Influence of Calcium and Magnesium in Increasing the Efficiency of Fertilisers for Rice in Kerala

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In some of the rice soils of Kerala crop response to fertiliser application is often disappointing. This may be due to several causes as response to fertilisers is a complex phenomenon. It has, however, been observed that when lime is applied in conjunction with fertilisers crop response is better, indicating a greater utilization of the added fertilisers. Work carried out in other countries has clearly shown that fertiliser efficiency can be significantly increased by the application of lime. As the great majority of the rice soils of Kerala are seriously deficient in lime, the overriding cause for poor crop response to fertilisers is obviously the lack of an adequate amount of calcium and magnesium in the soil. Thus there appears to be great scope for increasing our rice yields by the application of lime in conjunction with N P K fertilisers. As very little experimental evidence is now available on this important aspect of fertiliser use, the present study was undertaken to determine whether the application of calcium and magnesium would increase the efficiency of added fertilisers in the rice soils of Kerala.

Review of Literature

Numerous workers have studied the influence of Calcium compounds on soil reaction, nutrient availability and plant growth. Truog (1918), Albrecht (1932), Schmitt (1950) and Hutchings (1938) attributed the beneficial role of calcium in crop production to its effect in reducing soil acidity. Sauchelli (1950) and Aslander (1952) stated that it was a lack of nutrients and not an acid reaction that made most soils unproductive. Davis & Brewer (1940) Dunn (1943), Beater (1945), Smith and Hester (1948) and Robertson *et al* (1954) showed that calcium application increased the availability of phosphorus. The influence of lime on potassium availability has been studied by Ehrenberg (1919). He atributed the decreased uptake of potassium and low yields on limed soils to an "antagonistic effect" between calcium and potassium. York and Rogers (1947) concluded that it would be extremely difficult to make generalisations regarding the influence of lime on the availability of potassium in the soil because it was dependent upon the

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nature of soil and many other factors. Contradictory observations have been reported in literature on the role of lime in increasing crop yields. Subramonium, and Varadarajan (1057), Neischlag *et al* (1956) and Coleman (1955) observed that liming increased the yield of crops. On the other hand, according to Pierre *et al* (1935) and Mandal *et al* (1955) liming resulted in depression in crop yields.

The specific functions of magnesium within the plant and on soil properties are not yet fully established. Pryanishnikov (1930) assumed the existence of an antagonism between magnesium and hydrogen ions and consequently, application of magnesium salts will have a favourable effect on acid soils. Loew (1903), Truog (1947) and Enzmann (1956) have suggested that greater attention should be given to supplies of available magnesium in order that the phosphorus present in the soil might be utilised more effectively. Albrecht (1937) and Graham (1928) showed that magnesium increased biological fixation of nitrogen to a much greater degree than equivalent amounts of calcium compounds. Russel and Garner (1941), Neischlag (1959) and Jacobson *et al* (1947) observed that magnesium fertilisers contributed to an increase in the yield of crops

Materials and Methods

The influence of calcium and magnesium on the growth characteristics of rice was studied in a pot culture experiment of 2^3 x4 factorial randomised block design. The factors studied were Fertiliser., (0 & 40: 40: 40) Calcium (0 and 1000 lbs. CaO/ acre) and Magnesium (0 and 1000 lbs. Mgo/ acre) A basal dressing of organic manures at the rate of 1000 lbs/ acre was given. The soil used was Vellayani sandy clay loam and the rice variety grown was P. T. B. 12 of 125 days' duration.

Soil samples were drawn at regular intervals to determine the changes in p^H and available phosphorus and potassium.

Plant performance studies were also carried out to determine the effect of different treatments on the growth and yield of grain. After the harvest the plant materials were analysed for chemical composition.

Results

A. *Soil studies*

The data in Table I give the variation in the p^H and available phosphorus and

TABLE I

Effect of calcium and magnesium treatments on soil reaction and the availability of phosphorus and potassium

Treatment	Initial p^H	p^H after 3 weeks	p^H after 6 weeks	Available P_2O_5 Initial %	Available P_2O_5 After 4 weeks %	Available K_2O Initial %	Available K_2O After 4 weeks %
1. Control	6.0	6.38	6.38	0.0003	0.0006	0.0012	0.0032
2. Ca	Do.	6.38	6.50	Do.	0.0007	Do.	0.0032
3, Mg	Do.	6.50	6.53	Do.	0.0010	Do.	0.0046
4. Ca + Mg	Do.	6.45	6 53	Do.	0 0011	Do.	0.0038
5. N P K	Do,	6.38	6.37	Do.	0.0021	Do.	0.0053
6. N P K + Ca	Do.	6.58	6.58	Do.	0.0025	Do.	0·0063
7. N P K 4 Mg	Do.	6 53	6.53	Do.	0.0026	Do.	0.0058
8. N P K + Ca + Mg.	Do.	6.65	6.70	Do.	0.0026	Do,	0.0056

potassium. It is observed that the soil reaction is markedly increased by the combined application of calcium and magnesium. It is also noted that, the availability of phospnorus and potassium was favourably influenced by the application of calcium and magnesium compounds.

