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PRODUCTION POTENTIAL OF RICE- WHEAT CROPS AS INFLUENCED BY ZINC MANAGEMENT IN PARTIALLY RECLAIMED SODIC SOIL

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ABSTRACT

Field and laboratories studies were conducted for three consecutive years (2008-09 to 2010-11) to evaluate the production potential of rice-wheat crops as influenced by zinc management in partially reclaimed sodic soil at Kanpur (U.P). The results revealed that the maximum grain (4.3 and 3.8 t ha^{-1}) and straw (5.4 and 4.6 t ha^{-1}) yield of rice and wheat, respectively were recorded with application of 50 kg $ZnSO_4$ ha^{-1} each in kharif and rabi season. The mean increases over control varied from 11.5 to 99.2 % and 24.5 to 195.5% in grain and 11.5 to 97.0 % and 29.9 to 178.6% in straw of rice and wheat, respectively. Application of 50 kg $ZnSO_4$ ha^{-1} in each kharif and rabi season recorded highest uptake of N (81.3 kg ha^{-1}), P (16.2 kg ha^{-1}), K (87.8 kg ha^{-1}) and Zn (86.9g ha^{-1}) by grain and 40.8, 7.3, 73.5 kg ha^{-1} and 82.7 g ha^{-1} by straw of wheat, respectively. The maximum uptake values of these nutrients by rice cultivar were higher than that of wheat. The average value of apparent zinc recovery of rice differed from 5.9 to 90.0 and wheat 8.0 to 87.3, respectively. The maximum net return ₹. 29517 with benefit cost ratio 2.8 of rice and ₹. 33125 with B: C ratios 2.2 of wheat were recorded under the influence of 50 kg $ZnSO_4$ ha^{-1} applied in both kharif and rabi seasons.

Kew words: Zinc management, yield nutrient, uptake, rice- wheat cropping system, sodic soil.

INTRODUCTION

Salt affected soils are wide spread in northern part of the country. These soils bear distinctive characters of containing excessive concentration of soluble salts of sodium. Sodic soil pose many limitation to crop growth by way of the toxic effect of sodicity and certain nutrients element as well as poor fertility due to restriction availability of certain major and micro-nutrients. Availability of nitrogen and zinc to plants in these soils is extremely poor (Chaudhary *et al.* 2003 and Tripathi *et al.* 2012). Rice-wheat cropping system is well documented in partially amended sodic soil. Enhancing the yield potential of rice- wheat crops in such type of soil requires special management of soil, fertilizer nutrients and micro-nutrients. Availability of zinc to plants is extremely poor in sodic soil (Tripathi and Kumar 2013 and Tripathi *et al.* 2010). Zinc deficiency has been recognized as an important and wide spread nutritional disorder in such type of soils. The physico-chemical condition of sodic soil is also a serious problem in plant nutrition because these soils are very poor in organic matter (Chaudhary *et al.*2003 and Singh and Tripathi 2005). But for, with passage of time productivity growth of rice-wheat crops in partially reclaimed sodic soil with full complement of major nutrients treatments fell and become unsuitable (Singh and Tripathi 2008). For maximization of rice-wheat production there is urgent need for quantum jump in productivity as expansion of cultivable lands has become prohibiting. Taking these facts in view, an investigation was aims at examining the suitable level and addition system of zinc sulphate with key objective of identification the most efficient ones for rice- wheat cropping pattern in partially reclaimed sodic soil.

