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EFFECT OF CALCIUM, MAGNESIUM AND SILICON ON SOIL REACTION AND NITROGEN AND PHOSPHORUS STATUS OF THE RED LOAM SOILS OF KERALA

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The soils of Kerala are of low productivity. The heavy rainfall depletes the soils of their important bases like calcium and magnesium and renders the soil acidic. Silica is also lost continuously due to heavy leaching and soil erosion. The importance of these elements in the nutrition of rice is well established. But how far these elements influence the soil acidity and availability of major plant nutrients either alone or in combination has not been tackled so far and the present studies were undertaken to understand this problem in relation to the red loam soils of Kerala.

Materials and Methods

The effect of calcium, magnesium and silicon singly and in combination, on the soil reaction and availability of nitrogen and phosphorus was studied in a pot culture trial in a 2" X 4 factorial randomised block design. An uncropped series of dummy pots with the same treatments under identical conditions were maintained for drawing periodical samples for chemical study. The soil used for the study was red loam containing 0.08 per cent total nitrogen, 0.16 per cent total P_2O_5 and 0.04 per cent available nitrogen and only traces of available P_2O_5. Calcium, magnesium and silicon were given at two levels of 0 and 2.5 metric tons of CaO, 0 and 100 kg of MgO and 0 and 25 kg of silicon/ha respectively.

Cattle manure at the rate of 12.5 metric tons/ha and NPK at the rate of 30 : 30 : 30 kg/ha as ammonium sulphate, superphosphate and muriate of potash respectively were applied uniformly in all the pots. The nutrients calcium, magnesium and silicon were applied as calcium oxide, magnesium carbonate and sodium silicate, a week prior to planting. The entire dose of superphosphate, muriate of potash and half the dose of ammonium sulphate were applied to each pot prior to planting. The other half of ammonium sulphate was applied a month before flowering. The pots were watered daily with measured quantity of well water.

Samples of soil from each treatment in the uncropped series of pots were drawn just before planting and thereafter at intervals of one month from the date of planting. The total nitrogen, available nitrogen,

total phosphorus, available phosphorus and soil pH were estimated. Total nitrogen was estimated by Kjeldahl's method and total phosphorus by phosphomolybdate method. Available nitrogen was estimated by alkaline permanganate method and available phosphorus by Dickman and Bray's method; pH measurements were made in a photovolt pH meter with glass electrodes using a 1: 2.5 soil water suspension.

Results and Discussion

The soil reaction recorded during the cropping period at monthly intervals for the various treatments is given in Table 1. It is seen that the soil pH for all the treatments receiving calcium were 1.0 to 1.5 units higher than that of the control. The lower buffering capacity of the red loam soil may be one of the reasons for the appreciable increase in pH, consequent on the application of lime. The results of the work carried out by Nambiar (1960) and Varghese (1963) on similar soils also confirm these findings. In the present study it is found that a combination of calcium and magnesium was better than calcium alone in raising the pH. This is in agreement with the results of Schmutt (1960) who found that neutralization of acid soils is better achieved when liming was carried out with dolomitic limestone rather than calcium compounds alone.

Table 1

pH of red loam soil under various treatments at different intervals of sampling

Intervals (monthly)	Control	Si	Mg	Mg+Si	Ca	Ga+Si	Ca+Mg	Ca+Mg+Si
(At the time ofplanting)	6.0	6.1	6.2	6.2	7.1	7.3	7,5	7,7
Second sample	5.9	5.9	6.1	6.2	6.6	7.0	6.7	7,2
Third sample	5.8	5.9	6.0	6.2	6.3	6.4	6.8	7,,0
Fourth sample (at the time of harvest)	5.8	6.0	6.0	6.1	6.5	69	7.0	7.0

Data on the available nitrogen and phosphorus status of the various treatments are presented in the Table 2. Normally in a soil, immobilisation and mineralisation of nitrogen take place simultaneously. The applied inorganic nitrogen is being continuously immobilised to organic form (Waksman, 1952) or is getting denitrified under water logged

