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METHODS OF ZINC APPLICATION AND ITS EFFECT ON YIELD AND ZINC CONTENT OF RICE (*Oryza sativa*) AND WHEAT (*Triticum vulgare*)

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ABSTRACT

Maximum yield of rice was obtained with the dipping of the roots of seedling in a ZnO suspension and that of wheat by the residual effect of 50 kg/ha zinc sulphate applied in the soil to rice in the field experiments conducted for the comparison of different methods of zinc application. A significant effect of Zn fertilization was observed on the content and the uptake of zinc in two crops. The removal of zinc by straw was higher than that by the grain in case of rice, but there was a reverse trend in wheat.

Key words: Zinc, rice and wheat yield.

With the introduction of high yielding varieties of cereals and adoption of multiple cropping in India, the importance of micronutrients has been realised. The deficiency of Zinc has been reported in majority of Indian soils (Takkar and Randhawa, 1978). The zinc deficiency is considered to be the third most important nutritional factor after nitrogen and phosphorus limiting the growth of wetland rice (Ponnamperuma, 1977). Significant response of various field crops to zinc application in India have been reported (Bansal and Patel, 1986; Takkar *et al*., 1975; Nambiyar, 1979). The zinc deficiency is observed more frequently in soils with high pH, low organic carbon and light texture. There is very little information on the methods of application of zinc under field conditions. This study was, therefore, undertaken with a view to determine the direct and the residual effect of different methods of zinc application on the yield of rice and wheat grown on an Inceptisol.

MATERIALS AND METHODS

Field experiments were conducted on a sandy clay loam (Inceptisol) soil at the Government Agricultural Research Farm, Jora, Morena during four crop seasons (2 rice crops, Ratna followed by 2 wheat crops variety Kalyan sona). Each year new field was selected. The soil characteristics for 1977-78 were pH. 9.4, E.C.3.8 mmhos/cm. $CaCO_3$ 2.5%, exchangeable Na, Ca and Mg were 6.0, 1.5 & 0.5 me/100 g respectively, DTPA extractable Zn was 0.38 ppm. The experimental site of 1978-79 exhibited 9.7 pH, E.C. 4.2 mmhos./cm, $CaCO_3$ 2.7%, available N, P and K 80, 4.2 and 150 ppm respectively. The DTPA extractable Zn was 0.42 ppm, exchangeable Na, Ca and Mg were 7.3, 2.0 and 0.7 me/100g respectively. Commencing with rice during the wet season of 1977-78, treatments consisted of:

(1) Control (NPK alone).

(2) 25 Kg Zinc sulphate per ha applied to soil in rice followed by wheat (untreated).

(3) 50 kg Zinc sulphate per ha applied to soil in rice followed by wheat (untreated).

(4) Two sprays of Zinc sulphate (0.5%) at 20 and 40 days after transplanting in rice and after sowing in wheat.

(5) Root dipping of rice seedlings and seed soaking of wheat in 3% ZnO suspension for 4 hours before transplanting and sowing.

Uniform applications of 100 Kg N as Urea, 60 Kg P_2O_5 as superphosphate 40 Kg K_2O as muriate of Potash per hectare were given to each crop.

Recommended practices of fertilizer application, transplanting and sowing of wheat

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were adopted in 10 x 3 Sq. metre plots, in randomized block design with 5 replications. Wheat was sown at 100 Kg seed/ha on December, 1, 1977 and November 25, 1978 and 30 days old seedlings of rice were transplanted at 3 seedlings per hill at a spacing of 15 x 15 cm on July 25, 1977 and August 3, 1978.

Plant samples were collected 35 days after transplanting of rice and sowing of wheat, grain and straw samples were collected seperately at harvest to determine Zinc content and its uptake. Zinc in the diacid extract was determined by atomic absorption spectrophotometer. Chemical analysis of the soil was done by standard methods (Jackson, 1967).

RESULTS AND DISCUSSION

Yield of rice and wheat:

There was a significant increase in the yield of both grain and straw by the application of Zinc as compared to the control during both years. In case of rice, maximum yields were obtained with Zinc Oxide root dipped seedlings and this treatment was significantly superior from the remaining treatments (Table -1). Application of 50 Kg Zinc Sulphate produced nearly 2 quintals more rice than spray and 25 Kg Zinc Sulphate treatments during first year of experimentation but in second year the difference in yield was less. The differences due to methods of Zinc application, were non significant. The increase in yield with the application of Zinc may be ascribed to the deficiency of Zinc in the experimental field. The critical limit of DTPA extractable Zn according to Boawn (1971) was less than 0.5 ppm, Rathore *et al.* (1978) also reported likewise in alluvial soils of Madhya Pradesh. Higher Yields obtained in seedling treatments suggest that the availability of Zn was higher in this treatment than the others. In Zn applied (soil) treatments there is a possibility of the formation of sparingly soluble products. Bansal and Patel (1986), Rathore *et al.* (1978), Tiwari and Pathak (1976) also reported increase in rice yield with the application of Zinc.

