Indian J. Hill Farmg. 14 (1) : 48 — 55 2001

EFFECT OF DIFFERENT SOURCES AND LEVELS OF LIME ON ACIDITY COMPONENTS IN HAPLAQUEPT OF ASSAM

Pratibha Thakuria, P. K. Bordoloi and D. K. Borah
Department of Soil Science
Assam Agricultural University
Jorhat - 785 013, Assam, India

ABSTRACT

An incubation study was carried out to investigate the effect of sources of lime viz., pressmud, limesludge and agricultural limestone at 50 and 100% lime requirement, on the changes in acidity components such as total acidity, exchange acidity, exchangeable Al^{3+}, total potential acidity and pH dependent acidity in Haplaquept of Assam. Application of lime brought about a marked increase in soil pH and decrease in all the acidity components. The highest increase in pH and the highest decrease in acidity components were observed with agricultural limestone which was closely followed by limesludge and pressmud in that sequence. Irrespective of sources, lime applied at 100% lime requirement value showed higher increase in soil pH and decrease in all the acidity components as compared to lime applied at 50% lime requirement value.

INTRODUCTION

Low productivity of acid soils of Assam has been attributed to soil related constraints of which lower availability of P, Ca, Mg, Mo and B and higher concentration of Al, Fe and Mn leading to toxicity of the latters are important. Liming is generally advocated to increase the productivity of such soils since it decreases the contents of exchangeable Al and other acidity components and increases the availability of most of the plant nutrients. Agricultural limestone is commonly used for amelioration of acid soils. However, some industrial by-products such as pressmud and limesludge obtained from sugarcane industry and paper mill respectively, are also used as liming material. There is wide information gap on effect of these materials on acidity components in the soils of Assam. The present investigation was undertaken to study the effect of different sources and levels of liming materials on changes in acidity components in Haplaquept of Assam.

MATERIALS AND METHODS

Surface soil sample (0-15 cm) was collected from Titabar of Upper Brahmaputra Valley Zone of Assam. The physicochemical properties of the soil are analyzed as per the standard procedures (Jackson, 1973). The soil is sandy loam in texture having pH 5.5, clay content 15.5%, organic carbon 0.36%, CEC of 5.6 cmol(p+)/kg and base saturation 48.5%. Fifty gram of air dried soil sample was treated with calculated amounts of finely powdered pressmud,

limesludge and agricultural limestone corresponding to 50% and 100% lime requirement (LR) in 100 ml plastic beakers. The water content of the soil was maintained at 60% WHC and incubated at room temperature (25±1°C) for a period of 90 days..Water loss was made up as and when necessary so as to maintain the soil at 60% WHC. Soil samples were withdrawn from each beaker at 15, 30, 45, 60, 75 and 90 days. Soil sample were withdrawn from each beaker at 15, 30, 45, 60, 75 and 90 days after incubation and analyzed for pH, total acidity, exchange acidity, exchangeable Al^{3+} total potential acidity and pH dependent acidity. Soil pH was determined at 1:2.5 soil water suspension using a pH meter; total acidity was determined in NaOAc extract of soil by the method described by Kappen (1934). Exchange acidity was determined with I N KCl extractant (Amedee and Peech, 1976). Exchangeable Al^{3+} was determined with I N KCl (Black, 1965). Total potential acidity was determined with $BaCl_2$-triethanol amine extractant buffered at pH 8±0.02 by Peech's method (Black, 1965), pH dependent acidity was calculated by substracting exchange acidity from total potential acidity.

RESULTS AND DISCUSSION

pH : Results (Table 1) show that lime application with all the sources viz., pressmud, limesludge and agricultural limestone brought about progressive increase in pH of the soil with days of incubation. Such increase in pH due to liming may be attributed to the release of OH ions which directly take care of excess proton (Mahanta and Talukdar, 1995). Of the different sources of lime, the highest increase in pH was found with agricultural limestone. This might be explained in the light that agricultural limestone is pure source of $CaCO^3$ while the others are organic waste containing appreciable amount of organic carbon (limesludge 1.2% C and pressmud 12.2% C), which might have caused masking effect on increase in soil pH. Increase in the levels of lime increased soil pH. The highest pH was observed with agricultural limestone applied @ 100% LR which was closely followed by limesludge and pressmud @ 100% LR in that sequence.