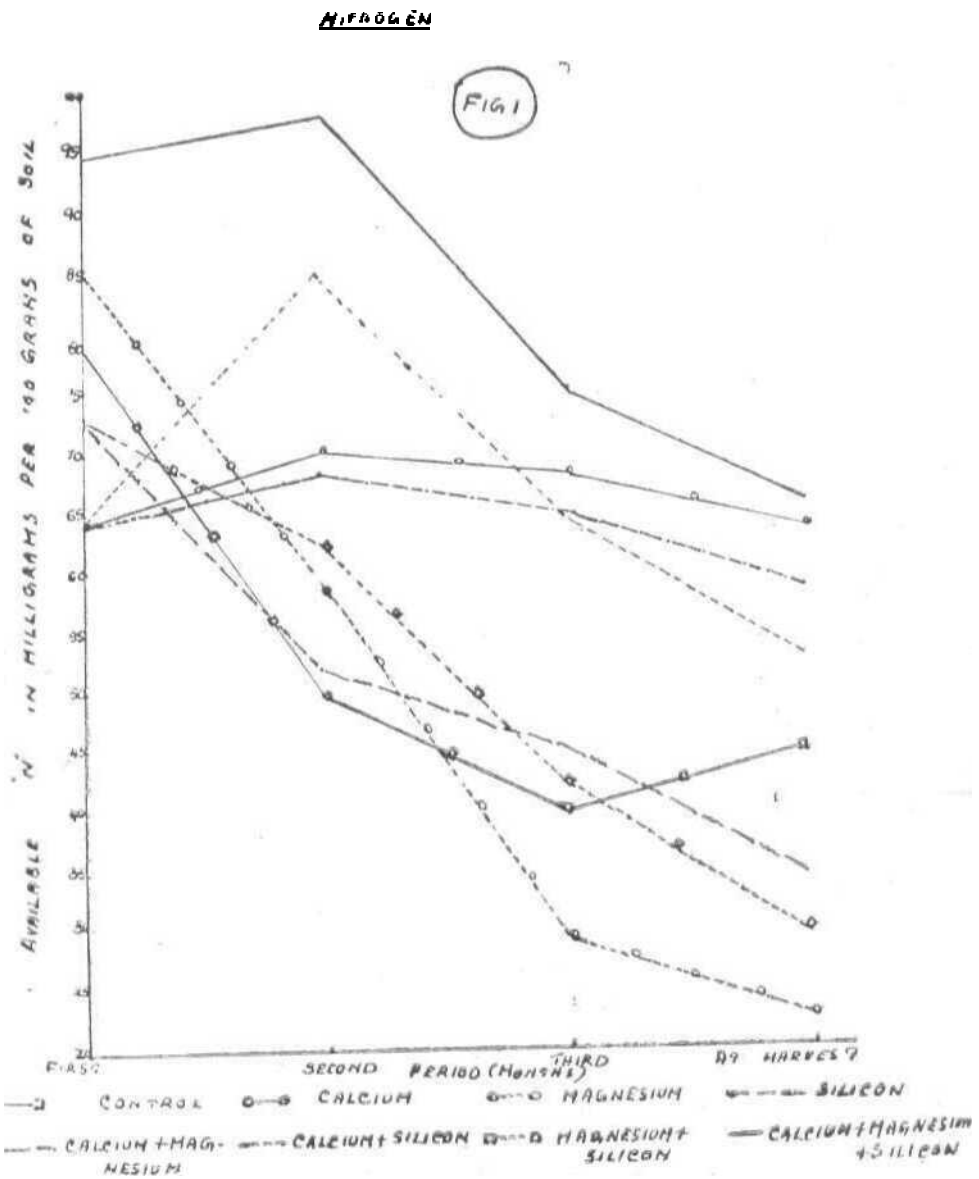
