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THE EFFECT OF ZINC IN COMBINATION WITH LIME ON THE COMPOSITION OF AND ABSORPTION OF NUTRIENTS BY RICE

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The role of zinc in the nutrition of rice has received widespread attention in recent years after Nene (1965) showed that the *Khaira* disease of paddy is due to the deficiency of this element. The investigations carried out by Varughese (1971), Valsaji (1972) and Praseedom and Koshy (1975) have shown that in many Kerala soils the status of zinc may be marginal. As the soils of Kerala are generally acid in reaction liming has become a regular practice in the major paddy growing tracts of the State. Since the liming of acid soils may reduce the availability of native zinc in soils the application of this nutrient along with lime may be necessary to ensure adequate supplies of zinc to crops. Hence the present study was undertaken to find out the effect of applying zinc along with lime on the composition of and nutrient uptake by rice.

Materials and Methods

The soils used in this study was a sandy clay (Tropaquept) collected from the Vellayani Kayal area. Its pH was 4.3 with a lime requirement of 2000 kg $CaCO_3$/ha. It contained 0.11% N, 0.02% P_2O_5, 0.36% K_2O, 0.10% CaO, 0.13% MgO and 4.2 ppm. available Zinc. The liming material used contained 43% CaO. Zinc was applied in the form of zinc sulphate, $ZnSO_4$ $7H_2O$.

Using the above materials a pot culture experiment was carried out during the Virippu season of 1974. Four rates of lime (0, 250 500 and 1000 kg $CaCO_3$/ha) and four rates of zinc (0, 10, 20 and 40 kg zinc sulphate per ha were used in this experiment in a randomized block design with three replications. The soil was air dried and ground and 10 kg portions were taken in earthenware pots of uniform size, 25 cm x 38 cm. Lime at the specified rates was added into each pot and mixed well with the soil. The soils in the pots were puddled by adding sufficient water. N, P_2O_5 and K_2O were then added to each pot at the rate of 35 kg/ha in the form of urea, superphosphate and muriate of potash. Zinc sulphate was added at the specified rates in aqueous solution. Twenty day old seedlings of rice variety *Annapoorna* were planted in each pot on 26-6-1974 at the rate of 3 plants per pot. An additional dose of N at 35 kg/ha was applied on the 20th day after planting as per the package of practices. The pH of the treated soils was noted in the wet and air-dried samples on the 20th day as well as after harvest. Irrigation was given using tap water at the optimum rate. The crop was harvested on

17-9-1974. The grain and straw from each pot were dried in an air oven a 70°C and their weights recorded separately. The straw was ground in ant electric grinding mill. The samples of grain and straw were then analysed following standard analytical procedures. Nitrogen was estimated by the micro Kjeldahl method as given by Jackson (1967). For the estimation of P, K, Ca, Mg and Zn triple acid digestion as suggested by Piper (1950) was followed. P was estimated by the Vanadophosphomolybdate method using a Klett Summerson Photoelectric Colorimeter. Postassium was estimated using an EEL Flame photometer. Calcium and magnesium were determined by the versenate method as described by Jackson (1967). Zinc was estimated in the straw only by the dithionite method as described by Black (1965). Samples of grain and straw were analysed for all constituents except zinc in all the replications and the data statistically analysed. Zinc was estimated only in the composite straw samples.

Results and Discussion

The variation in the pH of the soil as a result of liming is given in Table 1. The data pertaining to the composition of grain and straw for the various treatments of zinc and lime are presented in Tables 2 and 3 and the uptake of nutrients per pot in Table 4.

Variation in Soil pH:- From Table 1 it may be seen that the treatment with lime has raised the pH of the air dried soil from 4.3 to the level of 4.6—4.7 in the course of 20 days. But this value has again fallen to 4.3—4.4 by the time of the harvest. The pH of the wet *soil is found to be slightly higher* than the pH after air-drying. The results indicate that consistent increase in pH cannot be attained under field conditions by liming.