Acidity components

Total acidity : Results (Table 2) show that liming brought about progressive decrease in the total acidity with days of incubation. Within 90 days of incubation, the total acidity decreased from 39.17 to 49.55% over the initial value. It indicates that nearly half of the quantity of total acidity was neutralized by agricultural limestone and nearly 40% of this component was neutralized by the other two sources. Decrease in total acidity due to liming may be attributed to neutralization of hydroxy Fe and Al polymers (McLean el al., 1964). The highest decrease in total acidity was found with agricultural limestone and the lowest with pressmud. This might be explained in the light that agricultural limestone is pure source of $CaCO^3$ while limesludge and pressmud are organic wastes containing 1.2% and 12.2% organic carbon respectively. This organic carbon might have caused masking effect on decrease in total acidity. Decrease in total acidity was found more pronounced with increase in levels of lime. The lowest total acidity was observed with agricultural limestone @ 100% LR which was closely followed by limesludge and pressmud @ 100% LR in that sequence.

Exchange acidity

Liming progressively decreased exchange acidity with days of incubation (Table 2). Though the exchange acidity reduced to maximum at 90 days of incubation with all the sources,

however, nearly 50% of the exchange acidity was reduced within 15 days of incubation with these sources. Agricultural limestone showed maximum of 87.65% decrease at 15 days of incubation when applied at full dose of LR. Such decrease in exchange acidity might be due to depressed activity of Al^{3+} and H' by Ca. Similar result was also reported by Dixit and Sharma (1993) and Kumar and Verma (1997). However, the highest decrease in this component was found at 90 days of incubation which might be due to more effect of liming with time. In general, increase in levels of lime was found to decrease exchange acidity irrespective of sources. The highest decrease in exchange acidity was found with agricultural limestone @ 100% LR which was closely followed by limesludge and pressmud @ 100% LR in that sequence.

Exchangeable Al^{3+}

The exchangeable Al^{3+}, content of the soil (Table 3) under all the treatments recorded progressive decrease with days of incubation. The probable reason for repressing the exchangeable Al^{3}, to near minimum is the precipitation of trivalent Al as $Al(OH)^{3}$ in presence of high concentration of OH- ions (Makaya and Bishnoi, 1990). Within 15 days of incubation more than 40% decrease was observed with agricultural limestone. While, the other two sources showed equivalent decrease only at 60 days of incubation. More time taken by pressmud and limesludge in reducing the activity of Al might be due to the masking effect of organic carbon present in them. Of the different sources of lime, the highest decrease in exchangeable Al^{3+} was found with agricultural limestone and the lowest with pressmud, the reason for which is already mentioned. Increase in levels of lime decreased exchangeable Al^{3+} and the highest decrease in exchangeable Al^{3+} was observed with agricultural limestone @ l00% LR.

Total potential acidity

Results (Table 3) show a progressive decrease of total potential acidity with days of incubation, with maximum decrease at 90 days of incubation. Within 15 to 30 days of incubation, nearly 15 to 20% decrease was observed while about 25 to 40% decrease was observed at 90 days of' incubation. Comparing the other acidity components the per cent decrease was less in total potential acidity, Such lower decrease in total potential acidity was also recorded by Bhumbia and McL,ean (1965). Agricultural limestone accounted much higher decrease of this component as compared to limesludge and pressmud, the reason for which has already been explained above. Decrease in total potential acidity was found more pronounced with increase in levels of lime. The lowest value of total potential acidity was recorded with agricultural limestone ((I? 100% LR which was followed by limesludge and pressmud @ 100% LR.

