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EFFECT OF CALCIUM MAGNESIUM AND SILICON ON THE UPTAKE OF PLANT NUTRIENTS AND QUALITY OF STRAW AND GRAIN OF PADDY*

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Heavy rainfall characteristic of tropical climate and intensive cultivation depleted the soils of Kerala of many important plant nutrients and as a result crops grown in such soils showed symptoms of deficiency for many of these nutrients. Crop response to nitrogenous, phosphatic and potassic fertilizers was good in the early years of their wide spread use, But the response to these fertilizers in some areas has not been very encouraging in recent years. Thus a situation has arisen where NPK fertilization alone can no longer maximise the yield of paddy obtained from these soils. In the present investigation an attempt has been made to study the effect of calcium, magnesium ani silicon on the uptake of nutrients by the paddy crop and also to ascertain how the above nutrients influence the quality of straw and grain of paddy.

Materials and Methods

A pot culture experiment was conducted in a 2^3 X 4 factorial randomised block design. The soil used was red loam containing 0.08% N, 0.04% available nitrogen, 0.16% total P_2O_5, traces of available P_2O_5, 0 10% total K_2O, 0.28% CaO, 0.09% MgO and 2.01% soluble silica. The pH of the soil was 6. Calcium, magnesium and silicon were given at two levels of 0 and 2 5 metric ton GaO as calcium oxide, 100 kg of MgO as magnesium carbonate and, 0 and 25 kg of silicon as sodium silicate/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. Cattle manure and the nutrients Ca, Mg and Si were applied a week prior to planting. Half the dose of ammonium sulphate and the entire dose of superphosphate and muriate of potash were applied just before planting. The other half of ammonium sulphate was applied just before flowering. Twenty day old seedlings were transplanted at the rate of 6 seedlings

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per pot and later on thinned to three seedlings. The pots were watered daily with measured quantity of well water. The unhusked grain and straw from each pot were separately analysed for nitrogen, phosphorus, potassium, calcium, magnesium and silicon by standard methods (Piper, 1950 & Jackson, 1958).

Results and Discussion

The percentage composition of grain and straw are given in Tables 1 and 2 respectively. It is seen from the results that treatments receiving Mg alone, Ca alone and Ca + Si increased the percentage of nitrogen in grain and straw compared to the control. The crude protein content of grain and straw was taken as an index for their quality and are recorded in Table 3. Crude protein was found to be higher in treatments with calcium or magnesium either alone or in combination. The favourable influence of calcium in increasing the nitrogen uptake was reported by Coleman (1955) and Bhat (1964). This may be attributed to the increased mineralization of organic nitrogen in the presence of calcium and subsequent release of the available nitrogen Sadapal and Das (1961) obtained increased protein content of grain due to magnesium application. Mg may release Ga for the mineralization of organic matter or it may by itself favourably increase the pH for the microbial release of organic nitrogen. Silicon is found to reduce the nitrogen uptake. Wagava and Kenichi Kashima (1963) observed that when Si was applied, the percentage of nitrogen in every part of the rice plant was decreased. When silicon was combined with calcium or magnesium or both, the capacity of these nutrients for increasing the nitrogen uptake is reduced. This is true both in the case of straw and grain.

In the present study, silicon either alone or in combination with calcium or magnesium or both is found to increase the P_2O_5 content of grain as well as straw. Ganssman (1962) obtained increased P_2O_5 content in various cereals by the application of silicon. The increased uptake of P_2O_5 may either be due to the increased release of soil phosphorus or decreased fixation of fertilizer phosphorus by silicon. Akhramako (1934) attributed this to the formation of SiO2 — P2()5 absorption complex which was more easily absorbed by the plants than the phosphate ion, A combination of calcium and magnesium with silicon is found to be better than silicon alone in increasing the P205 availability. This may be due to the additive function of both the nutrients This is collaborated by the findings of Schollenburger (1922). . Magnesium either alone or in combination with silicon or calcium also increased the P_2O_5 content of grain and straw. The beneficial influence of magnesium on phosphorus uptake may be due to its effect in increasing the soil pH. An increase in P_2O_5

Table 1

Percentage composition of grain (Percentage on oven dry basis)

Treatments	Nitrogen (N)	Phosphorus (P_2O_5)	Potash (K_2O)	Calcium (CaO)	Magnesium (MgO)	Silicon (SiO_2)
1. Control	1.75	0.657	0.28	0.072	0.081	3 00
2. Si	1.65	0.664	0.34	0.143	0 230	5.51
3. Mg	230	0 791	0.38	0.125	0.355	4.00
4. Mg + Si	1.80	0.839	0.41	0.143	0.226	2.74
5. Ga	1.96	0.662	0.29	0.272	0.135	3 20
6. Ca + Si	1.93	0.802	0.31	0.179	0 214	3.80
7. Ga + Mg	1.88	0.694	0.33	0.250	0.386-	3.22
8. Ca + Mg + Si	1.58	0.630	0.40	0.288	0.294	3.40