Wheat grain and straw yield:

In order to find out the residual effect of Zinc Sulphate and the effect of spray and seed treatment, wheat crop was grown after rice during both the years. Fifty Kilogram Zinc Sulphate applied to rice significantly increased the yield of wheat during both the years of experimentation. Seed soaking and spray treatments gave significant yield during the year 1978-79. Significant increase in straw yield was obtained with the application of 50 Kg Zinc Sulphate/ha, seed soaking in Zinc Oxide suspension as well as 25 Kg Zinc Sulphate. It appears that application of Zinc, in soils containing less than 0.45 ppm DTPA extractable Zinc, increases wheat yield. The results further suggest that 50 Kg Zinc Sulphate

Table 1. Effect of treatments on grain and straw yield (kg/ha) of rice and wheat

Treatments	RICE				WHEAT			
	Grain yield		Straw yield		Grain yield		Straw yield	
	1977-78	1978-79	1977-78	1978-79	1977-78	1978-79	1977-78	1978-79
Control	5743	4085	8887	7726	4072	3020	7645	5797
NPK+25 Kg $ZnSO_4$	6006	4980	9308	7439	4254	3676	8052	6957
NPK+50 Kg $ZnSO_4$	6240	5020	9413	7865	4425	3929	8952	8267
0.5% Spray	6006	5010	9440	8718	4173	3777	8101	7967
Seed/Seedling dipping	7001	5215	11081	9322	4121	3666	8313	7265
Sem ±	22.36	36.51	283.96	18.26	48.20	42.30	46.55	56.27
C.D. at 5%	68.89	112.49	874.90	56.25	148.52	130.37	143.42	173.38

applied to rice may meet out the requirement of subsequent wheat crop. Significant increase in dry matter yield of wheat in the alluvial soils of Morena district has also been reported by Nambiyar (1979).

Concentration and uptake of Zinc:

Applied Zinc significantly increased the Zn content and uptake by grain and straw of both rice and wheat. Total removal of Zn in control was of the order of 348.2 and 272.6 gm per ha during 1977-78 and 1978-79 respectively, whereas the total uptake by wheat crop was 174.3 and 144.6 g/ha. The highest uptake values of the order of 670.5 and 588.6 g/ha were recorded in the treatment dipping rice seedling roots during these years respectively. Zinc removal by rice straw was much more than by grain and the highest was noted in seedling treatment followed by 50 kg zinc sulphate application. The results clearly suggest a beneficial effect of dipping rice seedling roots over other methods of application particularly soil application, where the efficiency of Zinc is very low due to its conversion to unavailable forms. On the other hand dipping the seedlings roots places Zinc right on the roots from where the young seedling can easily take it up. This improves remarkably the efficiency of applied Zn. Takkar *et al.* (1975) also reported beneficial effect of seedling dipping in Zinc Oxide suspension. Katyal and Ponnamperuma (1974) also obtained spectacular results by dipping rice seedling roots in two to four per cent Zinc Oxide suspension.

Table 2. Effect of different treatments on Zinc content (ppm)

Treatments	Rice						Wheat					
	1977-78			1978-79			1977-78			1978-79		
	Plant 40 days	Grain	Straw	Plant 40 days	Grain	Straw	Plant 40 days	Grain	Straw	Plant 40 days	Grain	Straw
Control (NPK)	15.1	11.4	31.3	17.7	9.55	30.4	16.1	27.2	9.7	16.7	24.8	9.6
NPK+ 25 kg $ZnSO_4$	28.7	14.7	39.7	26.1	14.9	47.4	23.8	38.2	14.4	24.6	35.3	15.1
NPK+ 25 kg $ZnSO_4$	36.2	16.6	44.8	37.1	17.3	54.3	29.0	42.5	19.4	28.63	37.3	18.3
0.5% Spray	29.8	17.2	40.8	28.9	15.8	47.1	20.2	36.0	13.6	22.1	35.2	12.9
Seed/seedling dipping	39.7	22.4	46.2	39.6	21.7	51.4	22.1	35.6	15.5	22.8	35.3	14.0
S.Em ±	1.461.649		1.72	1.55	1.79	2.18	1.78	1.9361.25		1.59	1.76	0.93
C.D. at 5%	4.495.081		5.29	4.76	5.52	6.70	3.635	5.9643.85		4.91	5.42	2.85