PH dependent acidity

pH dependent acidity decreased progressively with incubation period under all the treatments, the decrease being more pronounced at the increased levels of lime (Table 3). Such decrease in pH dependent acidity might be due to neutralization of hydroxy Fe and Al polymers (McLean el al., 1964). The decrease in pH dependent acidity was found to be the highest with agricultural limestone and the lowest with pressmud. This might be due to masking effect of organic carbon present in pressmud and limesludge. Increase in levels of lime

decreased pH dependent acidity and the lowest pH dependent acidity was recorded with agricultural limestone @ 100% LR.

The study envisages that agricultural limestone proved superior in increasing pH and decreasing all the acidity components. However, the high cost input of this material, limesludge and pressmud may also be used as liming material as they were found as effective in reducing the acidity components as agricultural limestone.

REFERENCES

Amedee, C. and Peech, M. (1976). The significance of KCl extractable Al(III) as an index to lime requirement of soils of the humid tropics. *Soil Sci.* 121: 227-233

Bhumbla, D. R. and McLean, E. 0. (1965). Aluminum in soils. VI. Changes in pH dependent acidity, cation exchange capacity and extractable aluminum with addition of lime to acid surface soil. *Proc. Soil Sci. Soc. Am* 29 : 370-374.

Black, C. A. (ed.) (1965). Methods of Soil Analysis. Part 2. Am. Soc. Agron., Madison, Wisconsin, USA.

Jackson, M. L. (1973). Soil Chemical Analysis. Indian edition. Prentice Hall of India Pvt. Ltd., New Delhi.

Kappen, G. (1934). Pochvennaya Kislotnost, Selkhogiz, Moscow, *cf. *J. Indian Soc. Soil Sci.* 39: 246, 1991).

Kumar, S. and Verma, T. S. (1997). Efficiency of lime in improving properties of acid Alfisols of North West Himalayas. *J. Indian Soc. Soil Sci,* 45: 605-607.

Mahanta, K. R. and Talukdar, M. C. (1995). Acidity and lime requirement in some soils of Upper Brahmaputra Valley Zone of Assam. *JASS*, 8 : 56-63

Makaya, A. S. and Bishnoi, S. K. (1990). Effect of lime and phosphorus application on some chemical properties of an Alfisol. *J Indian Soc. Soil Sci.* 38: 154-157.

McLean, E. D.-, Hourigan, W. R.; Shoemaker, H. E. and Bhumbia, D. R. (1964).Aluminium in soils : V. Form of aluminium as a xause of soil acidity and a complication in its measurement. *Soil Science.* 97 : 119-127.

Dixit, S. P. and Sharma, P. K. (1993). Effect of lime and potassium on soil acidity, formsof Aluminum and Iron and yield of crops in sequence. *J. Indian Soc. Soil Sci.* 41 : 522-526

Table 1. Effect of different sources and levels of lime on pH of the soil

Treatment	Days of incubation						
	1.5	30	45	60	75	90	Mean
C_1L_1	5.7	5.9	6.0	6.2	6.3	6.5	6.10
C_1L_2	5.9	6.0	6.3	6.5	6.6	6.8	6.35
C_2L_1	5.8	5.9	6.1	6.3	6.3	6.6	6.18
C_2L_2	6.0	6.1	6.2	6.5	6.6	6.7	6.43
C_3L_1	5.9	6.1	6.2	6.5	6.6	6.7	6.33
C_3L_2	6.1	6.3	6.5	6.6	6.8	7.0	6.55
Mean	5.90	6.06	6.25	6.43	6.55	6.75	

C_1 = Pressmud; C_2 = Limesludge, C_3 = Agricultural limestone

L_1 50% LR; L_2 = 100% LR

Table 2. Effect of different sources and levels of lime on total acidity and exchange acidity [cmol(p+)kg-ll