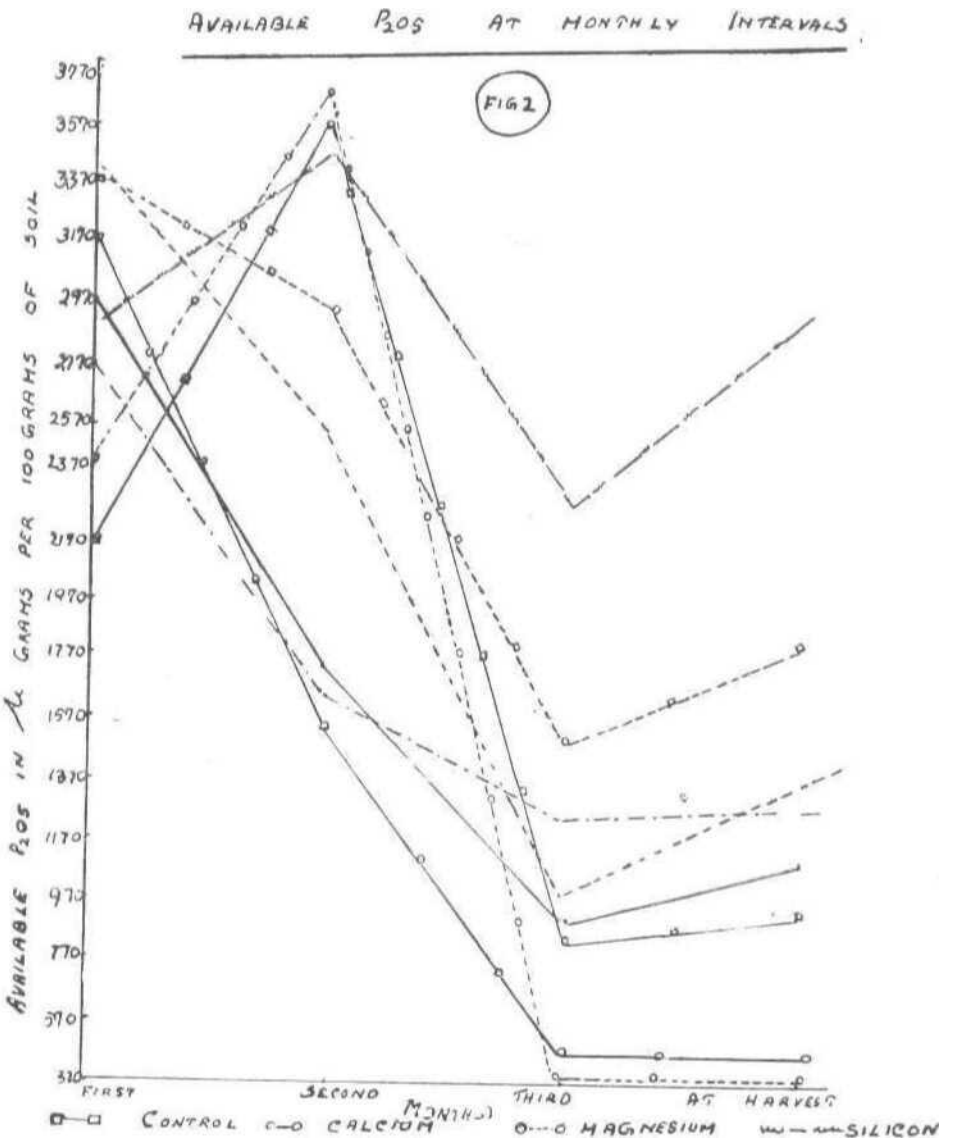