Table 2

Percentage composition of straw (Percentage on oven dry basis)

Treatments	Nitrogen (N)	Phosphorus (P_2O_5)	Potash (K_2O)	Calcium (CaO)	Magnesium (MgO)	Silicon (SiO_2)
1. Control	0.664	0.126	1.69	0.250	0.245	7.7
2. Si	0.588	0.135	2.06	0.200	0.221	11.4
3. Mg	0.692	0.170	1.84	0.357	0.396	8.4
4. Mg + Si	0.682	0.207	1.95	0.350	0.321	10.3
5. Ca	0.798	0.190	1.75	0 250	0.345	7.9
6. Ca + Si	0.617	0.260	1 89	0.180	0.357	12.2
7. Ca + Mg	0.680	0.302	1 42	0.750	0.427	10 5
8. Ca + Mg + Si	0.518	0.260	1.87	0.357	0.328	11.9

Table 3

Nutrient Recovery (Milligrams per pot)

Treatments	N	P_2O_5	K_2O	CaO	MgO	SiO_2
1. Control	175.0	56.8	142.8	23.4	38.1	775.8
2. Si	231.6	82.7	248.4	35.5	46.7	1150.2
3. Mg	344.1	110.5	255.3	55.4	86.9	1426.0
4. Mg + Si	424.4	178.9	403.6	84.3	93.5	2221.3
5. Ca	368.2	113.7	272.3	203.2	64.1	1481.9
6. Ca + Si	342.6	142.8	295.9	182.8	76.8	2152.0
7. Ca + Mg	303.4	113.0	207.4	118.5	95.6	1625.8
8. Ca+ Mg + Si	252.8	107.3	273.5	77.7	75.0	1843.9

Table 4

Crude protein content of grain and straw (Percentage on oven dry basis)

Treatments	Grain	Straw
1. Control	8.90	3.90
2. Si	9.89	2.51
3, Mg	11.47	4.47
4. Mg + Si	9.04	3.25
5. Ca	11.62	4.22
6. Ca + Si	9.42	3.205
7. Ca + Mg	11.10	3.96
8. Ca + Mg + Si	9.4	3.43
Significance	*	N.S
S.E.M.	1.66	
C. D.	1.893	–
Conclusion	5,3,7,2	
	2,6,8,4,1	
	7,2,6,8,4	

* Significant at 5% level

N. S. Not significant.

content of both grain and straw by magnesium fertilization is reported by Varghese (1963). Percentage of potash in the grain and straw was maximum in those treatments which included silicon. Takyman *et al* (1959) noticed an increase in the uptake of potassium by the application of silicon.

Calcium content of the straw and grain was maximum in the treatments where calcium alone was given. The treatments Ca + Si and Ga 4 Mg also increased the Ga content of the grain, though not to the same extent as Ca alone. The above results are in agreement with the findings of Deguchii (1960). The Ca content in both the grain and straw in the treatment Ga + Si is less than that in the treatment receiving Ca alone. Wagawa and Kew-ichi Kashima (1963 in a detailed study on silicon nutrition observed that the Ca content was decreased in the earheads, leaf blades and stalks by silicon.

The treatment Ca + Mg recorded higher MgO content in the grain and straw than Mg alone. In the case of grain, it is 8.8 per cent in the case of straw it is 7.8 per cent over that of the treatment Mg alone. Similar observations have been recorded by Eiseumenger *et al* (1939).

The Si content was found to be increased by soil application of soluble silicon, both in the grain and straw. Similar observations were made by Okamoto (1957). The uptake of silicon was found to be depressed when it is combined with calcium or magnesium. This is in agreement with the findings of Kobayashi *et al* (1956) who observed a reduced absorption of silicic acid by liming. This may be attributed to the fact that soluble silica is rendered insoluble by lime.

Summary and Conclusion

The quality of grain and straw as indicated by their protein content is markedly increased by the application of soil amendments like calcium oxide or magnesium carbonate. The phosphorus and potassium content of the grain and straw are increased by applying silicon either alone or in combination with calcium or magnesium. Application of soluble silicon increases the total silicon content of the plant. Calcium and magnesium content of the plant increases with the soil application of the above nutrients. Availability of Ca decreases when it is combined with silicon.

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