RESIDUAL EFFECT OF LIMING ON SOIL CHARACTERS

K. C. Marykutty[1] and R. S. Aiyer

College of Agriculture, Vellayani 695 522, Trivandrum, India

Conventionally, rate of soil acidification should be measured in terms Of changes (increase) in H ion activity per unit time. However, the sources and sinks of H ion(proton) in soil are more numerous and complicated than those of exchange-able cations such as Ca. Bolton (1977), Hoyt and Henning (1982) and Doerge (1986) explained the high degree of correlation existing between soil pH and cation saturation under environmental conditions where drainage occurs, any soil process which produces both H ions (protons) and leachable anions (other than OH) will result in soil acidification. This occurs due to the replacemant of exchangeable cations by H + and leaching of Ca salts during periods of excess precipitation and over irrigation. Soil acidity can also be affected by mineral sources of buffering such as Fe and Ail hydrolysis and the dissociation of H from Fe oxide/hydroxide surface of clay.

Theoretically, the rate of neutralisation of soil acidity by liming should be measured in terms of the decrease in H acidity per unit volume. However, this process activates to some extent the sources of proton (H+ ion) and suppresses the sink as well. This again complicates the reverse phenomenon to such an extent as to preclude possibilities of making generalised predictions. This necessitates detailed studies on the pattern of residual action of liming to arrive at judicious ratio of liming thatwill not accelerate proton release from the sources as they mop them up.

Materials and Methods

A pot culture experiment with five different levels of lime in four acid soil types was conducted successively for four seasons using a responsive rice variety (Jyothi) in order to study the residual effect of the amendments on soil properties. The experiment was laid out in a completely randomised design with three replica-tions. Based on the distribution of pH value of soils, four soils each representing one tract were selected in the following pH ranges as, below pH 3, pH 3-4, pH 4-5, and pH 5-6. The treatments were:

Treatment notations   Particulars oftreatment

So/7 *type*

S_1 (pH 5-6) Lateritic alluvium (Panenchery, Trichur district)

S_2 (pH 4-5) *Kole* (Vaniampadave, Trichur district)

S, (pH 3-4) *Pokkali* (Vyttila, Ernakulam district)

(pH <3) *Kari* (Kallara, Kottayam district)

Methods of lime requirement (LR)

M_1 Lime requirement (LR) on dry soil basis

M_2 Lime requirement (LR) on wet soil basis after a mean submergence 15 days

Levels of lime

L_0 No lime (control)

L_1 Fully burnt lime $\frac{1}{4}$ LR of the soil

L_2 Fully burnt lime $\frac{1}{2}$ LR of the soil

L_3 Fully burnt lime   LR of the soil

L_4 Fully burnt lime full LR of the soil

Surface soil samples (0-15 cm depth) were collected from the above mentioned places. The physico chemical characteristics of soil are given in Table 1. Earthern pots of uniform size were filled with 15 kg of dried and powdered soil. Sufficient water was added to the pots to wet the soil and to bring about a puddled condition. The quantities of lime applied as CaO to meet full LR determined on dry soil and wet soil basis (after the submergence of 15 days) were respectively 1.23 and 1.12 t/ha for lateritic alluvium, 3.64 and 3.36 t/ha for *kole*, 2.69 and 2.24 t/ha for *pokkali* and 9.97 and 9.24 t/ha for *kari* soils. Lime as per the treatments described above was added to ... soil only for the first crop. Two healthy seedlings of Jyothi variety (20 day old) were transplanted at the rate of four hills per pot on 21st September, 1982. Urea, superphosphate and muriate of potash were applied uniformly at the rate of 70 kg N, 35 kg P_2O_5 and 35 kg K_2O/ha for e (Anon, 1981).

Soil ; samples of every season were collected before transplanting the seedlings and at the end of the fourth season to study the changes in soil characters. The lime requirement, pH, exchangeable H, Al, Ca and Mg were determined by standard procedures described by Jackson (1958), Hesse (1971) and Black (1965).

