https://doi.org/10.29321/MAJ.10.A02228

Madras Agric. J. 73 (1) : 46-52 January, 1986

AVAILABILITY AND UPTAKE OF NITROGEN AND PHOSPHORUS AS INFLUENCED BY AMENDMENTS AND ZINC IN ALKALI SOILS

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To assess the effect of amendments and Zn individually and in combinations on the availability and uptake of N and P in alkali soil, a pot study was conducted with rice as test crop. Gypsum at 50 per cent requirement in combination with pressmud (12.5 t/ha) or daincha (25 t/ha) resulted in higher available N. Addition of FYM (25 t/ha) registered the highest available P. Zinc application had the favourable influence over available N, while the availability of P was in the reverse trend. Amendments and Zn significantly influenced the content and uptake of N in the grain, while the effect was not significant in straw. Zinc addition had an antogonistic effect on the content of P in grain and straw.

Alkali soils are low productive nature due to the presence of high exchangeable Na (>15 per cent). Rice, a widely grown crop in these soils accounted for two lakh hectares in Tamil Nadu is adversely affected. Reclamation of these soils would mean removal of exchangeable Na from the clay complex by way of addition of amendments and also enrich the availability of soil nutrients Further, deficiency of Zn has been reported (Ponnamperuma, 1972) because of high pH under submergence. Little information is available on the availability and uptake of N and P in alkali soils which are of greater importance for vegetative growth and grain formation. Hence, a pot study was conducted using rice (Bhavani) as test crop to investigate the efficiency of different amendments and Zn alone and in combinations on the nutrient availability, content and uptake.

MATERIALS AND METHODS

A pot experiment was conducted in an alkali soil of Trichy District in a Factorial randomized block design. The soil is having a pH of 9.2, E.C 0.7 m. mhos/cm and ESP of 56.54. It contains 78 6 ppm of available N, 3.0 ppm of available P and 70.0 ppm of available K. The treatments consists of three levels of Zn and four amendments viz. gypsum at 50 and 100 per cent of its requirement, FYM (25 t/ha), daincha (25 t/ha) and pressumud (12.5 and 25 t/ha). All possible combinations were tried and replicated twice Amendments were added, mixed and the soil was leached thrice in a period of two weeks. Zinc was applied as $ZnSO_4.7H_2O$ and the fertilizer doses were 120 Kg N, 60 Kg P_2O_5 and 60 Kg K_2O/ha in the form of urea, diammonium phosphate and potassium chloride. Phosphorus and K were applied basally, while N in two split doses at planting and tillering.

Soil and plant samples were collected at harvest Soil was analysed for available N (Subbiah and Asija, 1956) and available P (Olsen *et. al*, 1954) Grain and straw samples were

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Table 1 : Nutrient availability as affected by amendments and Zn

Amendments	Available N (ppm)				Available P (ppm)			
	Zn_0	Zn_{10}	Zn_{20}	Mean	Zn_0	Zn_{10}	Zn_{20}	Mean
Control	51.8	50.4	54.6	52.27	5.50	5.00	4.00	4.83
Gypsum 50%	49.7	60.9	52.5	54.37	5.50	5.00	3.50	4.67
Gypsum 100%	64.4	63.7	49.0	59.03	4.75	5.25	4.75	4.92
FYM (25 t/ha)	54.6	63.0	64.4	60.67	8.00	7.50	5.50	7.00
Daincha (25 t/ha)	51.8	54.6	58.8	55.07	5.50	5.00	4.50	5.00
Pressmud (25 t/ha)	52.5	56.7	68.6	59.27	7.00	7.00	3.50	5.83
Gypsum 50% + daincha (25 t/ha)	57.4	58.1	69.3	61.60	3.25	3.75	4.25	3.75
Gypsum 50% + Pressmud (12.5 t/ha)	57.4	61.6	66.5	61.83	5.50	4.50	3.25	4.42
Mean	54.85	58.63	60.46	-	5.63	5.38	4.16	—

	CD (5% level)	CD (5% level)
Amendments	3.11	0.86
Zn	1.90	0.52
Interaction	5.39	1.49

analysed for N (Humphries, 1956) and P (Jackson, 1967) contents and uptake were calculated. The amendments used were also analysed for their nutrient contents. (Farm Yard Manure : N = 0.62%; P = 0.17%; Daincha : N = 2.97%; P = 0.38%, Pressmud: N = 1.28%, P = 3.28%).