MATERIALS AND METHODS

The present investigation was planned and conducted during *kharif and rabi* season of 2008 to 2011 in a fixed layout in sodic soil of crop production farm Bojha, C.S. Azad University of Agriculture and Technology, Kanpur (U.P.). The initial physico-chemical and mechanical characteristics of the partially reclaimed experimental soil were sand 48.5%, silt 34.0% and clay 17.5%, pH 9.6, E.C. 1.25 dSm^{-1}, exchangeable Na^+ 65.5%, CEC. 12.37 cmol $(P^+)kg^{-1,}$ organic carbon 1.7 g kg^{-1}, bulk density 1.46 Mgm^{-3}, particle density 2.54 Mgm^{-3}, porosity 37.8 %, hydraulic conductivity 0.28 cm hr^{-1}, volume expansion 12.5 %. The texture of the soil was clay-loam under Typic Natrustals Taxonomical class having available N, P_2O_5, K_2O 145, 28, 215 kg ha^{-1}, respectively, DTPA extractable Zn was 0.18 mg kg^{-1} soil. The levels and application sequence of zinc sulphate namely T_1 – control (no zinc), T_2- 25 kg $ZnSO_4$ ha^{-1} only in first *kharif* season, T_3- 25 kg $ZnSO_4$ ha^{-1} alternate in *kharif* season, T_4- 25 kg $ZnSO_4$ ha^{-1} in alternate *rabi* season, T_5- 25 kg $ZnSO_4$ ha^{-1} each in both season, T_6- 50 kg $ZnSO_4$ ha^{-1} in first *kharif* season, T_7- 50 kg $ZnSO_4$ ha^{-1} in alternate *kharif*

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season, T_8-50 kg $ZnSO_4ha^{-1}$ in alternate *rabi* season, T_9- 50 kg $ZnSO_4$ ha^{-1} each in both season T_{10}- 75 kg $ZnSO_4$ ha^{-1} in first *kharif* season, T_{11}- 75 Kg $ZnSO_4$ ha^{-1}` in alternate *kharif* season, T_{12} - 75 kg $ZnSO_4$ ha^{-1} alternate in *rabi* season and T_{13}- 75 kg $ZnSO_4$ ha^{-1} each in both season. Seedlings of rice 'NDR-359' 35 days old were transplanted in second week of July during each year and wheat 'PBW-343' was sown in fourth week of November during all experimental years.The experiment was conducted in randomized block design with four replication. Nitrogen, phosphorus and potassium were applied @ 150, 60 and 40 $kgha^{-1}$, through urea, diammonium phosphate and muriate of potash, respectively. Each levels of $ZnSO_4$, phosphorus and potassium along with 1/3 dose of urea were added as basal at the time of transplanting/sowing of rice and wheat crops. Remaining doses of urea (N) was applied at tillering and flowering stage of rice and wheat crops Agronomical cultural practices such as irrigation, weeding and plant protection measures have been performed as per requisited. At maturity of rice and wheat crops, grain and straw yields were recorded. The net return and benefit: Cost ratios of both the crops under the influence of various treatments were calculated. Grain and straw samples were analyzed for their nitrogen content by modified Kjeldahl method (Jackson 1973), Phosphorus was determined by vanadomolybdate yellow colour method and patossium by flame photometer in di-acid digest. Zinc in di acid digest was estimated on atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

Grain and straw yield

It is obvious from the data (Table 1) that the grain and straw yields of both rice and wheat under the influence of various treatments significantly increased over control. The mean grain and straw yield of rice and wheat varied from 2.2 to 4.3 t ha^{-1} and 1.3 to 3.8 t ha^{-1} and 2.7 to 5.4 and 1.6 to 4.6 t ha^{-1}, respectively. In general, increasing dose of zinc sulphate markedly increased the grain yield of both crops but maximum grain and straw yields of rice (4.3 and 5.4 t ha^{-1}) and wheat (3.8 and 4.6 t ha^{-1}) were recorded under the influence of 50 kg $ZnSO_4$ ha^{-1} applied in each *kharif and rabi* season followed by 50 kg $ZnSO_4$ ha^{-1} and 75 kg $ZnSO_4$ ha^{-1} applied in alternate *kharif* season. Application of 75 kg $ZnSO_4$ ha^{-1} in each season showed adverse effect on the yield of rice and wheat crops. Lowest yields of rice and wheat were noticed in control plots. Thus, it is clear from the results that addition of 50 kg $ZnSO_4$ ha^{-1} each in *kharif and rabi* crops responded more in both rice and wheat crops in partially reclaimed sodic soil. These results are comparable to those reported by Tripathi *et al.* (2012) and Tripathi and Kumar (2013). On pooled basis the increases over control ranged from 11.5 to 99.2 and 14.8 to 97.2 % in grain and straw of rice and 24.5 to 195.5 and 29.9 to 178.6 % in grain and straw of wheat. Maximum average increase in grain (195.5%) and straw (178.6 %) of wheat has been recorded under 50 kg $ZnSO_4$ ha^{-1} applied in both *kharif* and *rabi* season. This fevourable effect of Zn may be because addition of zinc might have maintained a favourable balance among nutrients in wheat plants for optimum growth. Chauhan *et al.* (2014) also reported response of wheat to zinc application.