B. *Plant performance studies*

Data relating to the effect of calcium and magnesium on the growth and yield characers of rice are given in Table II. It is to be noted that the yield of filled grains was maximum for the treatment in which calcium and magnesium were used along with fertilisers. The next highest yield was obtained by the treatment in which fertilisers were applied in conjunction with calcium. Statistical analysis shows that the effect of treatment is highly significant at the 0.05 and 0.01 levels Separate analysis indicates that the effect of fertiliser, calcium and magnesium are significant at the above levels. It was also observed that calcium and magnesium applications increased the tillering of plants and there by contributed to better yield. The ratio of number of grain to chaff indicates that magnesium applied alone or in combination with calcium had a beneficial effect in reducing this ratio.

TABLE II

Effect of calcium and magnesium on the growth and yield characters of rice

Treatment	Number of tillers per plant	Length of earhead cms	Number of grains per ear head	Ratio of number of grains to chaff	Weight of filled grains g per pot	Weight of straw g per pot
1. Control	11	19.7	76	1.60	10.4	21.2
2. Ca	10	20.3	88	3.40	11.6	23.7
3. Mg	10	20.2	84	3.55	11.8	22.5
4. Ca + Mg	12	21.4	98	3.62	14.8	23.3
5. N P K	17	21.5	98	2.63	17.3	34.1
6. N P K + Ca	18	21.5	93	3.05	20,3	36.4
7. N P K + Mg	17	21.1	93	3.40	19.0	35.6
8. N P K + Ca + Mg	19	21.7	103	3.60	20.6	35,8

C. *Chemical composition of grain*

From Table III it may be seen that the nitrogen content of grain was maximum due to the application of calcium and magnesium. Magnesium application resulted in greater absorption of phosphorus by plants. The potassium content of grains tended to decrease due to application of calcium. The depressing effect of magnesium on potassium uptake was not as high as that of calcium.

TABLE III

Effect of calcium and magnesium on nutrient recovery by rice

Treatment	N mg/Pot	P_2O_5 mg./pot	K_2O mg./Pot	CaO mg./Pot	MgO mg./Pot
1. Control	141	44.1	20.1	11.4	10.5
2. Ca	164	56·1	23.9	22.8	15.9
3. Mg	163	59.6	25.4	13.9	23.5
4. Ca + Mg	210	78.7	28.4	20.9	20.1
5. N P K	266	123.0	75.4	36.7	18.2
6. N P K + Ca	318	163.4	68.0	54.4	23.9
7. N P K + Mg	296	158.6	69.4	38.7	41.1
8. N P K + Ca + Mg	324	164.4	70.5	47·3	32.6

The content of these three cations in the plant material was found to be dependent on one another. Magnesium was found to be the dominant cation in the grain and calcium in straw. An increase in the percentage of one cation was found to be associated with a decrease in the percentage of the other two.

Discussion

The beneficial effects of the application of calcium and magnesium in correcting soil acidity and increasing the growth and yield of rice are revealed by the data obtained. There was a significant increase in the p^H of soils treated with both calcium and magnesium. Better growth of plants at higher p^H may be attributed to greater availability of nutrients from the added fertiliser and from the soil. The effect of liming in reducing the toxic concentrations of certain cations like iron, aluminium and manganese may also be responsible for the better growth of plants in limed soils. According to Arnon and Johnson (1942) the availability of most plant nutrients will be a maximum in the p^H range 6.0 to 7.0. This finding is corroborated by the results of the present study.

The effect of calcium and magnesium in increasing the yield of rice seems to be partly due to their direct nutrient effect and partly to their influence in correcting soil acidity and increasing the availability of other nutrients. The effect of fertiliser on yield was highly significant indicating clearly that crop yields can be increased considerably by the judicious application of fertilisers. The data also show that fertiliser efficiency can be increased by the application of calcium and magnesium in conjunction with the fertilisers.

The yield figures correlated positively with the level of nutrients in the plant material. The increase in the phosphorus content of plants from the magnesium treated pots was very significant. This critical role of magnesium in increasing the utilisation of soil phosphorus deserves special emphasis. Truog *et al* (1947) obtained similar results and they confirmed the theory that magnesium functions as a "carrier" for phosphorus. This would explain the superiority of dolomite as a liming material, over other forms of lime which supply only calcium.

When considered independently, the effect of calcium appeared to be superior to that of magnesium in certain respects, like the yield of grain and the content of protein. But magnesium proved to be more effective in increasing the ratio of grain to chaff and also in the better utilisation of phosphorus by plants.

Summary

A pot experiment to study the influence of calcium and magnesium in increasing the efficiency of fertilisers applied to rice was carried out. Samples of soil and plant material were analysed for their nutrient contents. The chief findings were as follows:

Significant increase in soil p^H and available phosphorus was observed consequent on the application of calcium and magnesium compounds. Calcium tended to increase available K_2O in the soil. Significant yield responses to application of fertilisers (40: 40: 40) along with calcium and magnesium were obtained. Calcium increased the nitrogen content of grains whereas magnesium increased the ratio of grain to chaff. The P_2O_5 content in grain was a maximum for the magnesium applied plants.

The results of the present study underline the importance of including calcium and magnesium in any riianurial schedule for rice in Kerala.

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