Results and Discussion

The mean pH values at the time of planting of the first crop decreases progressively with each cropping and in all the four soils (Table 2). A gross decrease of 0.65 pH units in unlimed lateritic alluvium consequent to four successive cropping could be noticed and maximum acidification rate of 1.49 pH units could be measured on soils receiving the highest dose of lime. Similarly, the total decrease of 0.72, 0.43 and 0.45 pH units respectively could be noticed in the unlimed *kole, pokkali* and *kari* soils, the corresponding pH changes in the same soils with the highest rate of liming being 2.41, 2.33 and 2.23 pH units respectively. These results clearly illustrate the view that soil acidification rates increase with the application of increasing quantities of lime. Faster re-acidification of soils amended with high liming rates is explained by the pH dependance of acidifying processes such as nitrification,

Table   1

Physico–chemical characteristics of soils used for pot culture studies

Characteristics	Variam-padave *kole*	Kallara *kari*	Vyttila *pokkali*	Panencherry lateritic alluvium
Moisture (%)	2.10	2.58	2.20	1.98
Sand (%)	3.20	1.96	11.56	52.00
Silt (%)	15.99	15.90	17.50	10.50
Clay (%)	75.98	64.5	61.5	36.4
pH	4.60	2.60	3.60	5.65
EC (mmho/cm)	0.10	3.95	4.00	0.04
Eh (mv)	320.00	410.00	380.00	320.00
Organic carbon (%)	2.61	10.02	2.28	1.78
Fe_2O_8 (%)	7.82	10.29	3.84	8.42
Al_2O_3 (%)	6.99	11.64	438	11.13
Total N (%)	0258	0.996	0.321	0.172
Total P_2O_5 (%)	0.092	0.012	0.042	0.064
Total K_2O (%)	0.258	0.162	0.612	0.094
Total CaO (%)	0.316	0.260	0.388	0.318
Total MgO (%)	0.136	0.154	0.195	0.128
CEC (me/100g soil)	23.98	43.55	23.95	884
EffectiveCEC (me/100gsoil)	11.58	21.80	17.45	5.68
Base saturation (%)	12.97	5.92	57.49	33.77

mineralisation of organic matter and dissociation of organic acids in soil solution. Doerge *et al.* (1985) studied the re-acidification   of two lime amended soils in Western Oregon and calculated the residual effect of liming. They concluded that the rate at which the pH of the limed soil declined increased with the increasing rate of lime application.   The more re-acidification rates observed in *kole, pokkali* and *kari* soils with higher levels of lime application may thus due to the minerali-sation of the higher content of organic matter present in them and dissociation of organic acids in soil solution.   Increased quantities of root exudates   and plant residues returned to the soil following crop response to liming would also contri-bute to higher levels of organic acids in solution.

The mean values of the exchangeable hydrogen and aluminium recorded a the time of planting of the first crop increases progressively with each crop upto the harvest of the fourth and final crop (Table 3 and 4).   In all the soils studied the total rate of increase of the exchangeable hydrogen   after the harvest of the fourth is observed to be higher in limed soils compared to unlimed controls.   Lime application significantly decreased the exchangeable aluminium content of the soil.

Table   2

Residual effect of liming on pH of the soils

	Levels of time				Methods of LR determination		Control $L_{\hat{u}}$	Mean
	L_I	L_2	L_3	L_4	M_1	M_2		
1	2	3	4	5	6	7	8	9

pH at the time of planting of I crop

Soils								
S_1	6.38	6.44	6.61	6.75	6.56	6.54	5.55	6.44
S_2	5.31	6.03	6,38	6.68	6.12	6.08	4.72	5.95
S,	5.13	5.37	6.03	6.17	5.66	5.68	3.53	5.43
S_4	372	4.00	4.46	5.38	4.36	4 26	2.65	4.13
Mean	5.13	5.46	5.88	6.17	5.68	5.64	4.11	
LR								
M,	5.12	5.47	5.87	6.25				
M_2	5.15	5.46	5.87	6.09				

pH at the time of planting of II crop

Soils								
S_1	6.13	6.16	6.35	6.53	6.30	6.28	5.16	6.18
S	5.01	5.78	6·03	6.22	5.74	5.78	4.68	5.64
S_3	4.85	5.06	5.71	571	5.37	5.35	3.50	5.15
S_4	3.83	3.39	4.12	4.37	322	3.78	2.40	3.64
Mean	4.83	5.10	5.55	5.72	5.30	5.30	3.96	
LR								
M,	4.85	5.07	5.55	5.77				
M_2	4.81	5.13	5.56	5.68				

