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PERFORMANCE OF RICE AS AFFECTED BY FOLIAR APPLICATION OF DIFFERENT K FERTILIZER SOURCES

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A field study was conducted at Jatri Kohna, district Sheikhupura to evaluate the effects of foliar spray (1.5 % of K solution) of KCl, K_2SO_4 and KNO_3 on the yield of rice cv. 385. Foliar application of K_2SO_4 gave better paddy and straw yields, number of tillers, potassium content of paddy and straw than the other two sources of K. Potassium recovery (72.87 %) and agronomic efficiency (13.12 kg of paddy kg^{-1} of fertilizer applied) were also better in case of K_2SO_4 than other two sources: KNO_3 (44.87% and 8.69 kg of paddy kg^{-1} of fertilizer applied) and KCl (22.40% and 5.66 kg of paddy kg^{-1} of fertilizer applied).
Key words: Potassium; sources; foliar spray, rice.

INTRODUCTION

Rice being the second largest cultivated cereal crop after wheat is the most important summer cereal of traditional rice growing areas. It is among the major export commodities contributing about 5.2 % to the total exports that occupies a significant position in agricultural economy of the country. Presently, it is grown approximately on 2461 thousand hectares with a total production of 4848 thousand tons (Anonymous, 2003). Pakistan enjoys a near monopoly status in the export of fine aromatic Basmati-rice which fetches a price 3 to 4 times that of the normal coarse varieties and have more demand in the international markets. Therefore, there is a need to increase its yield to meet the domestic and export requirements. The proper and balanced application of fertilizers is one of the most important factors for increasing the yield and quality of the crops. Researchers generally agree that with intensive cultivation, the need for K will increase. In the rice cultivation, the farmers are bestowing much attention only to N fertilization and very often P and K application are carried out at minimal level, mostly ignoring K fertilization totally. This practice of imbalance and inadequate fertilizer application affects the soil productivity in general and particularly depletes the essential nutrients (Cassman *et al.*, 1996). Nutrient management practices determine the sustainability of the most intensively cropped systems (Flinn and DeDatta, 1984; Flinn *et al.*, 1982), K utilization by plants, through foliar application is well recognized and is being practiced in Agriculturally advanced countries.
At times, the indiscriminate and improper application with unfavourable conditions may not provide adequate nutrients supply because of its poor absorption and translocation in plant system. Therefore, there is an imperative need to provide the required nutrients over and above the regular soil application through foliar application as well. Three sources of K were tested in a study in the farmer's field on rice and data on their efficiency are reported in this paper.

MATERIAL AND METHODS

This field experiment was carried out at village Jatri Kohna, district Sheikhupura to investigate the efficiency of different K sources for foliar spray on rice crop. Various treatments (sources) of K application were as T_1= Control, T2 = KCl, T_3 = K_2 SO_4 and T_4 = KNO_3.
A 1.5% solution of different K sources was applied twice (30 and 45 DAT). The basal dose of N, P and Zn were applied @ 100, 50 and 10 kg ha^{-1} as urea, SSP and $ZnSO_4$, respectively. The treatments were organized in randomized complete block design (RCBD) using three replications. Plot size was 8 x 6 m^2. Rice genotype Basmati-385 was used as test crop.

Table 1. Physico-chemical analysis of soil at Jatri Kohna site.

Parameters	Units	Pre sowing value of composite samples
pH		7.54
EC (1:1)	dS m^{-1}	0.51
$CaCO_3$	(%)	1.23
OM	(%)	0.65
NO_3–N	mg kg^{-1}	5.45
P	mg kg^{-1}	4.12
K	mg kg^{-1}	68.0
Zn	mg kg^{-1}	0.53
Sand	(%)	41.5
Silt	(%)	35.7
Clay	(%)	22.8
Textural Class		**Loam**

One week before seedling transplanting, soil samples (0-15 cm depth) were collected from the field for physico-chemical analysis (Table 1). Soil samples were analyzed for particle size distribution by hydrometer method (Bouyoucos, 1962), $CaCO_3$ was estimated by acid neutralization (FAO, 1980) and soil organic matter by oxidation with potassium dichromate in sulfuric acid medium under standardized conditions by Walkley and Black procedure (Nelson and Sommers, 1982). Soil pH was measured in water (Soil water ratio 1:1) and electrical conductivity of the soil suspension was measured using conductivity meter. The P, K and Zn were determined by using AB-DTPA method (Soltanpour and Workman, 1979). For K determination from plant samples, wet digestion method (nitric acid + perchloric acid in 2:1 ratio) was followed and measured the concentration by flame photometer (Rhoades, 1982). The data regarding number of tillers per plant and biological yield at maturity were recorded. A flag leaf sample for the analysis of K was collected at panicle initiation stage. Potassium concentration in rice straw and paddy was also determined from proportion of applied K taken up by rice and expressed in terms of percentage. Potassium Recovery and Agronomic Efficiency were calculated using the experimental data as given by following formulae (Novoa and Loomis, 1981).

$$\text{K recovery (\%)} = \frac{\text{K uptake(fertilized plot)} - \text{K uptake(unfertilized plot)}}{\text{K applied}} \times 100$$

$$\underset{\text{(kg grain/ kg K applied)}}{\text{Agronomic Efficiency}} = \frac{\text{Yield (fertilized plot)} - \text{Yield (unfertilized plot)}}{\text{K applied}}$$

Data thus obtained were subjected to statistical analysis and treatment differences determined using LSD (Gomez and Gomez, 1984).

