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EFFECT OF LIME IN COMBINATION WITH GYPSUM ON SOIL ACIDITY PARAMETERS AND UPTAKE OF NUTRIENTS IN SOYBEAN

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Abstract: Liming results in significant increase in plant height, nodule number, dry weight of pod, grain yield, haulm yield, total dry weight and NPK uptake. Soil pH, effective CEC, total Ca, exchangeable Ca and available N were increased significantly due to liming. Significant reduction in Al saturation, exchangeable Al and available P and K occurred due to liming.

Key words: Liming, soil acidity, soybean

INTRODUCTION

Soil acidity is a major problem in many parts of the world, particularly on highly weathered soils. These soils have developed under humid conditions and contain very small amounts of exchangeable calcium and magnesium, high levels of exchangeable aluminium and possess low cation exchange capacity. Laterite soils covering nearly 60 per cent of the soils of Kerala are predominant in low activity kaolinite and hydrous oxide clays. These soils though acid and infertile can be very productive when limed and fertilised.

The practice of surface incorporation of lime often neutralises the surface acidity and toxic factors. The subsoil acidity and low Ca saturation continue to exist as a problem in the vicinity of roots. Sumner (1970) and Reeve and Sumner (1972) demonstrated the beneficial effect of surface applied gypsum on subsoil acidity. Pavan *et al.* (1984) suggested combination of dolomitic lime stone and gypsum for reducing exchangeable Al and supplying Ca and Mg in the surface as well as subsoil. The present study was undertaken to find out the effect of lime in combination with gypsum on acidity parameters and growth, yield and uptake of nutrients in soybean.

MATERIALS AND METHODS

The study was conducted in the Department of Soil Science and Agricultural Chemistry, College of Horticulture, Vellanikkara, Thrissur, during the period 1989-90. Bulk samples from 20 cm depth representing Vellanikkara series were collected and dried in shade and the larger clods were broken with a wooden mallet. The soil selected for the study recorded a pH of 4.7 (1:2.5 soil water suspension). The available nitrogen, phosphorus and potassium were 197.6, 8.6 and 207.2 kg ha^{-1}. The exchangeable Ca, Mg, Na and K (neutral *N* ammonium acetate) was 1.8, 0.4, 0.13 and 0.21 cmol(+) kg^{-1} respectively. The KC1 extractable aluminium recorded was 1 cmol (+) kg^{-1}. Earthern pots of uniform size were filled with 10 kg of the soil. The experiment was laid out in CRD with four replications. The treatments were:

TO : No lime

T_1 : $CaCO_3$ at the rate equivalent to 1.5 times exch. Al

T2 : $CaCO_3$ at the rate equivalent to 3.0 times exch. Al

T_3 : $CaCO_3$+ $CaSO_4.2H_2O$ (50:50) at rate equivalent to exch. Al

T_4 : $CaCO_3$ + $CaSO_4.2H_2O$ (50:50) at the rate equivalent to 3.0 time exch. Al

The treatments were applied in the surface 2 cm layer and mixed well. Then water was sprinkled just to moisten the soil. Ten days after the application of treatments soybean (variety Improved Pelicon) seeds were sown. Only one healthy plant was maintained in each pot. The crop was irrigated once in three days with 2 1 of water and no water was allowed to drain. Fertilisers ($N:P_2O_5:K_2O$) were given at the rate of 20:30:10 kg ha^{-1} (KAU, 1989). The crop was harvested four months after sowing by pulling out the plants without disturbing the root system.

The soil from each pot was mixed thoroughly and a representative sample was collected for chemical analysis. pH (water), total Ca and Mg and exchangeable Ca and Mg were determined using the procedures described by Hesse (1971). Exchangeable Al was determined in KCl extract by titration method (Thomas, 1982) and available N by alkaline permanganate method (Subbiah and Asija, 1956). Available P was extracted with Bray No.1 extractant and determined by chlorostannous reduced molybdophosphoric blue colour method in HCl system and available K was extracted by neutral 1 *N* ammonium acetate and estimated using an EEL flame photometer.

The plant parts (tops) collected at the time of harvest were analysed separately viz., shoot and pod for total N, P, K, Ca and Mg following standard analytical methods.

RESULTS AND DISCUSSION

Significant increase in the dry weight of pod and grain yield was observed in the treatment with $CaCO_3$ at 1.5 times exchangeable Al and corresponding Al saturation of 6.98% (Table 1). This indicates the possibility of getting a higher yield at this level of exchangeable Al. Significant increase in haulm yield was recorded by the treatment with $CaCO_3$ + $CaSO_4.2H_2O$ at the rate of 3.0 times exchangeable Al content. Significant increase in total dry weight was observed in all the treatments over the check. This may be due to the increase in growth and uptake of nutrients as a result of neutralization of exchangeable Al and effective water utilization with increased root proliferation.

