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Rice-wheat Response to Integrated Nutrient Management With Special Emphasis on Zinc Fertilization

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Abstract

ata on rice crop showed that yield and yield contributing parameters were significantly affected by various nutrient ombinations and sources. NPK + GM + $ZnSO_4$ gave the best results. It was followed by NPK + FYM + $ZnSO_4$ while ithout GM or FYM, Zn-chelate performed better than $ZnSO_4$. Foliar spray of $ZnSO_4$ was found inferior among all the ources and methods of zinc application. Grain yield of follow-up wheat crop was statistically similar in all the fertilizer ombinations, however, straw yield was maximum where FYM or GM were applied in addition to $ZnSO_4$ to the previous ce crops.

ntroduction

verage per hectare crop yields in Pakistan are among the west in the world. Our soils have potential to produce a t but low organic matter contents other than the ssociated problems such as alkaline soil pH, alcareousness, mining of nutrient with extensive cropping, se of micronutrient free NPK fertilizers and less use of anures (NFDC, 1998) is one of the major reasons for it. oils are being depleted due to injudicious use of plant utrients and cropping sequence. Among the micronutrient, n deficiency is the most widespread in the rice (Zia, 1995) nd follow up crops. Its deficiency extent is 87 per cent in ce-wheat system in the Punjab (NFDC, 1998). Rice esponded to Zn application (PARC, 1986) and caused crease in 10-12 per cent paddy. Therefore the dire need f the time is to boost up the yield of crops by maintaining ne soil fertility in good health.

lany scientists have recommended the use of organic anures to boost up the crop yields.The importance of rganic manures as a source of plant nutrition is due to its ultiple function in soil (Mamaril *et al.*, 1986). On one hand adds nutrients to soil and on the other it improves soil haracteristics (Gunnasena and Ahmad, 1977) by romoting infiltration rate and hydraulic conductivity of the oil. All these improve the productivity of the soils and ence the yields of crops like wheat and rice.

ince great opportunities/potential exist for increasing rice nd wheat production by an integrated nutrient anagement system using both organic and mineral ources of fertilizers. Present investigation was undertaken o evaluate the effect of organic and inorganic fertilizer ources along with different sources and methods of Zn pplication to rice and their residual effect was studied on wheat by applying only inorganic fertilizers .

Materials and Methods

A field experiment was conducted during 1990-91 at the esearch area of Soil Science, University of Agriculture, aisalabad. Soil was sandy clay loam in texture, low in organic matter, alkaline in reaction and free from salinity/sodicity hazards. Initial status of total nitrogen, available phosphorus, and zinc in soil was 0.052%, 6.2 mg kg^{-1} and 1.59 mg kg^{-1}, respectively. Under rice-wheat cropping system, NPK and Zn fertilizers with and without organic manures (Farm yard manure and green manure) was applied to rice. The treatments were NPK (120-90-60 kg ha^{-1}) alone as well as in combination with FYM and green manure (GM) of 45 days old *Sesbania aculeata*. All these treatments were superimposed by different zinc sources viz. $ZnSO_4$, and Zn-chelate @ 15 kg Zn ha^{-1}. An additional treatment of Zn as foliar spray @ 4 kg Zn ha^{-1} was also carried out with NPK only. FYM and GM (having 3.0 and 0.472 % total nitrogen, respectively) were added @ 10 t ha^{-1} each before transplanting rice variety Basmati-385. The sources of N, P and K were NPK mixture (12-12-17), diammonium phosphate and urea. At harvest, data on number of tillers m^{-2}, rice straw and paddy yield were recorded. Rice straw and paddy were analyzed for total nitrogen (Jacksen, 1962), total phosphorus (P) and potassium (K) and Zn by wet ashing (USDA, 1954, Method 54a) and estimated by USDA (1954) methods 61, 58a for P & K and Zn by atomic absorption spectrophotometer. After harvesting rice and before sowing wheat variety LU-26S, a composite soil sample from each plot was collected from 0-30 cm depth to see the soil status for total nitrogen (Jackson, 1962), available P (Watanabe and Olsen, 1965), potassium (USDA, 1954) and Zn (Lindsay and Norvell, 1978). Residual effect of nutrient combinations given to rice was studied on the follow up wheat crop by applying only NPK (120-90-60 kg ha^{-1}) in each treatment applied to rice. Sources were urea, diammonium phosphate and K_2SO_4. At maturity crop were harvested and data on wheat straw and grain were recorded.