pH at the time of planting   of III crop

Soils								
S_1	5.58	5.80	5.87	5.88	5,81	5.76	5.00	5.70
S	4.54	5.28	5.55	5.65	5.28	5.22	4.22	5.14
S_3	4.55	4.72	5.27	5.35	4.95	4.99	3.40	4.88
• ı	3.12	3.20	3.35	3.57	3.27	3.35	2.30	3.20
Mean	4.45	4.75	5.01	5.11	4.83	4.83	3.73	
LR								
M!	4.43	4.75	5.00	5.14				
M!	4 47	4.75	5.01	5.04				

pH at the time of planting of IV crop

Soils								
S_1	5.31	5.42	5.53	5.63	5.49	5.45	5.00	5.42
S_2	4.18	4.35	4.45	4.59	4.39	4.40	4.10	4.36
S_3	3.80	3.90	4.33	4.48	4.10	4.16	3.25	4.03
S_4	2.90	3.12	3.20	3.33	3.12	3.15	2.20	303
Mean	405	4.19	4.38	4,51	4.27	4.28	3.63	
LR								
M_1	4.06	4.18	4.37	4.49				
M_2	4.04	4.21	4.39	4.52				

pH after harvesting the IV crop

Soils								
S_1	5.09	5.17	5.23	5.26	5.21	5.17	4.90	5.17
S_2	4.11	4.17	4,20	4.27	4.20	4.17	4.00	4.17
S_3	3.52	3.58	3.80	3.84	3.71	3.66	3.13	3.62
S_4	2.68	2.73	2:77	2.85	2.78	2.74	2.20	2.70
Mean	3.85	3.91	4.00	4 06	3.93	3.55		
LR								
M^1	3.87	3.90	4.02	4.09				
M_2	3.83	3.89	3.98	403				

	I	II	III	IV	V
CD (0.05) for S	0.07	0.07	0.03	0.03	0.01
CD (0.05) for L	0.08	0.08	0.03	0.03	0.02
CD (0.05) for SxL	0.16	0.08	0.07	0.03	0.03
CD (0.05) for control	0.11	0.12	0.05	0.04	0.02
CD (0.05) for M	0.03	0.04	0.03	0.04	0.04
CD (0.05) for SxM	NS	NS	NS	NS	NS
CD (0.05) for LxM	NS	NS	NS	NS	NS

The exchangeable aluminium of the soils (me/100 g) decreaced from 7.69 to 0.83 due to liming at the time of the planting of the first crop. At the time of planting of the second, third and fourth crops and after harvest of the fourth crop, the mean exchangeable aluminium of the control soils and the highest level of liming (L_4) were 8.59 and 1.21, 8.81 and 4·64, 8.93 and 7.41 and 9.05 and 8.04 me/100g, respectively.

A progressive increase of the mean exchangeable aluminium of the soils with continuous cropping both in the limed (at all levels of liming) and in un-limed (control) series could be observed. Thus the values of the exchangeable aluminium at the beginning of the first cropping season and finally at the harvest of the fourth crop were respectively 4.87 and 8.83 for ; LR, 2.76 and 8.53 fo r LR, 1.53 and 8.14 for | LR, 0.43 and 8.04 for full LR dose and 7.69 and 9.05 for unlimed soils. Higher the rate of re-acidification in a limed soil, higher was the

Table 3

Residual effect of liming on exchangeable hydrogen content of soils
(me/100g soils)

1	Levels of lime				Methods of LR determination		Control LO	Mean
	L_1	L_2	L_3	L_4	M_1	M_2		
1	2	3	4	5	6	7	8	9
At the time of planting of I crop								
So/'/s								
S_1	0.85	0.35	0.16	0.11	0.37	0.38	1.20	0.46
S_2	1.15	0.68	0.36	0.17	0.58	0.59	4.12	0.98
S_3	1.00	0.64	0.31	0.16	0.52	0.54	2.12	0.69
S_4	13.76	6.12	3.05	1.23	6.02	6.04	19.92	7.59
Mean	4.19	1.95	0.98	0.42	1.87	1.89	6.83	
LR								
M_1	4.16	1.92	0.96	0.44				
M_2	4.22	1.97	0.98	0.40				
At the time of planting of II crop								
Soils								
S_1	1.36	0.72	0.43	0.36	0.73	0.74	1.62	0.83
S_2	2.34	1.38	0.97	0.74	1.32	1r39	4.48	1.70
S_3	1.29	0.95	0.57	0.38	0.78	0.82	2.55	0.99
	19.07	9.14	5.17	3.43	8.87	9.57	24.02	10.85
Mean	6.02	3.05	1.79	1.22	2.92	3.12	8.17	
LR								
M	5.88	297	1.68	1,17				
M	6.15	3.15	1.90	1.27				
At the time of planting of III crop								
Soils								
S_1	1.84	1.31	1.13	085	1.26	1.30	1.96	1.35
S_2	3.17	2.66	1.34	1.11	2 00	2.14	4.58	2.35
S_3	1.43	1.16	0.98	0.72	1.07	1.08	2.65	1.25
S_4	20.91	18.11	17.03	15.68	17.79	18.07	24.27	18.68
Mean	6.84	5.81	5.12	4.59	5.53	5.65	8.48	
LR								
M_1	6.80	5.72	5.05	4.56				
M_2	6.88	5.90	5.20	4.61				

