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EFFECT OF AMENDMENTS AND ZINC ON THE AVAILABILITY, CONTENT AND UPTAKE OF ZINC AND IRON BY RICE BHAVANI IN SODIC SOIL

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A pot experiment was conducted to study the effect of amendments and zinc on the availability and uptake of Zn and Fe in a sodic soil with the treatments comprising of organic and inorganic amendments as main plot and levels of Zn i. e. 0, 10 and 20 ppm as sub-plots using rice crop Bhavani. The study revealed that application of amendments improved Zn availability in soil and uptake by rice grain and straw. Increased application in levels of Zn increased the available Zn content and uptake by rice grain and straw where as Fe availability in soil, content in grain and straw was reduced. The uptake of Fe increased with the application of Zn at 10 ppm.

Wide spread deficiency of Zn and response of crops to its application have been reported (Randhawa and Takkar, 1975). Rice, a widely grown crop in India has been reported to show symptoms of Zn deficiency much more frequently in sodic soil than normal soil (Takkar and Tarjit Singh, 1978). Deficiency of Zn due to high pH and high available Fe, formation of $ZnCO_3$, $Zn(OH)_2$ and $ZnNH_4PO_4$ are expected in these soils (Dhillon *et al.*, 1975) and may be the major cause for low yields. Amendments viz., FYM, daincha, pressmud and gypsum have been used successfully to reclaim the sodic soil (Dargan *et al.*, 1976). However under submergence, pH tended to decrease and under such conditions it is possible to improve the Zn nutrition of rice with lesser quantities of amendments and Zn.

MATERIALS AND METHODS

A pot experiment was conducted in sodic soil (8 kg/pot) having pH 9.2, E. C. 0.7 m.mhos/cm and E. S. P. 56.54 with rice Bhavani as test crop. The available Zn and Fe content were found to be 0.4 and 4.8 ppm, respectively. The treatments included three levels of Zn (0,10 and 20 ppm) as $ZnSO_4.7H_2O$ and four amendments viz., gypsum (11 and 22 t/ha) as $CaSO_4.2H_2O$, FYM (25 t/ha), daincha (25 t/ha) and pressmud (12.5 and 25 t/ha) and their combinations. There were totally 24 treatment combinations replicated twice. Amendments were added, mixed and the soil was leached thrice in a period of two weeks. Nitrogen P_2O_5 and K_2O @ 120, 60 and 60 Kg/ha in the form of urea, ammonium dihydrogen phosphate and potassium chloride were applied. Phosphorus and K were added basally while N was applied in two splits at the time of planting and tillering.

Soil and plant samples were collected after harvest of the crop. Soil samples were analysed for available Zn and Fe by DTPA extractant (Lindsay and Norvell, 1978). Grain and straw

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samples were also analysed for total Zn and Fe contents (Biswas *et al.*, 1977) and uptake were calculated. The amendments used were also analysed for the Zn and Fe contents. (FYM : Zn = 66 ppm; Fe = 75 ppm; Daincha : Zn =52 ppm; Fe = 41 ppm, Pressmud : Zn =30 ppm; Fe = 34 ppm).

RESULTS AND DISCUSSION

Availability of Zn and Fe (Table.1)

The effect of various organic amendments were significantly superior to control and inorganic amendments increases the available Zn status of the soil where the values ranged from 1.71 to 2.14 ppm. The increase might be due to the favourable effect of organic amendments on microbial activity and root proliferation in soil which help in solubilising the native and applied Zn. The results was in accordance with the results of Takkar and Tarjit Singh (1978). The availability of Zn was found to be significantly increased with the level of applied Zn. The available Zn levels were 0.36. 2.25 and 3.23 ppm respectively for 0,10 and 20 ppm applied Zn. This is an expected trend of result and is in line with the work of Tiwari and Pathak (1978).

The various amendments had a significant influence on the availability of Fe. Among the amendments, the differences were not marked and the values ranged from 12.58 to 13 33 ppm. Increased levels of Zn application either at 10 ppm or 20 ppm decreased the Fe availability from 15.72 to 12.44 and 10.94 ppm, respectively which showed the antogonistic effect of Zn on Fe. The same trend of result was also earlier observed by Deb and Zeliang (1975). However, the interaction effects of amendments and Zn were not attained the level of significance.

ii *Content of Zn and Fe in grain* (Table.2)

All the amendments significantly increased the Zn content in grain over control but the effect was not attained the level of significance among the amendments. The Zn content ranged from 28.2 ppm (control) to 33.3 ppm (daincha 25 t/ha). The content of Zn increased from 19.3 ppm at zero level to 31.3 and 43.7 ppm at 10 and 20 ppm levels of Zn respectively. Tiwari and pathak (1978) reported the same trend of results. The results were further confirmed from the positive correlation between grain Zn content and soil available Zn ($r = 0.968^{**}$).

