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BALANCED NUTRITION FOR HIGHER YIELD AND UPTAKE OF NUTRIENTS IN RICE-GROWN ON RECENTLY RECLAIMED SODIC SOIL

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ABSTRACT

A field experiment was conducted at cultivator's field on recently reclaimed sodic soil of Etah district (Uttar Pradesh) with rice variety Usar-1 to compare the response of balanced nutrition through STR (NPK) + 60 kg S + 5 kg Zn ha^{-1} and SR (NPK) + 60 kg S + 5 kg Zn ha^{-1} at 100 and 125% levels during Kharif seasons of 2005-06 and 2006-07. The results indicated that all the treatments were significantly superior to control with respect to various parameters under study, and 125% STR gave significantly higher yield, than SR and 100% STR. Treatment 125% STR + 60 kg S + 5 kg Zn ha^{-1} produced the highest mean yields of grain and straw (44.0 and 57.5 q ha^{-1}, respectively). Addition of S and Zn with 125% STR resulted in an increase in grain yield by 6.3 and 5.0 q ha^{-1} and straw yield by 5.7 and 8.2 q ha^{-1} during first and second year, respectively. The content of nutrients in grain and stover were maximum under 125% STR + 60 kg S + 5kg Zn ha-^{1} followed by 125% STR + 60 kg S ha-^{1} and minimum in control. The uptake of N,P,K,S and Zn by grain and stover was maximum with 125% STR + 60 kg S + 5 kg Zn ha^{-1} and minimum in control.

Keywords: SR, STR nutrient uptake, yield, rice, balanced nutrition

INTRODUCTION

Among the degraded lands, salt affected soils are most problematic, occurring in arid, semi-arid regions, where loss of moisture due to evaporation is higher than precipitation, resulting in accumulation of chlorides, carbonates and bicarbonates of Na, K and Mg. In India these soils occupy nearly 8.58 m ha area with impaired productivity (Singh 2010). A sizable area of 15% salt affected soils of the country occurs in U.P. with larger share of sodic soils. These soils are characterized by alkaline pH, poor physical conditions and ESP more than 15. Besides the reclamation of salt affected soils their nutrient management is of critical importance for targeted yields. During reclamation of such soils, addition of amendments, leaching and drainage etc. result in impoverishment of nutrients in these soils (Tiwari and Tiwari, 2008). Soil testing provides the information regarding the status of nutrients in soil and that to be added through fertilizers. The old state and soil test recommendations have become obsolete with time and need upward revision. Rice was selected as post reclamation test crop because of its resistance to sodicity (Tripathi and Kumar, 2013).With this rationale the present study was undertaken to achieve maintenance and build up doses of NPKS and Zn for high sustainable yields in rice.

MATERIALS AND METHODS

An adaptive trial on farmer's field was conducted in Etah district during Kharif seasons of 2005 and 2006 on recently reclaimed sodic soil at fixed layout in RBD with ten treatments and three replication using rice variety Usar-1. The soil had pH: 9.1, EC 0.3 dSm^{-1}, available NPK and S as 150, 8.2, 180, 4.5 kg ha^{-1} respectively. Organic carbon 1.6 g kg^{-1}, Zinc 0.45 mg kg^{-1}and GR-3.3 t ha^{-1}. The treatments were T_1 (control), T_2 (NPK SR-120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1}), T_3 (T_2 + 60 kg S ha^{-1}), T_4 (T_3 + 5 kg Zn ha^{-1}), T_5 (100% STR-147 kg N, 62 kg P_2O_5 and 40 kg K_2O ha^{-1}), T_6 (T_5 + 60 kg S ha^{-1}), T_7 (T_6 + 5 kg Zn ha^{-1}), T_8 (125% STR), T_9 (T_8 + 60 kg S ha^{-1}) and T_{10} (T_9 + 5 kg Zn ha^{-1}).The grain and straw yields of rice crop were recorded at maturity. The concentrations of N, P, K, S and Zn were analysed in grain and straw. Nitrogen was determined by Kjeldahl method (Jackson, 1973), Phosphorus was determined in tri acid extract by vanadomolybdate yellow colour method. Potassium was determined in acid extract by flame photometer. S by turbidimetric method (Chesnin and Yien, 1951) and Zn by atomic absorption spectrophotometer. The uptake of nutrients was calculated on the basis of yield and content of nutrients.