At the time of planting of IV crop

Soils								
S₁	1.98	1.88	1.82	1.76	1.85	1.86	2.08	1.87
S₂	4.07	3.89	1.94	1.76	2.97	2.88	4.82	3.13
S₃	2.49	2.05	1.01	0.94	1.91	1.10	2.76	1.6!5
S₄	24.99	24.04	22.57	22.27	23.33	2360	25.25	23.70
Mean	8.48	7.97	6.79	6.61	7.77	7.10	8.72	
LR								
M₁	8.49	7.98	7.41	7.18				
M₂	8.28	7.94	6.16	6.04				

After harvesting the IV crop

Soils								
S₁	2.37	2.27	2.09	2.02	2.13	2.24	2.42	2.21
	4.31	4.59	4.30	4.15	4.42	4.50	4.90	4.51
S₃	3.01	2.60	2.37	2.10	2.48	2.56	3.05	2.5!3
S	25.09	24.68	23.90	23.41	24.10	24.44	25.83	24.4.4
Mean	5.11	8.53	8.16	7.92	8.28	8.43	9.04	
LR								
M₁	8.78	8.44	8.09	7.83				
M₂	8.85	8.63	8.25	8.01				

	I	II	III	IV	V
CD (0.05) for S	0.08	0.13	0.19	0.20	0.05
CD (0.05) for L	0.08	0.13	0.21	0.21	0.05
CD (0.05) for M	NS	0.09	NS	0.15	0.03
CD (0.05) for SxL	0.18	0.27	0.42	0.43	0.09
CD (0.05) for control vs rest	0.13	0.19	0.29	0.30	0.07
CD (0.05) for SxM	NS	NS	NS	NS	NS
CD (0.05) for LxM	NS	NS	NS	NS	NS

observed rate of increase of exchangeable aluminium content of the soil. Application of lime equivalent to 25 per cent of lime requirement gave appreciable direct and residual effect in neutralising the exchangeable aluminium (Prasad et ai., 1983).

The exchangeable calcium and magnesium content of the four soils studied decrease progressively with each crop upto the harvest of the fourth crop. The rate of increase of calcium and magnesium was greater as the level of lime increased, while the decrease was least in unlimed soil (Table 5 and 6). The mean values of calcium content (me/100g) at the beginning of the first cropping season and finally at the harvest of the fourth crop were 7.55 and 2.48 for ¼ LR, 11.52 and 2.74 for ½ L R, 15.67 and 3.13 for f LR, 21.3 and 3.35 for full LR dose and 4.76 and 2·35 for unlimed soils. The rate of decrease of calcium and magnesium is observed to

Table   4

Residual effect of liming on exchangeable aluminium content of soils
(me/100 g soil)