Table 3. DTPA extractable zinc (ppm) in soil after the harvest of rice and wheat

Treatments	1977-78		1978-79	
	Rice	Wheat	Rice	Wheat
Control	0.31	0.26	0.33	0.27
NPK + 25 Kg $ZnSO_4$	1.51	0.96	0.95	0.88
NPK + 50 Kg $ZnSO_4$	1.62	1.17	1.19	1.02
0.5% Spray	0.44	0.42	0.38	0.26
Seed/Seedling dipping	0.41	0.50	0.47	0.42
S. Em ±	0.187	0.061	0.065	0.041
C.D. at 5%	0.578	0.186	0.201	0.127

The Zinc concentration in control (wheat grain) was 27.2 and 24.8 ppm, which rose to 42.8 and 37.3 ppm in 50 Kg Zinc Sulphate treated plots during 1977-78 and 1978-79 respectively. The uptake by grain and straw increased with the application of Zn and the highest values were noted at the highest level of Zn application. The uptake by grain and straw in general was significantly higher in Zn treated plots. This was expected since the Zn uptake is the result of both concentration and yield (Takkar and Randhawa, 1978; Khamparia *et al.*, 1984). The total removal of Zn by rice crop was higher than that of wheat indicating preferential requirement of rice to Zinc. Tiwari and Pathak (1976) also reported similar results.

Zinc status of the soil after rice and wheat crops:

Zinc content of control plot came down to 0.26 and 0.27 ppm from 0.38 and 0.42 ppm respectively after the harvest of wheat during 1977-78 and 1978-79 (Table 3). There was an increase in the status of Zn by the soil application of Zinc Sulphate and it remained greater than 0.5 ppm (critical limit suggested for alluvial soils) even after taking second crop. Thus it is evident that soil application of Zinc besides meeting out the demand of the crops, leaves sufficient residual Zinc in the soil. Takkar and Randhawa (1978) reported that the residual effect of Zn depends on cropping sequence and soil types and may last even for five years.

REFERENCES

BANSAL, K.N. and PATEL, K.C. 1986. Effect of sources and levels of zinc on the yield and composition of Rice (*Oryza sativa*) on Alfisol under Field condition. *Journal of Agron. and crop Sci.*, 157, 24-30

BOAWN, L.C. 1971. Evaluation of DTPA extractable zinc as a zinc soil test for Washington soils. *Am. Pacific NW Fert. Conf. Proc.* 22nd Bozeman Mont 143-146

JACKSON, M.L. 1967. Soil Chemical analysis. Prentice Hall Inc. Englewood Cliffs N.J. USA.

KATYAL, J.C. and PONNAMPERUMA, F.N. 1974. Zinc deficiency-A wide spread nutritional disorder of rice in Agusan del Notre J Phillipp Agric. 58 (3 & 4) : 79-89.

KHAMPARIA, R.S., RATHORE, G.S. GUPTA, G.P. and GAJENDRAGADKAR, G.R. 1984. Zinc deficiency in some alluvial soils (Entisols) of Gird region and response of wheat to zinc application. *J. Indian Soc. Soil Sci.*, **32**, 313-317.

NAMBIYAR, K.K.M. 1979. Study on critical levels of zinc and manganese in maize, pearl millet, wheat and chickpea as related to four soil types. Ph.D.Thesis, J.N. Krishi Vishwa Vidyalaya, Jabalpur.

PONNAMPERUMA, F.N. 1977. Screening rice for tolerance to mineral stresses. *International Rice Research Institute Research paper Series* No.6.

RATHORE, G.S., GUPTA, G.P., KHAMPARIA, R.S. and SINHA, S.B. 1978 Response of wheat to zinc application in alluvial soils of Morena district Madhya Pradesh. *J. Indian Soc. Soil Sci.* **26**, 58-62.

TAKKAR, P.N., MANI, M.S. and RANDHAWA, N.S. 1975. Effect of direct and residual available Zinc on yield, zinc concentration and its uptake by wheat and groundnut crops. *J. Indian Soc. Soil Sci.* **23**,91-95.

TAKKAR, P.N., and RANDHAWA, N.S. 1978. Micronutrients in Indian Agriculture. *Fert. News*, 23, 3-26.

TIWARI, K.N. and PATHAK, A.N. 1976. Direct residual and cumulative effects of applied zinc on yield, chemical composition and ion uptake by rice and wheat crops in a fixed rotation under field condition. *Fert. News*, **21**, 31-37.