RESULTS AND DISCUSSION

Nutrient Availability (Table. 1)

(i) *Nitrogen* : Addition of various amendments and Zn to alkali soil had a profound influence on the available N status. Gypsum at 50% requirement and pressmud (12.5 t/ha) registered the highest available N (61.83 ppm), followed by the treatment of gypsum at 50 and daincha (25 t/ha) with 61.60 ppm and were on par with the FYM (25 t/ha). Pressmud (25 t/ha) and gypsum at 100% requirement (60.67, 59.27 and 59.03 ppm, respectively). In an earlier study Dargan and Chhillar (1975) also indicated that green manuring with daincha enhanced the reclaiming effect aud enriched the soil with N. Application of Zn at 10 and 20 ppm level significantly increased the available N (58.63 and 60.46 ppm) over no Zn application (54.95 ppm).

Interaction showed that addition of Zn increased the available N except in treatment combination with gypsum. The treatment combination of gypsum at 50% and daincha (25 t/ha) and Zn 20 ppm recorded the highest available N (69.3 ppm). At 10 ppm level of Zn, control recorded lower value (50.4 ppm) while at 0 and 20 ppm Zn levels, gypsum at 50% and 100% registered lower available N (49.7 and 49.0 ppm, respectively).

Phosphorus : Available P status of the soil differed significantly among the treatments tried. Appli-

Table 2. Nitrogen content (%) in Rice Grain and Straw

Amendments	Grain				Straw			
	Zn_0	Zn_{10}	Zn_{20}	Mean	Zn_0	Zn_{10}	Zn_{20}	Mean
Control	0.77	0.84	0.81	0.81	0.42	0.42	0.42	0.42
Gypsum 50%	0.77	0.88	0.84	0.83	0.42	0.46	0.46	0.44
Gypsum 100%	0.70	0.81	0.84	0.78	0.39	0.42	0.46	0.42
FYM (25 t/ha)	0.81	0.88	0.88	0.85	0.39	0.46	0.46	0.43
Daincha (25 t/ha)	0.84	0.91	0.95	0.90	0.46	0.53	0.49	0.49
Pressmud (25 t/ha)	0.74	0.81	0.88	0.81	0.49	0.42	0.46	0.47
Gypsum 50% + daincha (25 t/ha)	0.88	0.98	0.95	0.93	0.42	0.49	0.49	0.47
Gypsum 50% + Pressmud(12.5t/ha)	0.81	0.81	0.88	0.83	0.46	0.46	0.46	0.46
Mean	0.79	0.86	0.58	--	0.43	0.46	0.46	

	CD (5% level)	CD (5% level)
Amendments	0.04	N. S.
Zn	0.03	N. S.
Interaction	N. S.	N. S.

cation of FYM (25 t/ha) registered the highest available P (7.00 ppm) followed by Pressmud (25 t/ha). The highest available P in the above treatments might be attributed to the higher P content in pressmud and as well as the production of organic acids during decomposition, which lead to reduction of soil pH, might provide favourable condition for high P availability. This result is in accordance with the work of Sharma *et al.* (1979). Zinc addition had an antagonistic effect on the P availability. Highest of 5.63 ppm was noticed at zero level of Zn and was on par with 10 ppm Zn level (5.38 ppm), while 20 ppm Zn level accounted for the lowest (4.16 ppm) available P. The formation of $ZnPO_4$ at higher levels of Zn might be cause for low available P. Tiwari and Pathak (1978) stated that increased rates of Zn decreased the availability of P.