Composition of grain:- The nitrogen content of grain is influenced significantly by the application of zinc and lime. As the level of zinc application increased from 0 to 10, 20 and 40 kg/ha the nitrogen content of grain increased steadily from 1.54 per cent to 1.58 per cent, 1.60 and 1.67 per cent respectively. Lime, on the other hand, had a slightly depressing effect on the nitrogen content of the grain. As the level of lime application is increased from 250 Kg/ha to 500 Kg/ha and 1000 Kg/ha the nitrogen content of the grain is decreased from 1.69 per cent to 1.54 per cent and 1.47 per cent respectively.

The effect of zinc and lime on the phosphorus content of grain is also found to be significant. With increasing levels of zinc application there is a slight decrease in the P_2O_5 content of the grain. But with increasing applications of lime the tendency for the phosphorus content of the grain is also to increase. As the lime applied is increased from 0 to 250 and 500 Kg/ha the P_2O_5 content of the grain increases from 0.34 to 0.37 and 0.41 per cent respectively. But at 1000 Kg/ha of lime application the P_2O_5 content of the grain is again lowered to 0.38 per cent.

Table 1 Effect of different levels of lime and zinc on the pH of the soil (Original pH of air dried soil 4.3)

Treatment		Date of collection of soil			
		20th day after planting		After harvest	
$CaCo_3$ kg/ha.	Zinc sulphate kg/ha	pH immediately after collection (Wet)	pH after air drying	pH immediately after collection (Wet)	pH after air drying
0	0	5.2	4.7	4.3	4.2
	10	4.9	4.4	4.1	4.2
	20	5.5	4.6	4.2	4.0
	40	5.1	4.6	4.4	4.3
	Mean	5.2	4.6	4.3	4.2
250	0	5.4	4.5	4.4	4.3
	10	5.7	4.8	4.3	4.4
	20	5.2	4.4	4.2	4.1
	40	5.2	4.9	4.4	4.4
	Mean	5.6	4.7	4.3	4.3
500	0	5.3	4.5	4.5	4.3
	10	5.4	4.7	4.3	4.2
	20	5.6	4.7	4.4	4.4
	40	5.4	4.5	4.4	4.1
	Mean	5.4	4.6	4.4	4.3
1000	0	5.7	4.3	4.7	4.5
	10	5.0	4.6	4.5	4.3
	20	5.1	4.7	4.4	4.2
	40	5.5	4.8	4.5	4.4
	Mean	5.3	4.7	4.5	4.4
All levels	0	5.4	4.6	4.5	4.3
	10	5.3	4.6	4.3	4.3
	20	5.4	4.6	4.3	4.2
	40	5.5	4.7	4.4	4.3

Table 2 Effect of different levels of lime and zinc on the composition of rice grain, variety Annapoorna

Treatment			Composition of grain (per cent)				
CaCo, kg/ha	Zinc sulphate kg/ha	Wt. of grain g/pot	N	P_2O_5	K_2O	CaO	MgO
0	0	45.7	1.56	0.33	0.20	0.13	0.06
	10	38.6	1.69	0.37	0.22	0.11	0.09
	20	33.7	1.66	0.34	0.22	0.11	0.09
	40	42.7	1.71	0.31	0.22	0.14	0.07
	Mean	40.2	1.65	0.34	0.22	0.12	0.07
250	0	43.3	1.67	0.36	0.20	0.18	0.07
	10	45.8	1.71	0.35	0.23	0.14	0.08
	20	34.1	1.66	0.37	0.21	0.13	0.07
	40	26.9	1.73	0.39	0.23	0.12	0.09
	Mean	37.5	1.69	0.37	0.22	0.14	0.08
500	0	41.4	1.55	0.39	0.19	0.12	0.09
	10	43.7	1.49	0.41	0.21	0.18	0.07
	20	41.3	1.53	0.39	0.20	0.12	0.08
	40	41.8	1.61	0.43	0.23	0.12	0.09
	Mean	42.1	1.54	0.41	0.21	0.13	0.08
1000	0	39.5	1.39	0.45	0.23	0.12	0.10
	10	39.7	1.43	0.41	0.28	0.19	0.05
	20	40.8	1.56	0.35	0.20	0.12	0.08
	40	51.7	1.53	0.32	0.18	0.13	0.08
	Mean	42.9	1.47	0.38	0.22	0.14	0.08
All levels	0	42.5	1.54	0.38	0.21	0.14	0.08
	10	42.0	1.58	0.39	0.23	0.15	0.07
	20	37.5	1.60	0.36	0.22	0.12	0.08
	40	40.8	1.67	0.36	0.22	0.13	0.08
CD for comparison between levels of lime/zinc at 0.05 level		NS	0.07	0.03	NS	NS	NS
CD for comparison between combination of zinc and lime at 0.05 level		NS	0.15	0.07	NS	NS	0.02