	Levels of lime				Methods of LR determination		Control	Mean
	L_1	L_2	L_3	L_4	M_1	M_2		
1	2	3	4	5	6	7	8	9
At the time of planting of the I crop								
So/75								
S_1	0.14	0.10	0.06	0.04	0.08	0.08	0.20	0.10
S	2.15	1.95	0.95	0.62	1.39	1.44	4.64	1.78
S_3	2.44	1.57	0.99	0.66	1.37	1.46	3.72	1.67
S_4	14.77	7.40	4.13	1.99	6.91	7.23	22.20	8.75
Mean	4.87	2.76	1.53	3.83	2.44	2.55	7.69	
LR								
M_1	4.80	2.68	1.47	8.04				
M,	4.94	2.83	1.59	8.48				
At the time of planting of the iI crop								
S_1	0.25	0.18	0.13	0.09	0.16	0.18	0.37	0.19
S_2	2.65	2.36	1.36	1.28	1.86	1.94	4.87	2.23
S_3	2.79	1.89	1.33	0.91	1.71	1.76	4.08	1.99
S_4	17.01	8.88	5.31	2.63	8.30	8.60	25,03	10.29
Mean	5.67	3.33	2.03	1.21	3.01	3.12	8.59	
LR								
M^1	5.65	3.29	1.95	1.13				
M_2	5.69	3.36	2.12	1.29				
At the time of planting of the III crop								
Soils								
S_1	0.36	0.27	0.24	0.19	0.26	0.27	0.39	0.28
S_2	3.37	3.13	2.59	2.30	2.81	2.90	4.90	3.08
S	3.67	3.09	2.64	2.01	2.83	2.87	4.18	2.99
S_4	22.89	20.20	16.63	14.06	18.29	18.59	25.81	19.27
Mean	7.59	6.67	5.52	4.64	6.05	6.15	8.81	
LR								
M	7.52	6.59	5.48	4.62				
M ॒	7.63	6.75	5.56	4.66				

At the time of planting of the IV crop

Soils

S$_1$	0.49	0.43	0.39	0.35	0.41	0.42	0.59	0.43
S$_2$	4.59	4.34	3.89	3.62	4.09	4.13	5.01	4.21
S$_3$	4.15	4.00	3.61	3.21	3 70	3.77	4.31	3.80
S$_4$	24.52	23.72	22.66	22.46	23.37	23.31	25.84	23.61
Mean	8.44	8.12	7.64	7.41	7.90	7.90	7.91	8.93
LR								
M$_1$	8.46	8.13	7.61	7.38				
M$_2$	8.42	8.12	7.67	7.43				

After harvesting the IV crop

Soils

S$_1$	060	0.56	0.48	42	0.49	0.53	0.76	0.54
S$_2$	4.86	4.62	4.29	4.12	4.42	4.53	5.06	4.54
S$_3$	4.28	4.18	3. 87	3.76	3.92	4.13	4.39	4.03
S$_4$	25.62	24.75	23.91	23.87	24.33	24.74	25.99	24.69
Mean	1.83	8.53	8.14	8.04	8.29	8.48	9.05	
LR								
M$_1$	880	8.48	7.80	7.89				
M$_2$	8.88	8.57	8.28	8.20				

	I	II	III	IV	V
CD (0.05) for M	0.02	0.04	0.06	0.02	0.03
CD (0.05) for S	0.07	0	0.16	0.09	0.07
CD (0.05) for L	0.07	0.12	0.16	0.10	0.07
CD (0.05) for SxL	0.07	0.25	0.17	0.21	0.15
CD (0.05) for control vs rest	0.09	0.18	0.23	0.15	0.11
CD (0.05) for SxM	NS	NS	NS	NS	NS
CD (0.05) for LxM	NS	NS	NS	NS	NS

be maximum in *kari* soil and minimum in lateritic alluvium. Changes in the levels of extractable actions applied in the liming materials have also been used to estimate the rate at which limed soils acidify (Bolton, 1977; Hoyt and Henning, 1982). The finding of Doerge *et al*. (1985) showed that as with soil pH, the slopes of the regression lines become increasingly negative as the rate of lime applied increases. Removal of Ca^{2+} in the harvest plant materials undoubtedly accounts for a portion of decrease in the extractable within the surface.

If follows from the preceding discussion that reacidification of limed soil is a self-actuating process. When a soil is limed, acidifying processes are stimul-ated and net soil acidification occurs at an accelerated pace. As the pH of the

Table 5

Residual effect of liming on exchangeable calcium content of soils
(me/100 g soil)

,	Levels of lime				Methods of LR determination		Control L_0	Mean
	L_1	L_2	L_3	L_4	M_1	M_2		
1	2	3	4	5	6	7	8	9

At the time of planting of the I crop

So *ils*

S_1	4.49	6.02	6.61	3.04	6.43	6.16	3.89	6.02
S_2	9.61	14.02	19.96	23.77	17.06	16.57	5.75	15.58
S_3	6.83	12.33	17.33	24.04	15.47	14.69	4.56	13.91
S_4	9.28	13.72	19.10	29.10	18.41	17.30	4.86	16.41
Mean	7.55	11.52	15.67	21.30	14.34	13.68	4.76	
LR								
M_1	7.63	11.83	16.14	21.77				
M_2	7.48	11.21	15.20	20.82				