Table 1: Response of zinc management practices on the yield and zinc use efficiency of wheat and rice (mean of 3 years)

Treatment	Rice				Wheat			
	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Net return ₹. ha^{-1}	B:C ratio	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Net return ₹. ha^{-1}	B:C ratio
T_1	2.2	2.7	1541	0.4	1.3	1.6	1145	0.3
T_2	3.2	3.9	19298	1.5	2.4	3.0	7967	1.3
T_3	3.5	4.3	19359	1.7	2.6	3.0	13307	1.5
T_4	2.4	3.1	4540	1.3	1.6	2.1	1135	1.2
T_5	3.6	4.4	18416	1.6	2.4	3.1	10025	1.4
T_6	3.8	4.8	23329	1.7	3.2	3.5	17510	1.6
T_7	4.2	5.3	27312	2.7	3.6	4.4	31347	2.0
T_8	2.5	3.2	5719	1.4	2.2	2.7	10057	1.3
T_9	4.3	5.4	29517	2.3	3.8	4.6	33125	2.2
T_{10}	3.7	4.6	25575	1.6	2.9	3.6	14434	1.5
T_{11}	3.9	4.9	25299	1.9	3.3	3.8	19402	1.8
T_{12}	2.6	3.2	3545	1.1	2.0	2.5	3129	1.2
T_{13}	3.6	4.5	19130	1.0	2.8	3.4	8855	1.1
CD (P=0.05)	1.8	2.3			1.3	1.7	-	-

Economics

The result revealed that net returns with benefit: cost ratio varied from ₹.1541 to ₹. 29517 with 0.4 to 2.8 from rice and ₹. 1145 to ₹. 33125 with 0.3 to 2.2 from wheat, respectively (Table 1). Application of 50 kg $ZnSO_4$ ha^{-1} each in *kharif* and *rabi* season in both crops gave maximum net return with highest benefit: cost ratio. The lowest net return with minimum benefit: cost ratio were recorded in that sequence in which zinc sulphate was neither applied in *kharif* nor in *rabi* season. Application of 75 kg $ZnSO_4$ ha^{-1} through various sequences in each *kharif* and *rabi* season could not enhance the net returns and benefit: cost ratio in comparison to 50 kg $ZnSO_4$ ha^{-1} applied both in rice and wheat crops. Therefore, on the economic point of view, 50 kg $ZnSO_4$ ha^{-1} in both rice and wheat crop was found most beneficial**.** The increase in net returns by the application of Zn SO_4 might be due to positive effect of Zn grain and straw yield. The results have close conformity with those reported by Singh and Tripathi (2008), Mandal *et al.* (2009) and Chauhan *et al.* (2014).

Table 2: Effect of zinc management on uptake by of N, P, K, (Kg ha^{-1}) and Zn (g ha^{-1}) by grain and straw of rice (mean data of 03 years)

Treatment	Uptake by grain				Uptake by straw			
	N	P	K	Zn	N	P	K	Zn
T_1	26.8	5.7	30.4	44.8	22.0	3.8	35.4	43.2
T_2	55.4	8.9	51.4	68.4	33.5	5.7	63.4	64.6
T_3	61.6	10.0	65.1	76.0	37.1	6.5	72.5	71.2
T_4	43.0	7.0	45.9	53.0	26.2	4.5	50.6	50.2
T_5	64.9	10.7	67.0	78.8	38.1	6.7	74.9	73.0
T_6	75.3	12.8	75.1	85.5	42.4	7.5	83.0	81.8
T_7	84.6	15.4	83.6	95.5	47.4	8.4	93.2	91.3
T_8	50.1	9.9	49.5	56.4	27.9	5.0	54.5	54.8
T_9	88.8	18.2	84.2	97.6	48.0	8.6	98.8	92.5
T_{10}	76.7	13.5	71.8	84.8	40.8	7.3	83.8	79.3
T_{11}	82.0	14.3	76.6	90.0	42.6	7.9	89.8	85.2
T_{12}	53.7	9.9	49.9	58.7	28.4	5.1	58.8	55.7
T_{13}	76.8	15.0	70.5	85.7	40.3	7.3	84.0	76.6
CD (P= 0.05)	1.9	0.6	2.2	2.4	1.8	0.4	2.1	2.3