Nutrient Content

(i) Nitrogen (Table 2)

Grain: Gypsum at 50% requirement and daincha (25 t/ha) registered the highest N content (0.93%) in grain and was on par with the treatment of daincha (25 t/ha) with 0.90% N and these two treatments were significantly superior to other treatments. This might be due to the appreciable amount of N supplied by the green manure to the soil and this in turn increased the N content (Velayutham *et al.*, 1978). Gypsum at 100% requirement recorded the lowest (0.78%) content of N and was on par with control (0.81%). Addition of Zn increased the grain N content. The two levels of Zn, 20

Table 3. Phosphorus content (%) in rice Grain and straw

Amendments	Grain				Straw			
	Zn_0	Zn_{10}	Zn_{20}	Mean	Zn_0	Zn_{10}	Zn_{20}	Mean
Control	0.28	0.27	0.24	0.263	0.065	0.050	0.045	0.054
Gypsum 50%	0.31	0.29	0.26	0.286	0.055	0.045	0.045	0.052
Gypsum 100%	0.28	0.26	0.21	0.250	0.050	0.045	0.045	0.047
FYM (25 t/ha)	0.31	0.28	0.27	0.286	0.060	0.050	0.045	0.052
Daincha (25 t/ha)	0.28	0.26	0.22	0.253	0.055	0.045	0.010	0.049
Pressmud (25 t/ha)	0.31	0.28	0.23	0.273	0.060	0.045	0.040	0.045
Gypsum 50 % + daincha 25 t/ha)	0.27	0.24	0.22	0.243	0.055	0.040	0.040	0.045
Gypsum 50 % + Pressmud (12.5t/ha)	0.30	0.28	0.25	0.276	0.055	0.040	0.050	0.049
Mean		0.292	0.270	0.237	—	0.057	0.047	0.044

	C. D. (5% level	C. D. (5% level)
Amendments	0.021	N. S.
Zn	0.009	0.009
Interaction	N.S.	N. S.

and 10 ppm were on par with 0.88 and 0.86% of N and were significantly superior over zero level of Zn (0.79%N). The earlier results reported by Subramanyam and Mehra (1974) and Sarkunam and Venkataraman (1977) support this finding.

Straw : Application of daincha (25 t/ha) accounted for higher N content (0.490%) as compared to other amendments. The two levels of Zn (10 and 20 ppm) registered higher N content (0.460%) over no Zn appllcation (0.429%).

(ii) Phosphorus (Table 3)

Grain : Application of FYM (25 t/ha) was found to be registered higher P content in grain [0.286%). This might be due to the enhancing property of FYM through organic acids and pressmud being the rich source of P, increased the available P in soil and indirectly enhanced the P content in grain. This is in agreement with the work of Sharma *et al.* (1979).

Application of Zn significantly reduced the P content of grain from 0.292% at zero level to 0.270% at 10 ppm and 0.237% at 20 ppm levels. This may be due to the formation of $ZnPO_4$ in the soil which was fixed and in turn affect the absorption of P. This is in accordance with the earlier results of Tiwari and Pathak (1978) in rice.

Straw : Application of amendments did not have any significant influence on the P content of straw and the values ranged from 0.045% to 0.054%. Zinc addition at 10 and

Table 4 Nitrogen uptake (mg/pot) by rice grain and straw

Amendments	Grain				Straw			
	Zn_0	Zn_{10}	Zn_{20}	Mean	Zn_0	Zn_{10}	Zn_{20}	Mean
Control	51.20	95.75	106.05	84.33	53.75	89.35	91.50	78.20
Gypsum 50%	127.45	179.05	173.25	159.91	101.05	130.75	134.85	122.22
Gypsum 100%	130.55	167.35	178.50	158.80	95.25	130.80	149.50	125.18
FYM (25 t/ha)	98 45	177.05	171.90	149.13	73.10	124.70	120.80	106.20
Daincha (25 t/na)	179.75	292.55	302.85	258.38	162.75	222.75	208.75	198.08
Pressmud (25 t/ha)	117.85	162.65	171.15	150.55	110.25	108.65	106.95	108.62
Gypsum 50% + daincha (25 t/ha)	211.10	378.75	366.50	318.78	168.00	236.95	239 35	214.77
Gypsum 50% + Pressmud(12.5t/ha)	156.50	217.86	242.60	205.65	120.10	143.10	144.55	135.92
Mean	134.10	208.87	284.10	—	110.53	148.38	149.53	—

	C. D. (5% level)	C. D. (5% level)
Amendments	10.61	16.37
Zn	6.50	8.38
Intreractior	18.38	N. S.

20 ppm significantly reduced the P content of straw from 0.057% at zero ppm Zn to 0.047% and 0.044% respectively.

