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DIRECT, RESIDUAL AND CUMULATIVE EFFECT OF APPLIED ZINC FOR RICE IN RED SOILS

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ABSTRACT

Field experiments were conducted on red soils (Typic Ustorthent) at the Tamil Nadu Agricultural University Farm of Agricultural Research Station, Bhavanisagar to study direct, residual and cumulative effect of applied Zn to IR 20 rice. The continuous application of $ZnSO_4$ at 25 kg per ha for every season of rice crop significantly increased grain and straw yield and resulted in 17 per cent increase in grain yield over NPK treated control. Application of $ZnSO_4$ at 50 kg for first crop resulted in residual effect of Zn with increase in the grain yield of two subsequent crops. Similar trend was also observed for the level of 75 kg $ZnSO_4$/ha. Residual effect of $ZnSO_4$ application at 100 kg/ha to first crop was observed for five subsequent rice crops.

KEY WORDS : Zinc Effect, Rice, Red Soils

Continuous use of high analysis fertilisers and other soil and irrigation water problems for the high yielding rice varieties, led to many micronutrient nutritional disorders. Zinc deficiency has been found to be a common problem under the above circumstances and continuous submergence aggravates the problem. Devarajan *et al.* (1987) reported that soil application of $ZnSO_4$ over the recommended dose of N, P and K is suggested for Zn deficient soils in rice crop to maximise rice yield.

Large soil application of Zn was found to exert an appreciable influence on crops and soils for a relatively long period of time (Ellis *et al.*, 1969), but at the same time, its unplanned or excessive application could result in toxicity or conditions of nutrient imbalances. The present studies were undertaken to assess the direct, residual and cumulative effect of applied Zn on yield and Zn uptake by rice.

MATERIALS AND METHODS

Field experiments were conducted on red clay loam soil (Typic Ustorthent), deficient in DTPA extractable Zn (0.48 ppm), at the Tamil Nadu Agricultural University Farm, Agricultural Research Station, Bhavanisagar. The soil had pH 7.00; electrical conductivity 0.17 dS/m. Soil test indicated adequate amount of available P (15 kg/ha), K_2O (118 kg/ha) Cu (5.3 ppm). Fe (4.80 ppm), Mn (9.70 ppm) and available sulphur (24 ppm). There were five levels of $ZnSO_4$ (O, 25, 50, 75 and 100 kg/ha) and three methods of application (M_1-$ZnSO_4$ for every crop; M_2-$ZnSO_4$ - once in three crops and M_3-$ZnSO_4$ - once in six crops). Altogether, there were thirteen treatments under factorial randomised block design in three replications. IR 20 rice was used as test crop for all six seasons.

First crop was transplanted during August, 1985 and subsequent crops were raised without disturbing the original layout. A basal dose of N, P_2O_5 and K_2O was applied respectively, to each crop at 120, 60 and 60 kg/ha. Similarly, six crops were grown. After harvest of each crop, soil samples were collected and analysed for available Zn by DTPA method of Lindsay and Norvell (1978). Plant samples were digested in triacid mixtures (concentrated HNO_3:H_2SO_4:$HC1O_4$ in the ratio of 9:2:1 respectively). Zinc was estimated in triacid extract of a plant samples with Varian Techtron Atomic Absorption spectrophotometer - AA 120. Standard methods were followed for other soil analyses.

RESULTS AND DISCUSSION

Direct effect

There was a significant increase in the rice grain yield with the application of $ZnSO_4$ $7H_2O$ (Table 1). The increase in grain yield was significantly higher when $ZnSO_4$ was applied for every season to rice crop (M_1) than its application once in three crops (M_2) and once in six crops (M_3).

The response of rice crop to levels of $ZnSO_4$ was significant upto 75 kg/ha. The decrease in the grain yield of rice crop at 100 kg level of $ZnSO_4$

Table 1. Direct, residual and cumulative effect of applied Zn on rice yield (kg/ha)

Levels of $ZnSO_4$ (kg/ha)	Grain			Mean	Straw			Mean
	Method of Application				Method of Application			
	M_1	M_2	M_3		M_1	M_2	M_3	
0				3685				6080
25	4360	3950	3785	4032	6650	6200	6500	6450
50	4250	4090	3925	4088	6630	6375	6500	6502
75	4335	4305	4090	4243	6400	7000	6610	6670
100	4345	4115	3960	4140	6460	6525	6415	6670
Mean	4323	4115	3940	-	6535	6525	6500	