Table 3 Effect of different levels of lime and zinc on the composition of rice straw, variety Annnapoorna

Treatments		Composition of straw						
$CaCo_3$ kg/ha	Zinc sulphate kg/ha	Wt. of straw g/pot	N %	P_2O_5 %	K_2O %	CaO %	MgO %	Zn %
0	0	40.1	1.22	0.14	1.67	0.52	0.35	52.4
	10	52.3	1.63	0.14	1.38	0.50	0.42	48.0
	20	33.6	1.23	0.10	1.62	0.45	0.34	59.0
	40	47.7	1.29	0.11	1.43	0.65	0.33	63.7
	Mean	43.4	1.34	0.12	1.52	0.53	0.36	35.2
250	0	39.7	1.22	0.10	1.67	0.65	0.42	46.0
	10	46.0	1.28	0.13	1 87	0.59	0.37	49.0
	20	40.0	1.22	0.14	1.37	0.67	0.39	55.3
	40	32.0	1.29	0.18	1.56	0.74	0.28	51.8
	Mean	39.4	1.25	0.14	1.62	0.66	0.36	50.5
500	0	40.9	1.22	0.22	1.28	0.56	0.41	51.8
	10	45.3	1.05	0.11	1.33	0.64	0.33	53.5
	20	47.3	1.29	0.16	1.29	0.67	0.43	39.7
	40	39.7	1.29	0.18	1.53	0.54	0.33	52.3
	Mean	43.2	1.21	0.17	1.36	0.60	0.37	49.3
1000	0	40.0	1.34	0.12	1.51	0.57	0.35	40.8
	10	41.3	1.17	0.17	1.47	0.95	0.45	41.8
	20	42.0	1.17	0.15	1.44	0.47	0.31	43.8
	40	40.0	1.23	0.14	1.81	0.76	0.42	45.5
	Mean	40.8	1.23	0.15	1.56	069	0.38	42.9
All levels	0	40.1	1.25	0.15	1.53	0.57	0.38	47.8
	10	46.2	1.28	0.14	1.51	0.67	0.39	48.1
	20	40.7	1.23	0.14	1.43	0.57	0.37	49.3
	40	39.9	1.28	0.15	1.58	0.68	0.34	53.3
C D for comparison between levels of zinc/lime at 0.05 level		NS	NS	NS	0.19	NS	NS	—
C D for comparison between combination of zinc and lime at 0.05 level		N S	0.22	NS	0.37	NS	NS	—

Table 4 Effect of different levels of lime and zinc on the uptake of nutrients by rice, variety Annapoorna

Treatment		Uptake of nutrients g/pot				
$CaCO_3$ kg/ha	Zinc sulphate kg/ha	N	P_2O_5	K_2O	CaO	MgO
0	0	1.16	0.19	0.80	0.28	0.17
	10	1.18	0.21	0.77	0.32	0.25
	20	0.97	0.14	0.62	0.18	0.14
	40	1.31	0.18	0.74	0.37	0.18
	Mean	1.15	0.18	0.73	0.29	0.19
250	0	1.20	0.20	0.79	0.33	0.20
	10	1.37	0.21	0.95	0.37	0.20
	20	0.99	0.18	0.60	0.32	0.18
	40	0.86	0.15	0.55	0.25	0.11
	Mean	1.10	0.19	0.72	0.32	0.17
500	0	1.12	0.25	0.59	0.29	0.10
	10	1.14	0.22	0.77	0.37	0.18
	20	1.20	0.24	0.68	0.37	0.23
	40	1.15	0.25	0.70	0.28	0.17
	Mean	1.13	0.24	0.69	0.33	0.17
1000	0	1.11	0.23	0.73	0.28	0.18
	10	1.05	0.23	0.69	0.46	0.20
	20	1.12	0.19	0.66	0.25	0.16
	40	1.28	0.25	0.81	0.37	0.20
	Mean	1.14	0.22	0.72	0.34	0.18
All levels	0	1.15	0.22	0.73	0.29	0.16
	10	1.16	9.22	0.80	0.38	0.21
	20	1.07	0.:9	0.64	0.28	0.18
	40	1.15	0.21	0.70	0.31	0.17
C D for comparison between levels of zinc/lime at 0.05 level		NS	0.03	NS	NS	NS
C D for comparison between combination of zinc and lime at 0.95 level		0.29	0.07	NS	NS	NS