At the time of planting of the III crop

Soils

S_1	3.55	4.02	4.96	5.96	4.68	4.54	3.00	4.34
S_2	5.87	9.22	13.30	15.56	11.15	10.81	4.70	10.28
S_3	4.49	7.99	13.25	15.99	10.60	10.26	3.13	9.69
S_4	4.22	7.40	11.50	15.49	9.74	9.34	2.58	8.77
Mean	4.53	7.15	10.62	13.25	9.04	8.74	3.35	
LR								
M_1	4.60	7.25	10.72	13.59				
M_2	4.46	7.06	10,53	12.90				

At the time of planting of the III crop

Soils

S_1	3.06	3.40	3.95	4.25	3.67	3.66	2.91	3.58
S_2	4.49	5.68	9.22	11.71	7.91	7.64	4.16	7.37
S_3	3.81	4.81	7.70	10.99	6.61	6.73	2.98	6.26
S_4	3.15	3.69	5.93	8.59	5.41	6.28	2.38	5.01
Mean	3.47	4.39	6.70	8.88	5·89	5.82	3.11	
LR								
M_1	3.49	4.48	6.69	8.96				
M_2	3.44	4.34	6.70	8.81				

1	2	3	4	5	6	7	8	9
			At the time planting of the IV crop					
Soils								
S_1	2.86	3.11	3.21	3.81	3.28	3.22	2.69	3.19
S_2	3.89	4.04	6.09	8.17	5.60	5.49	3.60	5.33
S_3	2.95	3.59	5.30	6.35	4.61	4.48	2.73	3.34
S_4	2.33	2.55	2.84	3.47	2.78	2.81	2.12	2.72
Mean	3.01	3.32	4.36	5.45	4.07	4.00	2.79	
LR								
M_1	3.05	3.36	4.38	5.47				
M_2	2.97	3.28	4.33	5.43				
			After harvesting the crop					
Soils								
S_1	2.33	2.45	2.85	3.02	2.73	2.59	2.18	2.61
S_2	3.23	3.53	4.21	4.46	3.94	3.77	3.10	3.77
S_3	2.46	2.82	3.05	3.41	8.03	2.84	2.24	2.86
S_4	1.91	2.17	2.40	2.52	2.33	2.17	1.88	2.21
Mean	2.48	2.74	3.13	3.35	3.01	2.84	2.35	
LR								
M_1	2.53	2.82	3.22	3.46				
M_2	2.43	2.66	3.04	3.24				

	I	II	III	IV	V
(CD 0.05) for S	0.30	0.17	0.17	0.06	0.04
(CD 0.05) for L	0.32	0.18	0.18	0.06	0.04
(CD 0.05) for M	0.23	0.13	N. S.	0.05	0.03
(CD 0.05) for S x L	0.64	0.36	0.36	0.13	0.08
(CD 0.05) for control vs rest	0.45	0.26	0.25	0.09	0.06
(CD 0.05) for S x M	NS	NS	NS	NS	NS
(CD 0.05) for L x M	NS	NS	NS	NS	NS

Table 6

Residual effect of liming on exchangeable magnesium
content of soils(me/100 g soil)

	Levels of lime				Methods of LR determination		Control L_0	Mean
	L_1	L_2	La	L_4	M_1	M_2		
1	2	3	4	5	6	7	8	9
At the time of planting of the 1 crop								
Soi/s								
S_1	2.26	2.18	2.38	2.59	2.33	2.26	1.97	2.26
S_3	2.37	2.44	2.78	2.86	2.71	2.52	2.25	2.56
S_8	4.22	4.55	4.79	5.06	4.71	4.59	4.20	4.61
S	1.68	1.76	1.88	2 03	1.89	1.78	1.69	1.82
Mean	2.58	2.73	2.96	3.14	2.91	2.78	2.52	
LR								
M_1	2.63	2.78	2.98	3.25				
M_2	2.53	2.68	2.92	3.01				
At the time of planting of the II crop								
Soils								
S,	1.38	1.55	1.70	1.79	1,66	1.55	1.30	1.57
S	1.78	1.87	2.13	2.28	2.06	1.97	1.72	1.98
S,	3.14	3.11	3.30	3.60	3·34	3.23	3.06	3.26
S_4	1.17	1.27	1.38	1.55	1.39	1.29	1,14	3.26
Mean	1 86	1.95	2.13	2.30	2.11	2.01	1.11	
LR								
M,	1.91	2.00	2.19	2.36				
M_2	1.81	1.90	2.00	2.25				
At the time of planting of the III crop								
Soifs								
S_1	1.16	1.37	1.45	1.54	1.39	1.37	1.20	1.36
S,	1.53	1.56	1.76	1.84	1.69	1.65	1.31	1.63
S,	2.57	2.63	2.73	2.84	2.71	2.67	2.37	2.67
S!	1.07	1.12	1.17	1.19	1.16	1.12	1.03	1.13
Mean	1.58	1.67	1.78	1.85	1.74	1.70	1.48	
LR								
MI	1.59	1.60	1.80	1.87				
M!	1.57	1.65	1.75	1.82				

