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Integrated Nutrient Use Including Zinc for Rice

M. Yaseen, T.Hussain, A. Hakeem and S.Ahmad
Department of Soil Science, University of Agriculture, Faisalabad-38040, Pakistan

Abstract

Highest paddy and straw yields of Basmati-385 were obtained by the combined application of NPK + GM + $ZnSO_4$. It was closely followed by NPK + GM + $ZnSO_4$. It was observed that Zn application further increased the yields from those obtained by application of NPK + GM + FYM. Combined application of NPK, organic manures (GM or FYM) and Zn significantly increased the nitrogen and potassium concentrations while lowered the phosphorus concentration of paddy and straw. Reductibri in phosphorus was probably due to the antagnostic effect of Zn on P absorption. Results also indicate that Zn-application of soil was better than its foliar spray.

Introduction

Zinc is an essential plant nutrient and required in traces for the growth of plants (Jones and Jarvis, 1981). It is a necessary constituent of several enzymes taking part in the metabolism of plant. Its insufficient supply affects the health and yield of the plant. Hudda, a rice disease in Pakistan was identified as a disorder due to zinc deficiency (NFDC, 1979). Rice is considered to be the most important crop in Pakistan for zinc application (NFDC, 1998). In rice plant, zinc is associated with the production of auxin, nitrogen metabolism and activation of many enzymatic reactions (DeDatta, 1981; Tisdale *et al*., 1993).

Availability of zinc to plant is a problem. The capacity of the crop to extract zinc from the soil is governed both by the properties of soil and the plant root. High pH and high calcareousness or alkalinity reduce zinc availability (Tisdale *et al*. 1993). Zinc nutrition of rice in Pakistan has in recent years assumed great importance. However, little is done, so far, to improve its availability. The zinc status of soils and crops, therefore, needs to be considered and improved. Results of earlier experiments (Duraisamy *et al*., 1986; Swarup, 1987) showed increase in rice yield by Zn application along with green mar-wring on alkali soils. Zinc, therefore, is considered compulsory element for rice and should be replenished in the form of chemical fertilizer (Bansal and Nayyer, 1989; NFDC, 1998).

One possibility to improve the plant zinc availability is its use in integrated nutrient system which includes both organic and, inorganic fertilization. This practice is proposed to improve the zinc and other nutrients use efficiency of plant by improving the physical, chemical and biological conditions.

Materials and Methods

Experiment was laid out in RCBD with a net plot size of 4 m x 4 m. Soil was sandy clay loam in texture, normal (1.16 dS m^{-1}), low in organic matter and alkaline in reaction (pH 7.8). Initial status of total nitrogen, available phosphorus and Zn in soil was 0.052%, 6.2 mg kg^{-1} and 1.59 mg kg^{-1}, respectively. Following treatments were applied in triplicate.

Treatment	Description
Control	No fertilizer application
NPK alone	Applied at 120-90-60 kg ha^{-1}
NPK + Farm yard manure (FYM)	Applied at 10 tones ha^{-1}
NPK + Green manure (GM)	″ ″ ″
NPK + FYM + $ZnSO_4$	$ZnSO_4$ at 15 kg ha^{-1} was added through soil application
NPK + GM + $ZnSO_4$	″ ″ ″ ″
NPK + $ZnSO_4$	″ ″ ″ ″
NPK + Zn-chelate	″ ″ ″ ″
NPK + $ZnSO_4$	1% solution of $ZnSO_4$ was added through foliar spray

Rice cultivar Basmati 385 was sown. Forty days old nursery was transplanted in standing water. Two third of nitrogen as urea and whole of phosphorus as DAP, potassium as K_2SO_4 and FYM (farm yard manure) were incorporated before transplanting while remaining one third nitrogen was applied 40 days after transplanting. Forty-five days old. *Sesbania aculeata* was incorporated at 10 t ha^{-1} as green manure. Zinc-treatment were applied 20 days after transplanting. All the recommended practices were considered. Crop was harvested at maturity and yield parameters were recorded. Ground rice straw and paddy samples were analyzed for total nitrogen, phosphorus, potassium and zinc following standard procedures given in Jackson (1960).

Results and Discussion

Data revealed highly significant effect; of all the treatments on tillering and paddy yield of Basmati-385, compared to control (Table 1). Highest number, of, tillers m^{-2} and paddy were recorded where NPK + GM + $ZnSO_4$ was applied. It was followed by NPK + GM + $ZnSO_4$. All the othe, treatments had significantly least effect on tillering and paddy. Dong *et al*. (1981) also observed significant effect of Zn addition with green manuring. The results are in line with those of Duraisamy *et al*. (1986), Chaudhry *et al*.