Results and Discussion

Rice crop responded significantly to NPK, green manure (GM), farm yard manure (FYM) and Zn for tillering (Table 1). Highest number of tillers m^{-2} were obtained with the

Table 1: Effect of integrated nutrients on rice yield and residual effect on wheat yield

Treatment	Rice			Wheat		
	Tillers m^{-2}	Piddy (kg)	Straw ha^{-1}	Tillers m^{-2}	Grain (kg)	Straw (ha
Control	128 i	1920 h	2872 l	299 c	1502 b	2779 d
NPK alone	171 h	3293 g	4793 h	414 b	3496 a	6584 c
NPK + FYM	221 d	4730 c	6853 d	479 a	4292 a	7227 bc
NPK + GM	238 c	4916 c	7353 c	466 a	4128 a	7102 bc
NPK + FYM + $ZnSO_4$	261 b	5160 b	7763 b	496 a	4402 a	7903 a
NPK + GM + $ZnSO_4$	282 a	5250 a	8340 a	481 a	4326 a	7670 ab
NPK + $ZnSO_4$	198 f	4110 e	5986 f	449 ab	3628 a	6797 c
NPK + Zn-chelate	209 e	4330 d	6506 e	465 ab	3901 a	6965 c
NPK + $ZnSO_4$ (foliar spary)	187 g	3530 f	5310 g	455 ab	3425 a	6540 c

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

Table 2: Effect of integrated nutrients on nitrogen, phosphorus, potassium and zinc uptake by rice

Treatment	Paddy				Straw			
	N	P	K	Zn	N	P	K	ZN
		(Kg ha^{-1})				(Kg ha^{-1})		
Control	10.8 f	4.4 e	3.0 f	0.05 f	6.1 g	1.4 e	45.7 l	0.05 h
NPK alone	20.7 e	8.7 d	5.8 e	0.10 e	12.1 f	2.8 d	80.1 h	0.10 g
NPK + FYM	31.8 c	14.0 a	9.2 c	0.15 c	22.1 d	4.8 b	118.5 d	0.17 d
NPK + GM	34.4 b	14.7 a	9.6 c	0.17 b	25.7 c	4.9 b	127.7 c	0.18 c
NPK + FYM + $ZnSO_4$	36.1 b	14.5 a	10.7 b	0.19 a	29.4 b	5.4 ab	135.3 b	0.20 b
NPK + GM + $ZnSO_4$	49.2 a	14.8 a	15.2 a	0.19 a	36.7 a	5.6 a	146.0 a	0.22 a
NPK + $ZnSO_4$	27.6 d	10.0 bc	7.3 d	0.15 c	18.4 e	3.8 c	102.8 f	0.16 e
NPK + Zn-chelate	28.5 d	10.8 b	7.7 d	0.16 c	19.1 de	4.2 c	112.2 e	0.18 c
NPK + $ZnSO_4$ (foliar spary)	21.9 e	9.4 cd	6.3 e	0.13 d	14.9 f	3.1 d	90.2 g	0.14 f

Means sharing different latter(s) differ significntly at $P < 0.05$.

Table 3. Effect of integrated nutrients on nitrogen, phosphorus, potassium and zinc concentration after rice harvesti

Treatments	N	P	K	Zn
			mg kg^{-1}	
Control	0.04 d	5.15 e	52.5 f	1.40 e
NPK alone	0.06 c	6.68 c	76.7 e	1.52 d
NPK + FYM	0.06 bc	7.95 a	115.7 c	1.58 bc
NPK + GM	0.07 ab	7.88 a	115.7 c	1.55 cd
NPK + FYM + $ZnSO_4$	0.07 ab	7.23 b	157.3 b	1.68 ab
NPK + GM + $ZnSO_4$	0.07 a	7.18 b	179.4 a	1.66 ab
NPK + $ZnSO_4$	0.06 bc	6.37 d	99.2 cd	1.72 a
NPK + Zn-chelate	0.06 c	6.44 cd	96.2 cd	1.70 ab
NPK + $ZnSO_4$ (foliar spary)	0.06 c	6.71 c	87.1 d	1.53 d