Mean of six crops - Pooled Analysis

	C.D. at 5%	
	Grain	Straw
Mehods (M)	60	155
Zn levels (Zn)	78	200
M x Zn	135	345

Table 2. Direct, residual and cumulative effect of applied zinc on Zn content and its uptake by rice grain and straw (content ppm: uptake :g/ha

Levels of $ZnSO_4$ (kg/ha)	Grain								Straw							
	Method of Application						Mean		Method of Application						Mean	
	M_1		M_2		M_3				M_1		M_2		M_3			
	Content	Uptake	Content	Uptake	Content	Uptake	Content	Uptake	Content	Uptake	Content	Uptake	Content	Uptake	Content	Uptake
0							27	97							36	220
25	31	137	30	119	28	107	30	121	48	305	41	257	34	223	41	262
50	36	158	32	129	30	115	33	134	46	306	39	250	40	278	42	278
75	36	158	34	152	32	132	34	147	51	337	46	343	46	311	48	330
100	39	172	38	155	34	137	37	157	50	335	41	271	36	242	42	283
Mean	36	156	34	139	31	123			49	321	42	280	39	264		

Mean of six crops - Pooled Analysis

	C.D. at 5%			
	Grain		Straw	
	Content	Uptake	Content	Uptame
Methods (M)	0.54	18	0.61	10
Zn levels (Zn)	0.70	23	0.79	13
M x Zn	1.21	NS	1.36	22

might be due to imbalance of nutrients like P_2O_5, Fe etc. Chhibba *et al.* (1989) had obtained simjlar results in rice crop in the soils of Punjab state. The Zn content and its uptake by grain and straw was (Table 2) increased significantly with increasing levels of Zn. The increase in Zn content and its uptake by grain and straw was also significantly higher when $ZnSO_4$ was applied for every season to rice crop than its application once in three crops and once in six crops. The reason attributed for the significant increase in yield as well as Zn uptake by rice is the low additions of Zn for every seasons. The higher additions of $ZnSO_4$ at 100 kg, due to its possible toxic effect, depressed not only Zn uptake but also the grain yield of rice. Therefore, repeated low additions of Zn were preferred than a single high dose.

Residual effect

The residual effect of applied Zn (Table 3) was significant on grain yield of rice. Application of 50 kg $ZnSO_4$/ha to first crop provided residual Zn for the subsequent two crops. Similar was the trend for the level of 75 kg $ZnSO_4$/ha in relation to the residual effect of Zn on grain yield of rice. Residual effect of 100 kg $ZnSO_4$/ha was observed for the subsequent five crops. The residual effect of $ZnSO_4$ was low for the low level of $ZnSO_4$. This condition

Table 3. Residual effect of applied $ZnSO_4$ on rice grain yield (kg/ha)

Methods of application of $ZnSO_4$	Levels of $ZnSO_4$ (kg/ha)			
	25	50	75	100
NPK alone	3864	3864	3864	3864
M_1	4572	4456	4530	4472
M_2	4150	4298	4520	4330
M_3	3970	4130	4308	4164
C.D at 5%	270	225	160	215

Mean of six crops; Pooled analysis

Table 4. Direct, residual and cumulative effect of applied Zn on post harvest soil Zn content (ppm)

Levels of $ZnSO_4$ (kg/ha)	Methods of application			Mean
	M_1	M_2	M_3	
0				0.62
25	3.85	1.27	0.94	2.02
50	7.46	1.56	1.27	3.43
75	5.87	2.57	1.55	3.33
100	6.00	2.60	1.56	3.38
Mean	5.79	2.00	1.33	

Pooled analysis of six crops

	C.D at 5%
Methods (M)	0.07
Zn levels (Zn)	0.09
M x Zn	0.16

may arise mainly from the rapid transformation of readily available Zn in a slightly alkaline soil to forms generally unavailable to crops. Raikshy and Takkar (1983) observed similar results in the adsorption of Zn and Cu in the alkaline soils.

DTPA extractable zinc

DTPA extractable Zn increased with increasing levels of $ZnSO_4$ and this trend was observed upto 50 kg $ZnSO_4$ (Table 4). There was a slight reduction of available Zinc at the levels of 75 and 100 kg $ZnSO_4$, though the differences between these two levels were very negligible.

Among the different methods tried, continuous application of $ZnSO_4$ for every season of the crop resulted in the build up to Zn in soils. The present results are in conformity with the findings of Bajwa and Paul (1978), Savithri and Sree Ramulu (1980) and Gupta *et al.* (1986).

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