Nutrient uptake :

Nitrogen (Table 4)

Application of gypsum at 50% requirement and daincha (25 th/a) significantly, registered the highest N uptake values by grain (318.78 m.g /pot) and straw (214.77 m.g/pot). This might be due to the highest yield and the appreciable N supply through daincha. This result is in line with the work of Velayutham *et al.* (1978). This was followed by the treatment of daincha (25 t/ha) with 258.38 and 198.08 m.g pot for grain and straw respectively. Lowest uptake of N was noticed in control both in grain and straw (84.33 and 78.20 m.g/pot) and might be due to the lower yields

Application of Zn at 20 ppm level registered the highest N uptake by grain (214.10 m.g pot) and straw (149.53 m.g/pot) but was on par with 10 ppm level (208.87 and 148 38 m g/pot), and significantly superior to zero level Zn (134.10 and 110.53 m g/pot). The increased in uptake for Zn application may be due to higher yield and dry matter production. Panda and Nayak (1974) reported that increase in uptake to Zn application may be due to enzymatic effect in the metabolic processs. Similar findings were earlier reported

Table. 5. Phosphorus uptake (mg/pot) by rice grain and Straw

Amendments	Grain				Straw			
	Zn_0	Zn_{10}	Zn_{20}	Mean	Zn_0	Zn_{10}	Zn_{20}	Mean
Control	18.75	31.85	31.55	27.38	8.35	10.65	9.85	9.62
Gypsum 50%	51.35	59.35	53.60	54.76	13.30	15.85	14.35	13.17
Gypsum 100%	52.25	54.15	44.70	50.36	12.35	13.95	14.90	13.73
FYM (25 t/ha)	38.00	56.80	53.05	49.28	11.25	13.80	14.00	13.02
Daincha (25 t/ha)	59.90	83.65	70.50	71.35	19.65	19.10	17.05	18.60
Pressmud (25/ha)	49.80	56.60	45.00	50.46	13.45	10.75	9.40	11.20
Gypsum 50% + daincha (25 t/ha)	65.15	92.75	85.35	81 08	22.15	19.35	19.55	20.35
Gypsum 50% + Pressmud (12.5t/ha)	58.35	75.70	69.35	67.80	14.50	12.60	15.90	14.33
Mean	49.19	63.85	56.63	—	14.38	14.51	14.25	—

	C. D. (5% level)	C. D. (5% level)
Amendments	5.37	2.38
Zn	3.25	N.S.
Interaction	9 30	N.S.

by Mahatim Singh *et al.* (1978) in rice.

Phosphorus (Table 5).

The uptake of P by grain and straw followed the same trend as that of N uptake. Application of Gypsum at 50% requirement and daincha (25 t/ha) again showed its superiority registered the highest P uptake by grain (81.08 m.g) and straw (20.35 m.g /pot). But the effect was not significant in case of straw. This was followed by the treatment of daincha (25 t/ha) alone (71.35 and 18.60 m.g/pot for grain and straw respectively). All the other amendments were superior to control in enhancing the P uptake in grain and straw. Sharma *et al.* (1979) noted similar trend of results.

Zinc at 10 ppm was found to be superior to the other two levels (0 and 20 ppm), recorded the higher uptake values of 63.85 and 14.51, m.g/pot for grain and straw respectively. However, the effect was not significant in case of straw. The findings of Sarkunam and Venkataramanan (1977) and Mahatim Singh

et al. (1978) in rice support the results of the present investigation.

The first author wishes to acknowledge the ICAR Research Scheme on Micronutrients of Soils and Plants for the award of fellowship. Thanks are also due to the Tamil Nadu Agricuitural University, Coimbatore for according permission for publishing the M.Sc. (Ag.) Thesis.

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