The effect of the various treatments on the levels of potassium, calcium and magnesium in the grain were not found to be significant.

Composition of straw:- As in the case of the grain, the nitrogen content of straw showed a tendency to decrease with increasing levels of lime applied. For zero application of lime the nitrogen cement of the straw was 1.34 per cent which decreased to 1.25, 1.21 and 1 23 per cent respectively for lime application of 250, 500 and 1000 Kg/ha. The effect of zinc on the nitrogen content of the straw was not consistent.

The effect of treatments on the P content of the straw was non-significant, The potassium content was, however, influenced significantly by application of zinc and lime. The levels of calcium and magnesium were also not influenced significantly by applications of lime and zinc, The zinc content Of straw increased steadily from 47.8 to 53 3 ppm as the rate of application of zinc sulphate was increased from 0 to 40 Kg/ha. Lime, on the other hand, has an antagonistic effect on the zinc content of straw. Thus, as the level of lime application increased from 0 to 250, 500 and 1000 Kg/ha the level of zinc decreased from 55.2 to 50.5, 49.3 and 42.9 ppm respectively.

Uptake of nutrients:- The total quantities of the various nutrients removed from one pot by the grain and straw are given in Table 3. There was significant variation only in the case of nitrogen and phosphorus, whereas in the case of the other nutrients the effect of treatment on the total quantities removed per pot was found to be non-significant.

The most notable effect in the present study has been that of zinc in increasing the nitrogen content of grain. An increase in the nitrogen content of the grain means an increase in the protein content and therefore also a higher nutritive value.

It is to be noted that the application of lime at the rates used in this study has not raised the pH to such a level as to result in a deficiency of zinc. The availability of zinc is known to be suppressed as soil reaction is raised from an extremely acid range to a pH of about 6.0. But in the present case the increase in pH obtained as a result of liming even at the rate of 1000 kg/ha was not very appreciable. Hence it is to be concluded that there is very little danger to zinc availability consequent on the liming of our soils at the rates ordinarily recommended in the state, viz., 600 Kg/ha.

Summary

A pot culture experiment was carried out using the Vellayani Kayal soil (Tropaquept) in a randomized block design to study the effect of zinc in com-

bination with lime on the absorption of nutrients by rice. The soil used in the study had a pH of 4.3 and it contained 0.11% N, 0.02% P_2O_5, 0.36% K_2O, 0.10% CaO, 0.13% MgO and 4.2 ppm available Zn. The levels of zinc used were 0, 10, 20 and 40 Kg $ZnSO_4$ $7H_2O$/ha and those of lime were 0, 250, 500 and 1009 Kg $CaCO_3$/ha. NPK fertilizers (70+35+35 kg/ha) were also applied as per the package of practices. The application of lime did not result in appreciable increase in the pH of the soil under field conditions. The nitrogen content of grain was increased significantly by zinc, but it had no effect on the nitrogen content of straw. Application of lime reduced the nitrogen content of the grain. Zinc tended to decrease and lime tended to increase the P_2O_5 content of both grain and straw. But this effect was significant only in the case of grain. The K_2O, CaO and MgO contents of both grain and straw were practically unaffected by the application of zinc and lime. However there was a trend for CaO and MgO to increase in the plant material with increased applications of lime. When the total quantities of nutrients removed per pot was considered there was significant variation only in the case of nitrogen and phosphorus whereas in the case of the other nutrients the treatment effects, were non-significant.

