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Relationship of Some Soil Properties to Lime Requirement and pH in Hill Soils of Tamil Nadu

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The relationship of some soil properties with lime requirement and pH was studied in the hilly latosols of Tamil Nadu. Exchangeable aluminium was significantly correlated with pH but not the hydrogen. Considering the soil properties as an index of lime requirement it was found that the pH and organic matter can be more reliable than the exchangeable aluminium. The reasons for considering the organic matter and pH for assessing the lime requirement in acidic hilly soils are discussed.

The optimum environment for proper crop growth is denied in acidic soils which necessitates the need for ameliorating these soils using lime. Eventhough liming is closely related to pH based on the buffering capacity of the soils, only scanty information is available on the interrelationship with aluminium, organic matter and particle size distribution of the soils. Still controversy exists for the importance of aluminium over other mechanisms causing acidity in tropical soils. Ananthanarayana and Perur (1973) concluded that contribution of aluminium towards acidity is not much from their studies of acidic soils of Mysore. The work of Kamprath (1970) is in line with Jackson's (1993) earlier view that pH less than 5.6 may be primarily due to exchangeable aluminium. Similarly, views put forward for lime requirement are either associated with organic matter (Keeney and Corey, 1963) or with exchangeable aluminium (Reeve and Summer, 1970). Therefore, the primary object of the study centered around the above points.

MATERIALS AND METHODS

Twenty soil samples representing the five hills viz., The Nilgiris, Anamalais, Kodaikanal, Sherveroys and Kolli hills were collected and analysed for pH, loss on ignition, particle size distribution (International pipette method) and organic carbon (Walkley and Black, 1934). Exchangeable aluminium and exchange acidity were determined by titration from IN KCl extract of soils (Dewis and Freitas, 1970) and exchangeable hydrogen and total acidity were calculated. Lime requirement was also estimated (Shoemaker, *et al.* 1961).

RESULTS AND DISCUSSION

Most of the soils were sandy clay loam with a wide pH range of 3.7 to 6.8. The organic matter percentage

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varied from a minimal value of 0.6 to a maximum of 17.9 per cent. Total acidity varied from 0.007 to 0.228 me/100 g. The details of analysis are presented in Table I.

Soil pH is affected by the nature of clay colloids, amount of humus and hydrous oxides of iron and aluminium. In this study the correlation of soil pH with exchangeable hydrogen and exchangeable aluminium revealed that the contribution of exchangeable aluminium to acidity is significantly more, but not the hydrogen. The 'r' value for pH with exchangeable aluminium was -058**.

The soils studied were mostly laterites dominated by Kaolinte and rich in hydrous oxides of aluminium and iron. The low pH might be due to the stepwise hydrolysis of aluminium and iron (Seatz and Peterson, 1969). Interestingly no relationship was obtained between exchangeable H+ and pH. This was possible because soils with high organic matter content had a lower content of aluminium in soil solution at a given pH (Evans and Kamprath, 1970) and further the organic fractions might from complex with aluminium. This reduced the aluminium concentration in solution and exchangeable form which in turn affected the exchangeable H+.

The lime requirement values and the exchangeable aluminium were related closely ($r = 0.63^{**}$) than lime requirement and exchangeable hydrogen ($r = 0.44^{*}$). Even the other factors considered viz., clay ($r = 0.68^{**}$), total acidity ($r = 0.72^{**}$), organic matter ($r = 0.84^{**}$) and pH ($r = 0.89^{**}$) were found to give close prediction values for lime requirement.

The reason for close association between clay and lime requirement is not far to seek. The charges on the clay might originate both from dissociation of hydrogen ions from OH groups and from exchangeable aluminium groups. Since clay possess both exchangeable aluminium and exchangeable hydrogen, it is but natural to expect a close correlation for lime requirement with clay rather than it charged cations individually. Total acidity of the soil was found to have even closer correlation than clay for lime requirement. Naturally the total acidity, which represents potential and active acidity should have close correlation in the study.