Uptake of nutrients

It is obvious from the data (table-2) that mean values of uptake of N,P,K and Zn by grain of rice varied from 26.8 to 88.8, 5.7 to 18.2, 30.4 to 84.2 kg ha^{-1} and 44.8 to 97.6 g ha^{-1}, respectively. The corresponding ranges of uptake of these nutrients in straw were from 22.0 to 48.0, 3.8 to 8.6, 35.4 to 98.8 kg ha^{-1} and 43.2 to 92.5 g ha^{-1}. Maximum uptake of N, P, K, and Zn by rice grain and straw were recorded with 50 kg $ZnSO_4$ ha^{-1} applied in both *kharif* and *rabi* season followed by its application alternate in *kharif* seasons. This trend again confirmed the results of Mandal *et al.* (2009), Singh and Tripathi (2005) and Tripathi and Rawat (2002). In general, N, P, K and Zn uptake by grain and straw of wheat under the influence of zinc sulphate application ranged from 16.1 to 81.3, 3.4 to 16.2, 20.7 to 73.5 kg ha^{-1} and 26.9 to 86.9 g ha^{-1}, respectively and 13.3 to 40.8, 2.3 to 7.3, 21.1 to 87.8 kg ha^{-1} and 25.9 to 82.7 g ha^{-1}. This increase in uptake of nutrients by the crop withZn application may be ascribed to greater grain and straw production. Similar results were reported by Chauhan *et al.* (2014) in wheat and Tripathi et al. (2014) in rice.

From the results, it is concluded that increasing levels of $ZnSO_4$ up to 50 kg ha^{-1} markedly enhanced the grain and straw yield as well as nutrients uptake in both rice and wheat crops. Application of 75 kg $ZnSO_4$ ha^{-1} in *kharif* and *rabi* season showed adverse effect on yield and uptake of nutrients by both the crops.

Table 3: Effect of zinc management on uptake by of N, P, K, (Kg ha^{-1}) and Zn (g ha^{-1}) by grain and straw of wheat (mean data of 03 years)

Treatment	**Uptake by grain**				**Uptake by straw**			
	N	**P**	**K**	**Zn**	**N**	**P**	**K**	**Zn**
T_1	16.1	3.4	20.7	26.9	13.3	2.3	21.1	25.9
T_2	41.6	6.7	41.5	51.3	23.5	4.0	48.9	45.2
T_3	47.2	7.6	45.6	57.2	25.9	4.5	54.6	49.8
T_4	29.4	4.8	32.1	44.7	18.3	3.2	34.0	35.2
T_5	44.1	7.3	46.9	53.4	26.8	4.7	50.9	51.1
T_6	67.2	11.3	66.9	76.2	37.6	6.7	73.9	72.7
T_7	75.1	14.4	71.7	84.8	40.7	7.3	83.9	78.1
T_8	44.5	8.9	42.0	50.3	23.9	4.3	50.5	45.8
T_9	81.3	16.2	73.5	86.9	40.8	7.3	87.8	82.7
T_{10}	58.8	10.0	56.0	65.4	31.8	5.8	62.2	61.8
T_{11}	63.7	11.9	59.4	70.5	33.8	6.2	69.8	66.0
T_{12}	41.9	7.9	39.0	46.1	22.2	4.0	45.7	43.4
T_{13}	60.0	11.7	53.9	66.1	30.8	5.6	65.5	60.1
CD (P=0.05)	1.8	0.4	1.9	2.0	1.7	0.4	1.9	2.2

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