Treatment	Days of incubation						
	15	30	45	60	75	90	Mean
				Total acidity			
C_1L_1	2.9	2.65	2.54	2.32	2.23	2.05	2.45
	(13.95)	(21.36)	(24.63)	(31.16)	(33.83)	(39.17)	(27.30)
C_1L_2	2.8	2.50	2.40	2.25	2.05	1.90	2.22
	(16.91)	(25.82)	(28.78)	(33.23)	(39.17)	(43.62)	(31.16)
C_2L_1	2.7	2.58	2.40	2.21	2.19	2.05	2.37
	(19.88)	(23.44)	(28.78)	(34.42)	(35.01)	(39.17)	(29.67)
C_2L_2	2.78	2.38	2.20	2.01	2.00	2.05	2.18
	(17.51)	(29.38)	(34.72)	(40.36)	(40,65)	(39.17)	(35.31)
C_3L_1	2.48	2.40	2.20	2.00	1.80	1.80	2.16
	(17.51)	(28.78)	(34.72)	(40.65)	(45.59)	(46.59)	(35.90)
C_3L_2	2.48	2.38	2.0	1.92	1.75	1.70	2.04
	(26.41)	(29.38)	(40.65)	(40.03)	(48.07)	(49.55)	(39.46)

Treatment	Days of incubation						
	15	30	45	60	75	90	Mean
Mean	2.74	2.48	@ 2.29	2.12	2.00	1.88	
	(17.51)	(26.41)	(32.05)	(37.09)	(40.65)	(44.21)	
			Exchange acidity				
C_1L_1	0.94	0.80	0.58	0.55	0.41	0.25	0.58
	(41.97)	(50.62)	(64.20)	(60,05)	(74.69)	(84.57)	(64.20)
C_1L_2	0.90	0.83	0.55	0.52	0.38	0.25	0.57
	(44.44)	(48.76)	(66.05)	(67.90)	(76.54)	(84.57)	(64.81)
C_2L_1	0.50	0.36	0.30	0.25	0.20	0.12	0.29
	(69.13)	(77.78)	(81.48)	(84.57)	(87.65)	(92.59)	(82.10)
C_2L_2	0.32	0.22	0 - 19	0.13	0.10	0.07	0.17
	(80,25)	(86.42)	(88.27)	(91.97)	(93.83)	(95.68)	(89.51)
C_3L_1	0.38	0.20	0.15	0.10	0.08	0.05	0.16
	(76.54)	(87.65)	(90.74)	(91.97)	(95.06)	(96.91)	(90.12)
C_3L_2	0.20	0.18	0.14	0.08	0.06	0.03	0.12
	(87.65)	(88.99)	(91,36)	(95.06)	(96,30)	(99.15)	(92,59)
Mean	0.54	0.43	0.32	0.27	0.21	0.13	
	(66.67)	(73.46)	(80,25)	(83.33)	(87.04)	(91.98)	

C_1 = Pressmud-I C_2 = Limesludge, C_3 = Agricultural limestone
L_1 = 50% LR-1 L_2 = 100% LR
Figures in parentheses indicate per cent decrease

TABLE 3. EFFECT OF DIFFERENT SOURCES AND LEVELS OF LIME ON EXCHANGEABLE A13+, TOTAL POTENTIAL ACIDITY AND PH DEPENDENT ACIDITY [CMOL(P+)KG-LJ,