Soils	At the time of planting of the IV crop							
S₁	1.03	1.13	1.24	1.28	1.20	1.14	0.99	1.16
S₂	1.22	1.34	1.42	1.46	1.38	1.34	1.15	1.34
S₃	1 93	1.95	2.11	2.38	2.13	2.06	1.81	2.06
S₄	0.92	1.01	1.12	1.15	1.10	1.00	0.90	1.03
Mean	1.27	1.36	1.47	1.57	1.45	1.39	1.23	
LR								
M	1.28	1.38	1.51	1.63				
M.	1.26	1.34	1.44	1.51				

	After harvesting the IV crop							
S,	0.85	0.89	1.00	1.04	0.96	0.93	0.82	0.93
	1.06	1.11	1.19	1.25	1.18	1.13	0.97	1.11
S.	1.31	1.52	1.60	1.78	1.60	1.50	1.25	1.53
S₄	0.77	0.87	0.94	1.02	0.92	0.88	0.69	0.88
Mean	0.99	1.09	1.18	1.27	1.17	1.11	0.23	
LR								
M₁	1.02	1.13	1.22	1.30				
M₂	0.98	1.06	1.15	1.24				

	I	II	III	IV	V
CD (0.05) for S	0.06	0,04	0.04	0.03	0.01
CD (0.05) for L	0.06	0.04	0.05	0.03	0.01
CD (0.05) for M	0.05	0.03	0.03	0.02	0.01
CD (0.05) for S x L	0.13	0.08	0.08	0.06	0.03
CD (0.05) for control vs rest	0.09	0.06	0.06	0.04	0.03
CD (0.05) for S x M	NS	NS	NS	NS	NS
CD (0.05) for L x M	NS		NS	NS	NS

soil drops, so does the rate of acidification, eventually the pH of the soil prior to liming will be approached. However, the time duration required for this reacidification processes tend to attain the pH of the soil prior to liming has to be modelled for different rate of liming.

Summary

A pot culture experiment was conducted to study the residual effect of liming under continuous cropping to rice for 4 seasons with four different soils on soil characters. Soil reacidification rate was found to increase with the increasing levels of lime showing thereby that high rate of liming could cause reacidification problems defeating the very purpose of liming.

Acknowledgements

References

Anonymous, 1981. *Package of Practices Recommendations.* Kerala Agricultural University, Vellanikkara, pp. 13-15.

Black C. A Evan, D. D Ensminger, L. E., White J. T. and Clark, F. E. 1965. *Methods of Soil Analysis.* Part 2 No. 9 in the Series of Agronomy. Am. Soc. Agron. Inc. Madison, USA, pp. 917-1010

Bolton, J. 1977. Changes in soil pH and exchangeable calcium in two liming experiments on contrasting soils over 12 years. *J. Agric. Sci. Camp.* 89: 81-86.

Deorge, T. A. and Gardner, E. H. 1985. Re-acidification of two lime amended soils in Western Oregon. So/7 *Sci. Soc. Am, J.* 49: 680-685.

Hesse, P. R. 1971. *A Text Book of Soil Chemical Analysis. John* Murray Publishers Ltd., London, pp. 96-217.

Hoyt. P. B. and Henning, A. M. F. 1982. Soil acidification by fertilizers and longevity of lime application in the Peace River region. *Can J. Soil Sci.* 62: 155-163.

Jackson, M. L. 1958 So/7 *Chemical Analysis.* Prentice Hall, Inc. USA, pp.30-97

Prasad, R. N., Patiram, R. C. and Munnaram, B. 1983. Direct and residual effect of lime on yield of maize and uptake of nutrients on acid soils of Meghalaya. *J. Indian Soc. Soil Sci.* **31:** 233-235.