NITROGEN
FIG 1
AVAILABLE 'N' IN MILLIGRAMS PER 100 GRAMS OF SOIL
FIRST
SECOND
THIRD
PERIOD (MONTHS)
AT HARVEST
CONTROL
CALCIUM
MAGNESIUM
SILICON
CALCIUM + MAGNESIUM
CALCIUM + SILICON
MAGNESIUM + SILICON
CALCIUM + MAGNESIUM + SILICON

Table 2

Available nitrogen and phosphorus status of the soils in the various treatments at different stages during the cropping period (in milligrams per hundred grams soil on oven dry basis)

Treatments	First sample				Second sample				Third sample				Fourth sample			
	N				N				N				N			
Control	77.9	15.2	.00216	2.35	50.1	9.8	.00354	3.90	40.0	7.8	.00083	0.	45.0	8.7	.00092	0.99
Si	73.2	14.3	.00290	2.76	52.3	10.9	.00350	3.31	45.8	8.9	.00230	2.16	34.8	6.8	.00294	2.76
Mg	84.8	21.5	.00244	2.07	58.6	14.8	.00368	3.17	29.5	7.5	.00039	0.08	23.2	5.8	.00028	0.30
Mg+Si	73.3	206	.00340	4.87	62.3	17.4	.00294	4.23	43.5	12.2	.00151	1.64	31.0	8.7	.00183	1.90
Ca	64.0	21.6	.00322	3.73	70.1	23.6	.00156	1.79	68.0	22.8	.00046	0.52	63.2	14.3	.00041	0.47
Ca + Si	64.0	21.9	.00345	5.93	84.9	28.1	.00258	4.32	64.8	21.9	.00101	1.75	53.1	18.0	.00138	2.39
Ca+Mg	64.0	22.2	.00281	4.37	68.6	23.8	.00166	2.57	64.3	22.3	.00124	0.22	58.0	20.1	.00129	0.18
Ca+Mg+Si	94.1	30.8	.00300	4.51	97.2	28.2	.00175	2.02	74.8	24.2	.00092	1.06	65.3	21.1	.00104	1.27


AVAILABLE P2O5 AT MONTHLY INTERVALS
FIG 2
AVAILABLE P2O5 IN mg GRAMS PER 100 GRAMS OF SOIL
FIRST
SECOND
THIRD
AT HARVEST
MONTHS
CONTROL
CALCIUM
MAGNESIUM
SILICON

conditions (Abichandani and Patnaik, 1961). This may be the reason for the observed decrease in the available nitrogen status in all the treatments as observed in Fig. 1. Palfalvi (1958) studying the effect of different doses of lime in soil poor in calcium found that the application of lime progressively decreased organic matter and total nitrogen and increased the levels of mineral nitrogen. Abichandani afid Patnaik (1961) in their studies on soil nitrogen obtained double the rate in the mineralisation of organic nitrogen with 2000 lbs of lime within 15 days after application. The results from the present study show that the rate of decrease in the available nitrogen was less in those treatments which received lime. This may be due to the increased mineralisation of nitrogen which surpassed immobilisation and denitrification losses. The other two nutrients magnesium and silicon were found to be less effective in increasing the nitrogen status of red loam Foils.

It is also seen from Table 2 and Fig. 2 that silicon either alone or in combination with calcium or magnesium or both considerably increased the available phosphorus status of the soils. Votkevich (1936) observed an increase in the available phosphorus with increasing rates of silicon. Hosoda and Takata (1957) obtained a much higher increase in available soil phosphorus and P205 content of the plant with calcium silicate than with calcium carbonate. The observed increase in the available phosphorus status can be attributed to release of soil phosphorus or to decrease in the fixation of fertilizer phosphorus. Increase in soil pH in those treatments which included either calcium or magnesium may be another reason for the observed increase in the available P_2O_5. Truog (1948) claimed that liming increased the availability of the added phosphates by reducing its fixation by soluble iron and aluminium. A combination of all these factors is probably operative in the increased availability of phosphates in the treatments which included calcium, magnesium and silicon. The progressive decrease in the available P2O5 noticed during the cropping period may pe attributed to reicrobial fixation of available phosphorus.

Summary and Conclusion

Liming red loam soils of Kerala at the rate of 2.5 metric tons/ha of CaO raised the soil pH by 1 to 1.5 units. Liming with calcium oxide and magnesium carbonate was more effective than GaO alone. Availability of nitrogen in the soil was increased by the application of calcium or magnesium or both. Availability of P_2O_5 was increased by the application of silicon either alone or in combination with calcium or magnesium or both.

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