RESULTS AND DISCUSSIONS

Data in Table 2 revealed that paddy yield was significantly affected by the foliar application of different K sources. Number of tillers was significantly affected by the application of different K sources. The highest number of tillers hill^{-1} (13.89) were recorded where K_2SO_4 was applied followed by 12.67 tillers hill^{-1} with KNO_3 and 11.84 tillers hill^{-1} with the application of KCl. The straw yield was also significantly affected by the application of different K sources. The highest straw yield (4876 kg ha^{-1}) was recorded when K_2SO_4 was applied followed by 4518 kg ha^{-1} with KNO_3 and 4199 kg ha^{-1} with KCl application. Similarly the highest paddy yield (3336 kg ha^{-1}) was recorded with the application of K_2SO_4 as compared to 3150 and 3023 kg ha^{-1} obtained through the application of KNO_3 and KCl respectively. The comparatively higher paddy yield (about 20% over control) registered by K_2SO_4 application might be due to perfect nutrition with adequate source of K application (K_2SO_4) that have resulted in vigor growth of crop and ultimately higher yield. Similar results had also been discussed by Sarkar and Malik (2001). On the other hand, approximately 7 and 11% lower paddy yield (as compared to obtained with K_2SO_4) produced with KNO_3 and KCl application respectively might be due to the reason that generally high concentration of NO_3 ions absorption by leaves directly increases acidity which could cause stomatal disturbance as well as firing of leaves and as excessive Cl ions are related to toxicity in growing plants through active absorption across the cytoplasm membrane. Hence, it is quite possible that K sources containing NO_3 and Cl resulted comparatively less growth and yield. These results get support from previous findings of Koch and Mengel (1977) Matsuda and Riaz (1981), Glass and Siddiqui (1984) and Ramos *et al.*, (1999).

Table 2. No. of tillers, paddy and straw yield as affected by different sources of K

Treatments	Number of Tillers hill^{-1}	Crop Yield (kg ha^{-1})	
		Paddy	Straw
Control	10.29 $_d$	2784 $_d$	3909 $_d$
KCl	11.84 $_c$	3023 $_c$	4199 $_c$
K_2SO_4	13.89 $_a$	3336 $_a$	4876 $_a$
KNO_3	12.67 $_b$	3150 $_b$	4518 $_b$

Potassium concentration in straw and paddy were significantly affected by the application of different K sources (Table 3). The highest K concentration

Table 3. K concentration and K uptake in straw and paddy as affected by different sources of K

Treatments	K contents (%)		K uptake (kg ha^{-1})	
	Straw	Paddy	Straw	Paddy
Control	1.45 $_c$	0.36 $_d$	56.78 $_c$	10.09 $_d$
KCl	1.51 $_c$	0.42 $_c$	63.60 $_c$	12.77 $_c$
K_2SO_4	1.66 $_a$	0.50 $_a$	80.83 $_a$	16.74 $_a$
KNO_3	1.58 $_b$	0.46 $_b$	71.49 $_b$	14.32 $_b$

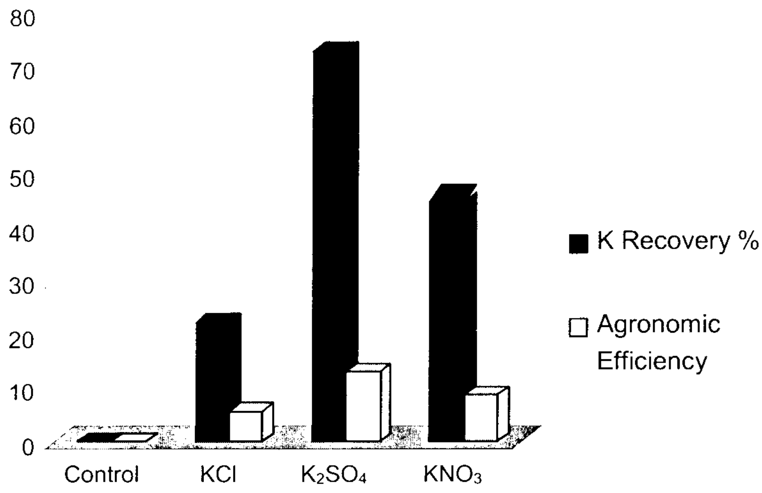

Fig. 1. K Recovery and agronomic efficiency as affected by different sources of K application in rice

(1.66%) in straw was observed with K_2SO_4 application followed by KNO_3 (1.58 %) and KCl (1.51%). Similarly maximum K concentration (0.50%) in paddy was observed with the application of K through K_2SO_4 sources. The data regarding K uptake by straw and paddy (Table 3) revealed that different sources of K application differed significantly being maximum with K_2SO_4. The order of K uptake (kg ha^{-1}) in case of straw as well as paddy was $K_2SO_4 > KNO_3 > KCl >$ Control. Potassium recovery (%) and agronomic efficiency were significantly affected by different K application sources (Fig. 1). The highest values for K recovery (72.87%) and agronomic efficiency (13.12) were observed when K was applied as K_2SO_4 followed by KNO_3 and KCl. Potassium recovery as well as agronomic efficiency followed the same order as that of K uptake, i.e., $K_2SO_4 > KNO_3 > KCl$. Similar findings had also been previously discussed by Uexkull von (1978).

CONCLUSIONS

The application of K_2SO_4 produced highest tillers, straw and paddy yield. The maximum concentration of K and K uptake in straw and paddy was recorded with K_2SO_4. Similarly the highest values for K recovery and agronomic efficiencies were calculated with K_2SO_4. Therefore it can be concluded that the K_2SO_4 is the best source of K for foliar spray to increase paddy yields.

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