(1992) and NFDC (1998). They reported further increase in rice yield due to addition of Zn with GM or FYM. Foliar application of Zn had least affect on rice yield among all the Zn-treatments (Table 1). Bansal and Nayyer (1989) have already reported superiority of soil application of Zn-chelate and $ZnSO_4$ over foliar spray. Similar effects were observed on rice straw yield (Table 1). Increase in over all yield of rice with the combined application of NPK + GM + $ZnSO_4$ or NPK + FYM + $ZnSO_4$ might be due to the increase in available nitrogen and its synergistic effect on the availability of other nutrients which resulted in higher yield. This conclusion can be further confirmed from the chemical composition of straw and paddy (Table 2).

Highest nitrogen concentration in both paddy and straw was obtained in NPK + GM + $ZnSO_4$ treatment while least nitrogen, concentration was with NPK alone and NPK + $ZnSO_4$ (foliar) application. Rinaudo *et al*. (1981, 1982) observed a significant increase in N concentration with combined application of inorganic fertilizer and green manuring. However, Takkar (1996) and NFDC (1998) reported that soil application of Zn (8 kg $ZnSO_4$ ha^{-1}) supported nitrogen absorption of paddy. Contrast to nitrogen highest P concentration was obtained by NPK + FYM and NPK + GM. Except control all the other treatments differed non-significantly with each other. It was also observed that P concentration was lowered in the treatments where Zn was applied. It might be due to the antagonistic effect of Zn on P. Singh and Singh (1980) and Chaudhry *et al*. (1992) reported similar findings. Overall concentration of k was higher in straw than paddy. However, its trend due to treatment effect was similar to that of nitrogen (Table 2). Treatment effect was highly pronounced for Zn. Among all the treatments especially Zn treatments maximum Zn concentration in paddy and straw was observed in the treatment where NPK + Zn chelate and NPK + ZnSO, were applied (Table 2). It might be due to more availability of Zn from Zn-chelate and $ZnSO_4$. The availability of Zn could also be supported by the added organic materials. Green manure and FYM application increased the effectiveness of Zn application (Amer *et al*., 1980). Maskina and Randhawa (1983) reported that application of organic manures with Zn had beneficial effect on the availability of Zn and increased the Zn concentration of plant. Results of this experiment support the application of Zn in combination with green manure or farm yard1 manure.

Table 1: Number of tillers, rice straw and paddy yield

Treatments	Tillers m^{-2}	Paddy	Straw
		--------- kg ha^{-1} -------	
Control	128 i	1920 h	2872 l
NPK alone	171 h	3293 g	4793 h
NPK + FYM	221 d	4730 c	6853 d
NPK + GM	238 c	4916 c	7353 c
NPK + FYM + ZnSO4	261 b	5160 b	7763 b
NPK + GM + ZnSO4	282 a	5250 a	8340 a
NPK + $ZnSO_4$	198 f	4110 e	5986 f
NPK + Zn-chelate	209 e	4330 d	6506 e
NPK + $ZnSO_4$ (foliar spary)	187 g	3530 f	5310 g

Means sharing different letter differed significantly at $p < 0.05$.

Table 2: Nitrogen, phosphorus, potassium and zinc concentration in rice straw and paddy

	Paddy				Straw			
	N	P	K	Zn	N	P	K	Zn
Treatments	---------- (%) ----------			(ppm)	---------- (%) ----------			(ppm)
Control	0.56 e	0.23 e	0.16 d	26.96 f	0.21 g	0.05 c	1.59 d	18.619
NPK alone	0.63 cd	0.26 c	0.18 c	31.69 e	0.25 f	0.06 b	1.67 c	21.28f
NPK + FYN!	0.67 bc	0.30 a	0.19 bc	32.33 de	0.32 cd	0.07 a	1.73 ab	24.74e
NPK + GM	0.70 b	0.29 a	0.19 bc	33.36 cd	0.35 bc	0.07 ab	1.74 ab	24.33e
NPK + FYM + ZnSO4	0.70 b	0.28 b	0.21 b	35.46 bc	0.38 b	0.07 ab	1.74 a	26.62bc
NPK + GM + $ZnSO_4$	0.94 a	0.28 b	0.29 a	35.96 ab	0.44 a	0.07 ab	1.75 a	26.19c
NPK + ZnSO4	0.67 bc	0.24 d	0.18 bc	36.93 ab	0.31 de	0.06 b	1.72 ab	26.99ab
NPK + Zn-chelate	0.66bcd	0.25 d	0.18 bc	37.01 a	0.29 de	0.06 b	1.72 ab	27.25a
NPK + $ZnSO_4$ (foliar spray)	0.62 d	0.27 d	0.18 bc	36.64 ab	0.28 of	0.07 ab	1.70 bc	25.60d

Means sharing different letter(s) differ significantly at $P < 0.05$

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