In the case of Fe content also no significant differences were observed among the amendments tried. The Fe content ranged from 100 to 137.5 ppm. As the rate of Zn application increased, the Fe content of grain was found to decrease from 135.9 ppm (ZnO) to 101.6 ppm (Zn20). This result indicate the antogonistic effect of Zn on Fe which was further confirmed by the negative correlation of the Zn and Fe contents of grain ($r = -0.692^{**}$). Similar result was also reported by Deb and Zeliang (1975.)

iii *Zn and Fe content of straw* (Table. 3)

Zn content of rice straw was significantly increased due to the application of the amendments, but the amendments did not vary significantly among themselves. The Zn content ranged from 32.2 ppm (control) to 38.3 ppm (Pressmud 12.5 t/ha + 50% G.R). As the rate of application of Zn increased, the content of Zn also found to be increased significantly. The values were 26.1, 37.7 and 47.0 ppm respectively for 0, 10 and 20 ppm Zn levels. The interaction effect showed that the highest Zn content of 49.1 ppm was observed for the application of FYM (25 t/ha) at 20 ppm Zn level and lowest (19.4 ppm) in absolute control.

Regarding Fe content, significant differences were observed among the amendments tried. Application of daincha at 25 t/ha registered the highest Fe content of 225.0 ppm as compared to control (162 5 ppm). The Fe content of straw also showed the same trend as that of grain. The Fe content found to be decreased from 228.1 ppm (Zn O) to 210 9 and 151.6 ppm respectively for the application of 10 and 20 ppm Zn.

iv *Uptake of Zn and Fe by grain* (Table. 4)

Application of daincha (25 t/ha) and 50% gypsum requirement registered the highest Zn and Fe uptake and the values being 1.14 and 4.85 mg/pot respectively and this might be due to the higher grain yield. This was followed by the application of daincha 25 t/ha alone in which the uptake values were 1.0 and 3.62 mg/pot for Zn and Fe The lowest uptake of Zn (0.32 mg/pot) and Fe (1.15 mg/pot) was noticed in control. Application of 20 ppm Zn recorded the highest Zn uptake (1.06 mg/pot) where as it was 10 ppm of Zn for the highest Fe uptake (2.84 mg/pot). Zero ppm Zn level accounted for the low uptake values for both Zn (0.33) mg/pot) and Fe (1.14 mg/pot).

Combined application of daincha and gypsum registered the Zn uptake of 1.70 mg / pot at 20 ppm Zn level where as for the same treatment, 10 ppm Zn level accounted the highest Fe uptake 5.33 mg/pot in rice grain.

v *Uptake of Zn and Fe by rice straw* (Table.5)

Zn and Fe uptake by straw followed the same trend as that of grain. The treatments daincha + 50% gypsum recorded the uptake values of 1.77 and 10 24 mg/pot respectively. Increasing levels of Zn increased the Zn uptake and the values being 0.68, 1.21 and 1.52 mg/pot for 0, 10 and 20 ppm Zn levels. The highest Fe uptake of 6.91 mg/pot was accounted by Zn at 10 ppm level and Zn 20 ppm reduced the Fe uptake (4.98 mg/pot). The interaction effects were also significant for both Zn and Fe uptake.

Table 1. Availability of Zn and Fe as affected by amendments and Zn

Amendments / Zn levels (ppm)	Available Zn (ppm) 0	10	20	Mean	Available Fe (ppm) 0	10	20	Mean
Control	0.28	1.83	3.05	1.72	15.00	12.00	10.75	12.58
50% Gypsum requirement	0.33	2.13	3.30	1.92	15.75	12.75	11.00	13.17
100% Gypsum requirement	0 33	1.68	3.13	1.71	16.00	12.25	10.75	13.00
Farm yard manure (25 t/ha)	0.43	2.00	3.23	1.88	15.75	12.50	11.00	13.08
Daincha (25 t/ha)	0.41	2.58	3.14	2.04	16.00	12.75	11 25	13.33
Daincha (25 t/ha) + 50% G. R.	0.39	2.58	3 18	2 05	15.75	12.25	10.50	12.83
Press mud (25 t/ha)	0 35	2.62	3.45	2.14	16.00	12.75	11.25	13.33
Press mud (12.5 t/ha) + 50% G.R.	0.36	2 58	3.40	2.11	15.50	12.25	11.00	12 92
Mean	0.36	2.25	3.23	—	15.72	12.44	10.94	—

	CD (P = 0 05)	CD (P = 0.05)
Amendments	0.265	0.360
Zn levels	0.162	0.230
Interaction	NS	NS