Nutrient uptake

The N uptake (Table 1) in soybean was significantly influenced by treatments with maximum value recorded by the treatment with $CaCO_3$ at 1.5 times exchangeable Al. Similar results were obtained for available N also (Table 2). Therefore, the increased uptake of N may be due to the increased availability of N as a result of liming. Liming resulted in significant increase in P uptake. The maximum P uptake was recorded by the treatment with $CaCO_3$ + $CaSO_4.2H_2O$ at 3.0 times exchangeable Al. The supply of Ca to the soil reduced exchangeable Al and the combined

Table 1. Effect of lime in combinarion with gypsum on yield and nutrient uptake in soybean

Treatments	Yield, g plant^{-1}					Nutrient uptake, mg pot^{-1}				
	Dry weight of pod	Dry weight of root	Grain yield	Haulm yield	Total dry weight	N	P	K	Ca	Mg
T_0	1.55	0.50	0.60	1.38	3.63	51.1	12.1	36.2	44.7	27.9
T_1	4.23	0.83	2.40	2.40	7.46	151.2	34.6	72.1	105.1	39.0
T_2	3.78	0.90	2.08	2.53	7.21	135.3	26.0	85.7	111.9	55.7
T_3	2.68	0.63	1.53	2.60	5.91	114.6	24.5	73.6	88.3	42.6
T_4	3.88	0.80	2.18	3.45	8.13	149.5	39.6	106.4	114.7	53.1
SEm±	0.55	0.10	0.34	0.36	0.96	19.7	4.6	13.7	19.3	7.0
CD(0.05)	1.66	NS	1.03	1.09	2.88	59.6	13.8	41.3	NS	NS

Table 2. Effect of lime in combination with gypsum on acidity parameters and nutrient content of soil

Treatment	pH	cmol (+) kg^{-1}		Al saturation %	Total %		Available, kg ha^{-1}			cmol (+) kg^{-1}	
		CEC	Exch Al		Ca	Mg	N	P	K	Exch Ca	Exch Mg
T_0	5.40	5.20	0.975	17.68	0.425	0.400	88.2	9.80	225.4	2.80	0.98
T_1	5.68	6.95	0.475	6.98	0.425	0.300	181.2	8.03	212.8	4.33	1.75
T_2	5.90	8.53	0.175	2.05	0.575	0.225	127.2	6.88	194.6	6.63	1.26
T_3	5.40	6.23	0.775	12.08	0.400	0.300	151.7	6.85	219.8	4.13	0.95
T_4	5.45	7.58	0.400	5.20	0.350	0.300	162.2	7.08	210.0	5.00	1.70
SEm±	0.02	0.22	0.13	2.07	0.05	0.02	14.0	0.65	5.2	0.36	0.38
CD(0.05)	0.07	0.66	0.387	6.22	0.143	0.067	42.3	1.95	15.9	1.08	NS

application of lime and gypsum resulted in the reduction of Al at a lower depth also. Reduction of exchangeable Al in subsoil resulted in increased root proliferation. Kehoe and Curnow (1963) pointed out that improved uptake of P from limed soil may be due to improved ability of plants to take up P rather than to an improved rate of supply by the soil. Similar to N and P, the K uptake was significantly influenced by liming and maximum K uptake was recorded by the combination treatment of $CaCO_3$ + $CaSO_4.2H_2O$ at 3.0 times exchangeable Al content, though the available K was decreased by liming (Table 2). A high level of Al in the soil or in the plant is not likely to reduce K absorption and translocation in cowpea (Meena, 1987). In fact, low levels of Al have been reported to act as a stimulant for K absorption (Fageria and Carvalho, 1982). The Ca and Mg uptake showed an increasing trend though not significant, with increase in the rate of liming.

Soil acidity parameters

An increase in pH and effective CEC and a reduction in exchangeable Al and Al saturation have been observed as the most important and immediate effects consequent to liming (Table 2). The effect of liming to reduce exchangeable Al levels is an established fact. The present study has strengthened the view that complete neutralization of exchangeable Al is not a must in management of acid soils for achieving high yields.

Nutrient content of soil

The significant increase in total Ca by $CaCO_3$ at 3.0 rimes exchangeable Al (Table 2) may be due to an increased supply of Ca and neutralization of exchangeable Al to very low levels. The higher content of available N in the limed soil may be due to a better association between the macro and micro symbionts. This is evidenced by the higher nodulation of soybean in these treatments.

The available P in soil showed a significant decreasing trend with liming. It may be noted that although the difference in available P content of limed and nonlimed is significant, the decrease in available P following liming is marginal. Hence, the decrease in soil available P in the limed soil could be probably due to the increased uptake of P by the plant. As observed in the case of available phosphorus, the available K in soil also showed a definite decreasing trend with increase in the rate of liming. The increase in exchangeable Ca in the limed treatments may be due to the increased supply of added materials, $CaCO_3$ and/or gypsum. However, the exchangeable Mg in soil was not much affected by liming.

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