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

application of NPK + GM + $ZnSO_4$ followed by NPK + FYM + $ZnSO_4$. NPK with soil application of Zn as Zn-chelate, $ZnSO_4$, Zn foliar spray and alone produced lower number of tillers m^{-2}. This might be due to the efficient use of nitrogen and the phosphorus fertilizers due to application of organic manures in combination. As GM of *Sesbania aculeata* is a susceptible biomass, so it is easily decomposed by cellulolytic fungi when added to soil (Malik and Haider, 1977). It therefore, brings about the solubilization of nutrients particularly the phosphorus by producing o acids. This was also confirmed by Bottenberg (1981) reported that addition of leaves of *Leucaena leucoc* as green manure, significantly increased the num tillers in rice. The application of GM, FYM and combination with Rice straw and paddy yields (T differed significantly with different treatment combi Maximum straw and paddy yields were produced w integration of NPK with GM and $ZnSO_4$, follow

IPK + FYM + $ZnSO_4$. The lowest straw and paddy yields vere recorded in control. inorganic fertilizers increased the vailability of total nitrogen and other essential nutrients in oil for plant. Hussain *et al.* (1988) and Zia (1995) also eported a significant increase in paddy yield of rice KS-282 vith integrated nutrient management. Among the Zn ources, soil application of Zn-chelate and $ZnSO_4$ produced igher paddy yield than that of foliar application. Bansal and ayyer (1989) and NFDC (1998) obtained similar results. itrogen uptake by paddy was substantially increased with M, FYM and Zn combination compared to control (Table). Maximum N, P, K and zn uptake was observed with PK + GM + $ZnSO_4$. Nitrogen uptake in this treatment was atistically higher than all the other treatments while P ptake was statistically at par with NPK + GM, PK + FYM + $ZnSO_4$ and NPK + FYM however, Zn uptake as statistically at par with only NPK + FYM + $ZnSO_4$ ombination. This might be due to nitrogen and other utrients contributed by GM or FYM in addition to nutrients dded through chemical fertilizers. Landha et al. (1989) also eported that GM of sesbania considerably enhanced the ptake of N, P and K by rice crop. Data in Table 2 reveal milar trend of N, P, K and Zn uptake by rice straw. All eatments differed significantly with each other as well as ith the control. Maximum N, P, K and Zn uptake was bserved with NPK + GM + $ZnSO_4$ + NPK + FYM + $ZnSO_4$. itrogen concentration in soil after harvesting rice was ghly significant and was maximum in treatments where YM and GM were applied while P concentration was atistically maximum in the treatments of NPK + FYM and PK + GM compared to all other treatments (Table 3). PK + GR + $ZnSO_4$ contributed more K in the soil which was gnificantly higher compared to all other combinations hile Zn concentration in soil was statistically similar in the eatments where Zn was applied in the form of $ZnSO_4$ or n-chelate except when Zn was applied as foliar spray. eelu and Morris (1984) and Rekhi & Meelu (1984) found at application of FYM and GM to soil enriched the soil and owed considerable improvement in soil fertility. Singh *et* (1988) applied FYM, and *Sesbania bispinosa* as green anure and reported that available P in soil after rice rvest was increased.

esidual effect of all the treatments applied to rice was udied on wheat by applying (120-90-60 kg NPK ha^{-1}) to the treatments. Data on number of tillers m^{-2} (Table 1) dicated superiority of all the treatments over control but ey did not differ statistically among themselves. Tillering as slightly higher in FYM and GM treated plots. Tiwari *et* (1980) also found a positive residual effect of green anuring. Similarly the residual effect on wheat grain yield as non significant except control. Maximum straw yield as obtained with NPK + FYM + $ZnSO_4$ combination and it as statistically at par with that of NPK + GM + $ZnSO_4$ and gnificantly higher compared to all other treatments. It can e concluded that residual effect of FYM and GM is not so pparent on the follow up crop. It may have significant sidual effect if this practice would be continued on long rm basis. According to Takkar (1996) residual effect of 5- kg Zn ha^{-1} application to rice-wheat system lasted for as ng as five rice crops and six wheat crops.

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