Table 2. Content of Zn and Fe in rice grain

Amendments / Zn levels (ppm)	Zn content (ppm) 0	10	20	Mean	Fe content (ppm) 0	10	20	Mean
Control	18.5	26.9	40.9	28.8	125.0	112.5	100 0	112.5
50% Gypsum requirement	20.3	30.1	43.9	31.4	137.5	112.5	87.5	112.5
100% Gypsum requirement	18.5	31.0	44.1	31.2	137.5	100 0	75.0	104.2
Farm yard manure (25 t/ha)	17.0	31.8	43.9	30.9	150.0	112.5	112.5	125.0
Daincha (25 t/ha)	21.8	32 6	45.6	33.3	137.5	125.0	112.5	125.0
Daincha (25 t/ha) + 50% G.R.	20.3	31.8	43.9	32.0	150.0	137.5	125.0	137.5
Press mud (25 t/ha)	18.5	22.6	42.4	31.2	112.5	100.0	87 5	100.0
ess mud (12 5 t/ha) + 50% G. R.	19.4	33.5	44.8	32.6	137.5	125.0	112 5	125.0
Mean	19.3	31.3	43.7	—	135.9	115.6	101.6	

	CD (P = 0.05)	CD (P = 0.05)
Amendments	2.49	15.56
Zn levels	1.53	9.53
Interaction	NS	NS

Table 3. Content of Zn and Fe in rice straw

Amendments / Zn levels (ppm)	Zn content (ppm) 0	10	20	Mean	Fe content (ppm) 0	10	20	Mean
Control	19.4	33.4	43.9	32.2	187.5	162.5	137.5	162.5
50% Gypsum requirement	26.9	40.0	44.8	37.2	250.0	187.5	150.0	195.8
100% Gypsum requirement	25.3	38.3	47.4	37.0	225.0	187.5	125.0	179.2
Farmyard manure (25 t/ha)	26.9	36.6	49.1	37.6	225.0	200.0	137.5	187.5
Daincha (25 t/ha)	27.8	38.3	47.4	37.8	262.5	250.0	162.5	225.0
Daincha (25 t/ha) + 50% G.R.	26.1	39.1	49.3	37.8	250.0	237.5	175.0	220.8
Pressmud (25 t/ha)	26.9	37.4	48.3	37.5	212.5	212.5	162.5	195.8
Pressmud (12.5 t/ha) + 50% G.R.	29.3	38.3	47.3	38.3	212.5	250.0	162.5	208.3
Mean	29.1	37.7	47.0	—	228.1	210.9	151.6	—

	CD (P = 0.05)	CD (P = 0.05)
Amendments	1.52	20.65
Zn levels	0.93	12.65
Interaction	2.63	NS

Table 4. Uptake of Zn and Fe by rice grain

Amendments / Zn levels (ppm)	Zn uptake (mg/pot) 0	10	20	Mean	Fe uptake (mg/pot) 0	10	20	Mean
Control	0.12	0.31	0.54	0.32	0.83	1.29	1.32	1.15
50% Gypsum requirement	0 34	0.62	0.91	0.62	2.28	2.31	1.81	2.13
100% Gypsum requirement	0.35	0.65	0.94	0.65	2.57	2.08	1.60	2.08
Farmyard manure (25 t/ha)	0.21	0.64	0.86	0.57	1 84	2.28	2.22	2.11
Daincha (25 t/ha)	0.49	1.05	1.46	1.00	2.94	4.02	3.61	3.52
Daincha (25 t/ha) + 50% G.R.	0.49	1.23	1.70	1.14	3.63	5.33	4.85	4.60
Pressmud (25 t/ha)	0.30	0.66	0.83	0 60	1.81	2.02	1.72	1.85
Pressmud (25 t/ha) + 50% G.R.	0.38	0.91	1.24	0.84	2.68	3.38	3.13	3.06
Mean	0.33	0 76	1.06	—	1.14	2.84	2.52	—

	CD (P = 0.05)	CD (P = 0.05)
Amendments	0.07	0.38
Zn levels	0.04	0 23
Interaction	0.12	0·65

Table 5. Uptake of Zn and Fe by rice straw

Amendments Zn levels (ppm)	Zn uptake (mg/pot) 0	10	20	Mean	Fe uptake (mg/pot) 0	10	20	Mean
Control	0.25	0.71	0.96	0.64	2.41	3.46	3.28	3.05
50% Gypsum requirement	0.65	1.15	1.33	1.04	6.03	5.39	4.45	5.29
100% Gypsum requirment	0.62	1.20	1.56	1.13	5.55	5.46	4.12	5.04
Farmyard manure (25 t/ha)	0.51	1.03	1.31	0 95	4.28	5.58	3.98	4.61
Daincha (25 t/ha)	1.00	1.63	2.02	1.55	9.41	10.62	6.40	8.81
Daincha (25 t/ha) + 50% G.R.	1.06	1.89	2.36	1.77	10.07	12.09	8.55	10.24
Pressmud (25 t/ha	0.61	0.90	1.14	0.88	4.79	4.78	3.54	4.37
Pressmud (12 5 t/ha) + 50% G. R.	0.77	1.21	1.50	1.16	5.60	7.88	5.55	6.34
Mean	0.68	1.21	1.52	—	6.01	6.91	4.98	—

	CD (P=0.05) Zn	CD (P=0.05) Fe
Amendments	0.09	0 54
Zn levels	0.06	0.31
Interaction	0.15	0.85

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