A multiple linear regression analysis clearly broughtout the significant relationship for lime requirement with organic matter and pH which is due to the negative relationship between pH and organic matter. This is in conformity with the findings of Keeney and Corey (1963).

$$Y = 37.82 - 5215.09\ b_1 - 5162.40\ b_2 + 0.69^{**}\ b_3 + 0.04\ b_4 + 5213.36\ b_5 - 5.81\ b_6$$

(b_1 = exch. Al; b_2 = exch. H; b_3 = organic matter; b_4 = clay; b_5 = Total acidity; b_6 = pH)

The decomposition of organic matter and presence of organic acids could lower the pH and the functional groups of organic matter might form complexes with aluminium and hydrogen and release them slowly. The negative charge on soil organic matter might be high due to the functional groups present in it which behave as slow acting weak

TABLE. Properties of hill soils

Location and hills	Elevation (Metres)	PH	Loss on ignition %	Organic Matter %	Coarse sand %	Find sand %	Silt %	Clay %	Total acidity me/100g	Exchange-able Alumi-nium me/ 100 g	Exchange-able hydro-gen me/100g	Lime requirement tons/ha $CaCO_3$
The Nilgiris												
Kakkathoppu, Ooty	2166	4.8	33.8	13.2	30.3	8.3	18.4	41.36	0.0750	0.036	0.039	22
Kakkathoppu Seed Farm, Ooty	2166	4.5	31.8	10.8	19.6	14.7	15.3	48.18	0.0310	0.023	0.008	21
Gudalur	976	5.2	11.4	3.7	39.4	16.5	17.6	26.36	0.0340	0.022	0.012	13
Chundakalimedu, Ooty	885	5.9	11.1	3.1	38.1	14.0	15.4	31.36	0.0170	0.003	0.014	7
Kairsili Estate, Kotagiri	1526	3.9	30.3	9.2	23.6	11.3	28.6	35.58	0.2280	0.182	0.046	25
Kallar Fruit Research Station	763	4.8	10.0	1.7	61.1	18.2	9.1	11.07	0.0025	0.001	0.002	9
Anamalais												
Top slip	763	6.8	5.4	3.1	60.6	12.3	10.6	15.61	0.0160	0.003	0.013	–
Thai Mudis	1250	4.7	17.5	4.8	35.8	6.1	16.1	41.93	0.0570	0.051	0.006	16
Waterfalls Estate Anamalai	1068	3.7	18.7	6.1	31.8	11.3	3.5	53.64	0.0070	0.003	0.004	22
Kodaikanal												
Woodside, Kodaikanal	2135	4.0	45.8	17.9	36.6	10.5	22.9	28.96	0.3140	0.310	0.004	28
Laughing water, Kodaikanal	2135	5.4	35.9	14·8	32.2	15.4	24.5	29.14	0.0580	0.003	0.055	21
Agricultural Research Station, Kodaikanal	2287	4.3	35.9	12.1	35.4	12.2	14.9	39.02	0.2050	0.130	0.075	25
Agricultural Research Station, Kodaikanal	2237	5.6	20.7	8.6	53.6	7.8	13.6	24.92	0.0280	–	0.028	13
Perumal Malai by pass, Kodaikanal	1449	6.0	13.7	5.4	48.2	11.1	15.0	23.58	0.0240	0.003	0.021	9
Oothu, Kodaikanal	1067	5.9	11.8	2.8	41.0	11.0	22.7	24.05	0.0220	0.003	0.019	7
Shervoroys												
Yercaud	1525	5.7	21.2	8.1	31.4	9.0	19.7	43.70	0.0910	0.042	0.049	16
HPB 17/21, Yercaud	1434	5.4	14.4	6.1	52.8	5.6	13.3	29.71	0.0210	0.005	0.016	15
MSPN Estate, Yercaud	1068	6.0	13.9	3.6	39.2	10.1	23.7	25.56	0.0230	0.020	0.003	5
Modern Theatres, Salem	396	6.8	2.7	0.6	73.1	14.5	6.1	7.00	0.0120	0.003	0.009	–
Kolli												
Kolli Top	1196	5.8	18.3	4.1	34.8	9.9	20.7	34.65	0 0160	0.003	0.013	9

acids. Further the work of Palaniappan (1975) revealed that these soils contained high amount of sulphur which has a positive relationship with organic matter and negative relationship with pH and hence the organic sulphur compounds might also cause acidity. This is the reason why the pH and organic matter content of the soils were closely related to the lime requirement unlike in other mineral soils. McLean *et al* (1965) working with soils varying in organic matter upto about 10 per cent attributed the variable charge of soils to the organic fraction.

Thus, it could be decided that for these organic matter rich, low pH soils the lime requirement could be better gauged from the pH and organic matter, rather than total acidity and exchangeable aluminium, because the latter two are mainly the result of decomposition of organic matter and their interaction with aluminium.

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