https://doi.org/10.29321/MAJ.10.A02197

Madras Agric. J. 74 (10-11): 421-425 October-November 1987

STUDIES ON THE SOURCES AND METHODS OF APPLICATION OF ZINC TO LOWLAND RICE

R. ILANGOVAN[1] and SP. PALANIAPPAN[2]

Field experiments were conducted to study the effect of different sources and methods of application of zinc (a) to rice in two Zn deficient rice fields of Wetlands, Tamil Nadu Agricultural University, Coimbatore. The results revealed that soil application of six percent Zn-DAP enhanced the grain yield significantly over no Zn control. Four, five and six per cent Zn-DAP recorded higher yield over soil application of $ZnSO_4$ @ 25 kg/ha, foliar application of $ZnSO_4$ @ 0.5 per cent. sprayed on 30 and 45 days after planting and seedling root dipping in two per cent ZnO suspension.

Widely prevalent Zn deficiency warrants the need for research on the method of application and sources of Zn to overcome the malady effectively. Significant yield increases in rice with different Zn sources viz., Zn-urea, Zn-SSP and Zn-DAP application have been reported by Sarkar *et al* (1980), Singh (1983), Deb *et al.* (1986) and Singh *et al* (1986). The purpose of this investigation was to determine the effectiveness of different grades of Zn-DAP (1 to 6 per cent) by comparing with different methods of application of Zn deficient lowland.

MATERIALS AND METHODS

The experiment was conducted with rice variety IR 50 as test crop in Zn deficient fields (DTPA Zn below 2 ppm) of wetlands involving different Zn treatments (Table 2). The design adopted was split-plot design with three replications. The soil type of two experimental fields were of clay loam with pH of 7.5 and 7.9 and was low in DTPA-Zn (0.7 and 1.1 ppm) and N (234.5 and 210.6 kg/ha) and organic carbon (0.21 and 0 24 per cent), high in available P (38.5 and 40 kg/ha) and K (325.6 and 316.9 kg/ha).

For all the treatments a common dose of 100:50:50 NPK kg/ha were applied through prilled urea, DAP, different grades of Zn-DAP (1 to 6 per cent) SSP and MOP. Zn-DAP containing 1 to 6 per cent Zn as ZnO was formulated and supplied by M/s. Southern Petrochemical Industries Limited, Tuticorin. Nutrient contents in the different grades of Zn-DAP materials are presented in the Table 1. The plant sample collected at harvest stage was washed with 0.1 N Hcl and deionised water and dried in the air oven at 60°C for 72 hours. It was powdered in a Wiley mill with stainless steel blades. The plant samples were analysed for N,P,K and Zn by standard procedures and uptake was calculated by multiplaying the nutrient content with DMP per unit area The grain yield was expressed at 14 per cent moisture level. The straw was sundried and yield

1 Part of the M.Sc. (Ag) thesis submitted by Senior author to the Tamil Nadu Agricultural University Coimbatore-3

2 Professor and Head, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore-3.

Table 1. Nutrient contents in the different grades of Zn-DAP materials

Zn-DAP materials	Total N	Total P_2O_5	Total Zn
1% Zn—DAP	18.00	45.4	1
2% Zn—DAP	17.50	44.7	2
3% Zn—DAP	17.25	44 1	3
4% Zn—DAP	17.03	43.5	4
5% Zn—DAP	16.8	42.8	5
6% Zn—DAP	16.5	24.2	6

recorded. The yield was expressed in kg/ha and Zn uptake was compared with respective DMP and expressed in g/ha.

RESULTS AND DISCUSSION

The influence of different Zn sources and methods of application of Zn on the growth and straw yields of rice and nutrient uptake at harvest stage and presented in Tables 2 and 3.

NPK uptake at harvest

Application of Zn significantly increased the NPK uptake in both the seasons. This was due to higher N absorption and increase in DMP in the Zn applied plots. Beavington and Varley (1979) also reported increased N uptake due to Zn application. Significant influence of Zn treatments were were observed on P uptake at harvest. The synergistic influence of Zn on P uptake was noticeable with 19 percent (kharif), 13 per cent (summer) increases in P uptake in Zn applied plot ove control. This kind of positive influence of Zn on P uptake might be due to the formation of zinc ammonium phosphate on soils under submergence. This could have favoured the increased availability of both Zn and P and higher translocation, resulting in synergism between Zn and P (Singh and Mittal, 1983 and Balakrishnan *et al*, 1985). Comparing the two sources of P (SSP and DAP), plots receiving the DAP recorded the higher P uptake than those applied with SSP. Kothandaraman (1981) and Raju *et al.* (1983) have reported the superiority of DAP over SSP as a source of P to wetland rice. Application of Zn in general, enhanced the K uptake harvest in both the seasons. The increases might be attributed to the increased DMP in Zn approved plots, consequently there was increase in K uptake. This is in accordance with the findings of Dwivedi and Takkar (1974) who reported increased K uptake due to Zn application

