Botanica Vyas Nagar, New Delhi, pp. 163-168.
[5] Gupta, P.K. (2006b). Estimation of available nutrients. Plant , Water and Fertilizer analysis. Published by Agro Botanica Vyas Nagar, New Delhi, pp. 170-179.
[6] Gupta, P.K. (2006). Soil pH and electrical conductivity. Plant, Water and Fertilizer Analysis. Published by Agro Botanica Vyas Nagar, New Delhi, pp. 81-89.
[7] Hesse, P.R. (1973). A text Book of Soil Chemical Analysis, John Murray (Publishers) Ltd. London.
[8] Jackson, M. L. (1973). Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd. New Delhi.
[9] Kumar, K. (1995). Nature of acidity and its relation with lime requirement of some acid soils of Manipur hills. J. Hill Res., 10(2): 131-135.
[10] McLean, E.O. (1965). In Methods of Soil Analysis, Part II (Black C.A., Ed.). Am Soc. Agron. lnc., Madison, Winconsin, USA.
[11] Mishra, U.K., Satapathy, S. and Panda, N. (1989). Characterization of some acid soils of Orissa. I-Nature of soil acidity. J. Indian Soc. Soil Sci., 37: 22-28.
[12] Misra, U.K.,(2004). Acid Soil and its Management. Journal of the Indian Society of Soil Science Vol.: 52, No.: 4, pp. 332-334
[13] Motiramani, D.P., (1971). In Soil and Water Research in India. Retrospect and Prospect, New Delhi, pp. 98.
[14] Nayak, D. C., Sen, T. K., Chamuah, G. S. and Sehgal, J.L. (1996). Nature of soil acidity in some soils of Manipur. J. Indian Soc. Soil Sci., 44(2): 209-214.
[15] Patton, S., Sharma, S.K. and Singh, P.K. (2007). Characterization of the acidity of soils under different land use pattern in Nagaland. J Indian Soc. Soil Sci., 55(2): 134-138.
[16] Peech, M., Cowan, R.L. and Baker, J.H. (1962). Proc. Soil Sci. Soc. Am., 26: 37.
[17] Sarkar, Dipak, Baruah, U., Gangopadhyay, S.K., Sahoo, A.K., Velayutham, M. (2002). Characteristics and classification of soils of Loktak command area of Manipur for sustainable land use planning. J Indian Soc. Soil Sci. 50(2): 196-204.
[18] Sourav, G., Dipak, S. and Sahoo, A.K. (2005). Nature, distribution and Ameliorative Response of Soil acidity in a test site of Hot Dry Sub-Humid Belt of West Bengal., J. Indian Soc. Soil Sci., 53(1): 66-73.