സംഗ്രഹം

കുമ്മായവും സിങ്കും കൂടി ഒന്നിച്ച് പ്രയോഗിക്കുന്നതു് നെൽച്ചെടി പോഷണമൂലകങ്ങളം ആഗിരണം ചെയ്യുന്നതിനെ എപ്രകാരം ബാധിക്കുമെന്നു് മനസ്സിലാക്കുവാൻ പൂച്ചട്ടികളിൽ ഒരു പരീക്ഷണം നടത്തി. വെള്ളായണി കായലിലെ മണ്ണാണു് പരീക്ഷണത്തിനുവേണ്ടി ഉപയോഗിച്ചതു്. അതിന്റെ പി. എച്ചു് 4.3 ആയിരുന്നു. അതിൽ 0.11% നൈട്രജൻ, 0.02% ഫോസ്ഫറസ് പെന്റോക്സയിഡും, 0.36% കാത്സ്യം ഓക്സയിഡും, 0.13% ffltn"m"lnMloQ)<, ഓക്സയിഡും ലഭ്യമായ രൂപത്തിൽ 4.2 ദശലക്ഷമാനം (പി. പി. എം) സിങ്കും അടങ്ങിയിരുന്നു. ഹെക്ടയാർ ഒന്നിനു് 0, 10, 20, 40 കിലോഗ്രാം എന്ന കണക്കിൽ സിങ്ക് സംഫേറ്റും, 0, 250, 500, 1000 കിലോഗ്രാം എന്ന കണക്കിൽ കാത്സിയം കാർബണേറ്റും 70+35+35 എന്ന തോതിൽ രാസവളങ്ങളും ചേർത്തു. കുമ്മായം ചേർത്തതുകൊണ്ടു് മണ്ണിന്റെ പി. എച്ചിനു് സാരമായ വ്യത്യാസമൊന്നും ഉണ്ടായില്ല. സിങ്കുചേർത്തതുകൊണ്ടു് നെൽമണിയിലെ നൈട്രജന്റെ അംശം ഗണ്യമായി വർദ്ധിച്ചെങ്കിലും, വൈക്കോലിലെ നൈട്രജനെ അതു് സ്വാധീനിച്ചില്ല. സിങ്കു് നെല്ലിലെയും കച്ചിയിലെയും ഭാവകാംശത്തെ കുറക്കുന്നതിനും, കുമ്മായം അതു് വർദ്ധിപ്പിക്കുന്നതിനും സഹായിച്ചു. എന്നാൽ നെൽ മണിയുടെ കാര്യത്തിൽ മാത്രമെ ഈ പ്രവണത ഗണനീയമായിരുന്നുള്ളു. കുമ്മായവും സിങ്കും ചേർത്തതുകൊണ്ടു് നെൽമണിയിലെയോ, വൈയ്ക്കോലിലെയോ പൊട്ടാസിയം, കാത്സിയം, മഗ്നീഷിയം എന്നീ മൂലകങ്ങളുടെ തോതിനു് പറയത്തക്ക വ്യത്യാസം ഒന്നുംതന്നെ ഉണ്ടായില്ല. എന്നാൽ കുമ്മായം കൂട്ടതലായി ചേർത്തതുകൊണ്ടു് കാത്സിയത്തിന്റെയും മഗ്നീഷിയത്തിന്റെയും തോതു് ചെടിയിൽ വർദ്ധിക്കുന്നതിനുള്ള ഒരു പ്രവണത ദൃശ്യമായിരുന്നു. ഓരോ ചട്ടിയിൽനിന്നും നെൽച്ചെടി ആഗിരണം ചെയ്ത നീക്കിയ പോഷണമൂലകങ്ങളുടെ ആകെ തുക പരിഗണിച്ചപ്പോഴും നൈട്രജന്റെയും ഫോസ്ഫറസിന്റെയും കാര്യത്തിൽ മാത്രമെ ഗണ്യമായ വ്യത്യാസമുള്ളതായി കണ്ടുള്ളു; ffiOQ മൂലകങ്ങളുടെ അളവിനെ കുമ്മായവും സിങ്കും സ്വാധീനിക്കുന്നതായി കണ്ടില്ല.

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