Treatment	Days of incubation						
	15	30	45	60	75	90	Mean
				Exchangeabl Al^{3+}			
C_1L_1	0.65 (13.33)	0.60 (20.00)	0.54 (28.00)	0.50 (33.33)	0.45 (40.00)	0.35 (53.33)	0.51 (32.00)
C_1L_2	0.60 (20.00)	0.51 (32.00)	0.45 (40.00)	0.40 (46.67)	0.31 (58.67)	0.20 (73.33)	0.41 (45.33)
C_2L_1	0.59 (21.33)	0.56 (25.33)	0.45 (40,00)	0.35 (53.33)	0.30 (60.00)	0.25 (60.67)	0.40 (46.67)
C_2L_2	0.50 (33.33)	0.45 (40.00)	0.30 (60.00)	0.25 (60.67)	0.20 (73.33)	0.13 (82.67)	0.31 (58.67)
C_3L_1	0.40 (46.67)	0.31 (58.67)	0.24 (68.00)	0.20 (73.33)	0.10 (86.67)	0.07 (90.67)	0.22 (70.67)
C_3L_2	0.24 (68.00)	0.17 (77.33)	0.10 (86.67)	0.07 (90.67)	0.01;, (93.33)	0.01 (98.67)	0.11 (95.33)
Mean	0.50 (33.78)	0.43 (42.22)	0.35 (53.33)	0.30 (60.00)	0.24 (69.67)	0.17 (77.33)	
				Total potential acidity			
C_1L_1	23.0 (12.88)	22.30 (15.53)	21.70 (17.80)	21.15 (19.89)	20.60 (21.97)	20.10 (23.86)	21.47 (18.67)
C_1L_2	21.76 (7.61)	21.50 (18.56)	21.00 (20.45)	20.50 (22.35)	20.00 (24.24)	19.20 (27.27)	20.66 (21.74)
C_2L_1	22.76 (13.79)	22.00 (16.67)	21.04 (20.30)	20.82 (21.14)	19.76 (25.15)	18.50 (29.92)	20.81 (21.17)
C_2L_2	20.76 (21.36)	20.54 (22.20)	20.20 (23.48)	19.94 (24.47)	19.04 (27.88)	17.50 (33.71)	19.66 (25.53)
C_3L_1	22.65 (14.20)	21.50 (18.56)	20.95 (21.02)	20.25 (23.290	19.35 (26.70)	17.00 (35.61)	20.27 (23.22)

Treatment	Days of incubation						
	15	30	45	60	75	90	Mean
$C_3 L_2$	20.70	20.15	20.04	19.65	19.00	15.76	10.05
	(21.59)	(23.65)	(24.09)	(25.57)	(31.92)	(40.30)	(27.84)
Mean	21.94	21.33	20.81	20.39	19.46	18.01	
	(16.99)	(19.20)	(21,17)	(22.77)	(26.29)	(31.78)	
	pH dependent acidity						
$C_1 L_1$	22.37	21.81	21.27	20.80	20.39	19.92	21.09
	(9.13)	(11.98)	(14,16)	(16.06)	(17.71)	(19.61)	(14.99)
$C_1 L_2$	21.26	21.14	20.70	20.34	19.89	19.12	20.41
	(14.20)	(14.69)	(16.46)	(17.92)	(19.73)	(22,84)	(17.63)
$C_2 L_1$	22.32	21.74	20.84	20.67	19.64	18.40	20.60
	(9.33)	(12.27)	(15.90)	(16.58)	(20.64)	(25.75)	(16.87)
$C_2 L_2$	20.45	20.30	19.99	19.83	18.94	17.44	19.49
	(17.47)	(18.08)	(19.33)	(19.97)	(23.57)	(29.62)	(21.34)
$C_3 L_1$	22.27	21.25	20.70	20.15	19.27	16.96	20.10
	(10.13)	(14.24)	(16.46)	(18.68)	(22.23)	(31.56)	(18.89)
$C_3 L_2$	20.45	19.95	19.94	19.56	17.95	15.73	18.93
	(17.47)	(19.49)	(19.53)	(21.06)	(27.56)	(36.52)	(23.61)
Mean	21.52	21.03	20.59	20.23	19.35	17.93	
	(13.16)	(15.13)	(15.95)	(18.36)	(21.91)	(27.64)	

C_1 = Pressmud; C_2 = Limesludge, C_3 = Agricultural limestone

L_1 = 50% LR; L_2 = I 00% LR

Figures in parentheses indicate per cent decrease