RESULTS AND DISCUSSION

Grain and straw yield

It was observed (Table 1) that the trend of results was similar during both the years. The grain yield varied from 19.0 to 43.3 and from 19.5 to 45.0 q ha^{-1} and in straw it ranged from 27.0 to 52.4 and 28.0 to 60.7 q ha^{-1} during first and second year, respectively. Application of 125% STR +60 kg S + 5 kg Zn ha-^{1} gave the highest yields of grain and straw during both the years, which was significantly higher than the rest of treatments. Addition of 60 kg S and 5

kg Zn ha^{-1} with 125% STR was significantly superior to 100% STR alone and the contribution of 60 kg S + 5 kg Zn ha^{-1} in increasing the yield was 6.3 and 5.0 q ha^{-1} in grain and 5.7 and 8.2 q ha^{-1} in straw during first and second year, respectively indicating 14% mean increase in yield of grain and straw due to addition of 60 kg S + 5 kg Zn ha^{-1}. The experimental soil was deficient in N and P and more specifically in S and Zn the observed responses of these nutrients in the present study are explicit. Gupta *et al.* (2009) reported a 12.6% increase in rice yield due to S + Zn over STR. Tripathi and Kumar (2013) also observed significant increase in rice yield grown on partially reclaimed sodic soil due to S and Zn application.

Table 1: Effect of different fertilizer treatments on yield (q ha^{-1}) of rice

S. No.	Treatments	Grain		Straw	
		2005-06	2006-07	2005-06	2006-07
T_1	Control	19.0	19.5	27.0	28.0
T_2	NPK (SR)	30.5	31.0	43.0	45.5
T_3	NPK (SR) + S_{60}	31.5	33.0	43.5	44.5
T_4	NPK (SR) + S_{60} + Zn_5	33.8	36.8	45.8	46.8
T_5	100% STR	33.0	35.0	44.5	47.8
T_6	100% STR + S_{60}	34.5	37.3	46.7	50.0
T_7	100% STR + S_{60} + Zn_5	37.5	38.9	49.5	53.0
T_8	125% STR	37.0	40.0	48.5	52.5
T_9	125% STR + S_{60}	39.0	42.6	51.8	56.5
T_{10}	125% STR+S_{60} + Zn_5	43.3	45.0	54.2	60.7
	$SE_{m\pm}$	1.69	1.81	2.38	2.24
	CD (P = 0.05)	3.52	3.78	4.96	4.67

There was no significant difference in yield due to SR and 100% STR but 125% STR was significantly superior to SR and 100% STR in respect of grain ans straw production. Thus there is justification to upgrade the soil test levels by 125% (Tiwari and Tiwari 2008, Gupta *et al.* 2009). Dubey *et al.* (2006) observed maximum yield of rice with 180 kg N and 90 kg P_2O_5 ha^{-1}, which is almost equal to 125% STR values in the present study.

Content of Nutrients

The ranges of the content of nutrients were observed as: N 1.43 to 1.52% in grain and 0.23 to 0.28% in straw. P- 0.34 to 0.38% (grain), 0.18 to 0.23% (straw), K 0.36 to 0.41 (grain) and 1.25 to 1.30% (straw), S 0.21 to 0.24% (grain) and 0.10-0.12% (straw), Zn 15.0 to 18.0 mg kg^{-1} (grain) and 30.0 to 41.0 mg kg^{-1} in straw (Table 2). Addition of nutrient resulted in significant increase in the contents of NPKS and Zn and the maximum values were observed in 125% STR + 60 kg S + 5 kg Zn ha^{-1}. Treatment 150% STR + 60 kg S ha^{-1} was at par with respect to content of nutrients in grain and straw of rice. The minimum values of these nutrients were recorded in control. The results of this study are in conformity with several investigators (Tiwari 2001, Singh 2004 and Rai *et al.* 2013). Increase in the contents of N, P and K with increasing levels of fertilizers has also been reported by Tripathi (2007), which may be ascribed to improved plant metabolism and accelerated absorption of nutrients from soil solution (Rai *et al.*, 2013).