Zinc uptake

In both the stages, Zn uptake was influenced by the different Zn sources and methods of application. At all the stages, control plots (no Zn) recorded the lower uptake of Zn compared to other treatments in both the seasons. Jadhav and Patil (1983) and Jawahar (1985) also observed that applied Zn increased the Zn uptake in rice at all the stages of growth. At harvest 6 and 5 per cent Zn-DAP and 25 kg $ZnSO_4$/

Table 2. Effect of sources and methods of Zn application on grain and straw yield of IR 50 (kg/ha)

Treatments	Grain yield		Straw yield	
	Kharif	Summer	Kharif	Summer
No Zn—SSP	5155	5167	5794	6901
1% Zn—DAP	5780	5668	5931	7164
2% Zn—DAP	5909	5958	5959	7365
3% Zn—DAP	5988	6340	6120	7373
4% Zn—DAP	6057	6169	6624	7513
5% Zn—DAP	6087	6511	6395	7303
6% Zn—DAP	6214	6616	6374	7915
$ZnSO_4$—Basal (25 kg/ha)	5924	6103	6124	7233
$ZnSO_4$—Foliar (0.5%)	5809	5984	6205	7286
ZnO (R. D.)	5830	5931	6132	7670
No Zn—DAP	—	5325	—	6973
S.E.D.	243	306	145	207
C.D.	493	618	294	418

Table 3: Effect of sources and methods of Zn application on NPK (Kg/ha) and Zn (g/ha) uptake at harvest stage of IR 50 rice

Treatments	Nitrogen		Phosphorus		Potassium		Zinc	
	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer
No Zn-SSP	86 6	84.8	28.0	28.9	88.0	91.4	197.4	206.7
1% Zn-DAP	109.3	96.0	33.4	33.2	102.1	101.0	323.1	338.4
2% Zn-DAP	107.3	102.5	32.9	35.0	109.6	102.2	374.6	411.6
3% Zn-DAP	103.9	97.9	32.5	31.4	109.3	107.1	452.3	435.3
4% Zn-DAP	100.9	107.2	33.4	38.2	105.4	124,1	452.6	475.1
5% Zn-DAP	109.5	105.1	33.2	40.0	108.1	115.1	485.0	494.7
6% Zn-DAP	110.3	108.8	34.4	39.8	107.1	125.1	518.7	524.9
$ZnSO_4$-(Basal)	102.1	103.5	32.8	37.1	105 5	106.3	475.3	437.0
$ZnSO_4$-(Foliar)	107.3	109.1	34.0	35.8	107.3	109.0	417.6	370.8
ZnO (R.D)	107.3	97.4	32 8	36.7	109.7	106.8	373.0	339.8
No Zn-DAP	—	94.6	—	35.2	—	92.6	—	215.8
S.E.D.	4.24	6.27	1.63	2.77	6.02	8.26	27.80	29.50
C.D.	8.60	12.67	3.30	5.59	12.20	16.69	56.40	59.60

ha applied through soil recorded higher Zn uptake. This was due to the increased supply of Zn (7.1, 5.8 and 5.75 kg Zn/ha respectively) from these sources. Singh *et al.* (1985) reported that Zn uptake of rice was higher in Zn-SSP applied treatments. ZnO root dipping and foliar application of $ZnSO_4$ also recorded higher uptake of Zn than control in both the seasons, but these treatments were not comparable with the soil application of Zn either as $ZnSO_4$ or Zn-DAP. This indicates that soil application of Zn increased the availability and uptake of Zn and so this method is to be preferred.

GRAIN AND STRAW YIELD

Application of different sources of Zn and methods of application significantly influenced the grain yield over no Zn control. Increase in grain yield worked out to 20.5 and 28.1 per cent over control in kharif and summer respectively. Among the different grades of Zn-DAP, 6 per cent grade recorded higher yield (6214 and 6610 kg/ha in kharif and summer, respectively). No Zn control plots recorded the lowest grain yield in both the seasons. This clearly indicates that Zn addition is a necessity in Zn deficient soils for high yields. Soil and foliar application of $ZnSO_4$ and ZnO root dipping also increased the yield over control and was statistically comparable to the different grades of Zn-DAP. Sarkar and Deb (1984), Biddesha and Maskina (1985) and Saravanan and Ramanathan (1986), also found the increased grain yield due to Zn application.

Straw yield was also improved by Zn application. Application of 4, 5 and 6 per cent Zn-DAP recorded the highest straw yield which was significantly superior to control. In summer 6 per cent Zn-DAP recorded the highest straw yield followed by ZnO root dipping and other grades of Zn-DAP.

From these results, it may be concluded that application of different grades of Zn-DAP materials registered significant and marked improvement in grain and straw yields of rice in Zn deficient lowland soil. Application of Zn fertilizer, in general, improved the uptake of N, P, K and Zn. Soil application of Zn-DAP, especially 6 per cent grade, was efficient and economic in meeting the Zn nutrition of rice in a Zn deficient lowland rice soil.

ACKNOWLEDGEMENTS

The senior author wishes to thank the SPIC Limited, Tuticorin for awarding a Junior research fellowship for his post graduate studies and to the Tamil Nadu Agricultural University for permitting him to publish his M Sc. (Ag.) thesis.

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