Table 2: Effect of different treatments on NPKS (%) and Zn (mg ka^{-1}) in rice (mean of two years)

Treatments	Nitrogen		Phosphorus		Potassium		Sulphur		Zinc	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	1.43	0.23	0.34	0.18	0.36	1.25	0.21	0.10	15.0	30.0
T_2	1.43	0.23	0.34	0.18	0.34	1.25	0.21	0.10	15.0	31.0
T_3	1.44	0.24	0.34	0.20	0.37	1.26	0.22	0.11	16.0	32.0
T_4	1.44	0.24	0.35	0.21	0.37	1.26	0.22	0.11	16.0	33.0
T_5	1.46	0.25	0.36	0.20	0.40	1.26	0.22	0.10	16.0	34.0
T_6	1.47	0.25	0.36	0.20	0.40	1.27	0.23	0.11	16.0	35.0
T_7	1.48	0.26	0.37	0.21	0.40	1.29	0.22	0.11	17.0	38.0
T_8	1.49	0.26	0.37	0.22	0.41	1.29	0.22	0.10	17.0	35.0
T_9	1.52	0.27	0.38	0.22	0.41	1.30	0.23	0.22	18.0	38.0
T_{10}	1.52	0.28	0.38	0.23	0.41	1.30	0.24	0.22	18.0	41.0
$SE_{m\pm}$	0.018	0.011	0.005	0.009	0.016	0.020	0.007	0.006	0.62	1.35
CD (P=0.05)	0.037	0.024	0.010	0.020	0.033	0.041	0.016	0.013	1.26	2.82

Uptake of Nutrients

Data on uptake of nutrients as a function of biomass yield and nutrient concentration are given in Table 3. Nitrogen uptake varied from 18.6 to 50.2 kg ha^{-1} in grain and 7.8 to 19.3 kg ha^{-1} in straw, P from 4.4 to 12.5 kg ha^{-1} in grain and 5.2 to 16.2 kg ha^{-1} in straw, K 4.7 to 13.5 kg ha^{-1} in grain and 43.7 to 90.0 kg ha^{-1} in straw. S uptake varied from 2.7 to 8.0 kg (grain) and 3.4 to 8.6 kg ha^{-1} (straw) Zn uptake varied from 9.5 to 59.2 g ha^{-1} (grain) and 101.3 to 283 g ha^{-1}(straw). There was a significant increase in uptake values of NPKS and Zn due to different treatments over control. The maximum and minimum uptakes were recorded in 125% STR + 60 kg S + 5 kg Zn ha^{-1} and control, respectively.

Table 3: Uptake of N, P, K, S (kg ha^{-1}) and Zn (g ha^{-1}) in rice as affected by different treatments (mean of two years)

Treatments	Nitrogen		Phosphorus		Potassium		Sulphur		Zinc	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	18.6	7.8	4.4	5.2	4.7	43.7	2.7	3.4	19.5	101.3
T_2	30.0	12.4	7.2	9.7	8.0	67.6	5.5	5.4	32.4	165.8
T_3	32.7	12.8	7.8	10.7	8.5	67.8	5.0	5.9	36.2	174.3
T_4	35.4	13.5	8.8	11.6	9.4	73.0	5.6	6.5	40.3	189.4
T_5	35.3	13.7	9.1	11.2	9.7	71.0	5.3	5.6	38.6	190.4
T_6	38.4	14.2	9.4	11.9	10.4	74.2	6.1	6.7	43.0	203.9
T_7	41.4	15.7	10.3	13.2	11.2	79.4	6.3	7.4	47.4	224.2
T_8	42.6	16.0	10.7	13.3	11.9	78.1	6.4	6.4	47.0	214.9
T_9	46.4	16.7	11.5	14.5	12.5	83.9	6.6	7.7	53.1	245.3
T_{10}	50.2	19.3	12.5	16.2	13.5	90.0	8.0	8.6	59.2	283.1
$SE_{m\pm}$	1.11	0.90	0.30	0.49	0.32	3.78	0.08	0.36	1.13	5.17
CD (P = 0.05)	2.27	1.88	0.62	1.02	0.66	7.87	0.17	0.76	2.36	10.78

It was evident that for obtaining 44.15 q ha^{-1} grain yield plus 57.4 q ha^{-1} straw yields (mean of two years) the net nutrient removal of 69.5 kg ha^{-1} N, 28.2 kg ha^{-1} P, 103.5 kg ha^{-1} K, 16.6 kg ha^{-1} S and 342.3 g ha^{-1} of zinc was observed in this study. Increase in uptake values of NPKS and Zn due to increased levels of nutrients in rice grown on reclaimed sodic soil has been reported by Kumar *et al.* (2012). Similar increase in nutrient uptake of above nutrients due to increased fertility levels in wheat has also been reported by (Singh *et al.* 2010).

In the present study results revealed that SR and 100% STR levels of nutrients are sub optimal for yield maximization in recently reclaimed soils. Thus, raising the STR levels of NPK upto 125% (183:77 :50) and addition of 60 kg S and 5 kg Zn ha^{-1} was an appropriate combination of nutrients for optimization of rice yields on sustainable basis.

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