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COMPARATIVE RICE YIELD AND ECONOMIC ADVANTAGE OF FOLIAR KNO_3 OVER SOIL APPLIED K_2SO_4

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A field experiment was conducted at Kala Shah Kaku to study the effect of foliar application of potassium nitrate (KNO_3) in comparison to soil incorporated potassium sulphate (K_2SO_4) on the growth and yield of fine rice "Super Basmati". The treatments were control, i.e. soil application of K_2SO_4 @ 70 Kg ha^{-1} (T_1), foliar application of KNO_3 @ 0.5% solution (T_2), foliar application of KNO_3 @1% solution (T_3), foliar application of KNO_3 @ 1.5% solution (T_4) and foliar application of KNO_3 @ 2% solution (T_5). Foliar KNO_3 application @ 1.5% and 2% solutions increased paddy yield by 5.74% (4.97 t ha^{-1}) and 10.85% (5.27 t ha^{-1}) against that of soil incorporated K_2SO_4 (4.7 t ha^{-1}). Significant increase in number of tillers (m^{-2}), thousand grain weight, biological and paddy yield was recorded with foliar KNO_3 @ 1.5% and 2% over soil applied K_2SO_4; however, non-significant differences were found on plant height, panicle length, and grains panicle^{-1}. Foliar KNO_3 @ 1.5% and 2% solutions resulted in net returns of Rs. 14,828 and Rs. 23,804 ha^{-1}, respectively.
Keywords: Foliar KNO_3, soil incorporated K_2SO_4, paddy yield, economic return

INTRODUCTION

Pakistan is an agricultural country and rice is an important cereal crop in this country due to its economic importance and food value. So, rice is taken as an effective tool for increasing the national income particularly due to its significance for exports. Rice is a source of the largest foreign exchange earning and stands next to wheat as a staple food of the people of Pakistan. It has emerged as a major export commodity, which accounts for 6.7 percent of value added in agriculture and 1.6 percent in GDP. About 2.67 million hectares are put under this crop annually with total production of 6.68 million tones and the average rice yield per hectare is 2500 Kg ha^{-1} (Anonymous, 2009-10) which is low as compared to many rice growing countries of the world. Per acre yield at farmer's level is almost half to that of Egypt, China, USA and Korea. Among various factors responsible for low rice yield in the country, the use of potash fertilizers needs to be thoroughly studied to find out the best combination of K nutrients that should be both economical and adequate to enhance the productivity owing to the increase in traditional potash fertilizers. Addition of NPK fertilizers improves crop yields (Shehu *et al*. 2010). The element K has become a limiting factor due to the mere use of N and P. In the rice cultivation, K application is partially or completely ignored by the farmers which results in the imbalance fertilization that affects rice productivity (Cassman *et al*., 1996). It is the 3rd major nutrient element required for plant growth. The indiscriminate use of K fertilizer can lower the yield and deteriorate the kernel quality. The balanced and adequate use of K fertilizers has considerable effects on quality, ripening and grain yield. Thus, the enhancement in K use efficiency is essential for increasing rice production (Arif *et al.,* 2010). The major fraction of K fertilizer directly applied to soil gets fixed with clay fraction and becomes unavailable to crop plants (Ali *et al*., 2007). Problem of K fixation can be reduced to a certain limit and the K use efficiency can be improved by exploring different K application methods (Manzoor *et al*., 2008). Further, the price of traditional K fertilizers is getting higher day by day and becoming unaffordable to farmers (NFDC, 2005). The foliar K application could be an economical way to fulfill the K deficiency against soil incorporated K application due to its requirement in lesser amounts. The foliar spray of KNO_3 inhibits the toxic effects of salts besides increase in production (Ahmad and Jabeen, 2005). Majority of Pakistani soils are calcareous in nature with pH value greater than 8.5 that affects K availability. K utilization by plants through foliar application is well recognized and is being practiced in agriculturally advanced countries (Ali *et al*., 2007). Consequently, there felt a dire need to evaluate the foliar potash application which is an economical way to increase yield by fulfilling the essential potassium need.

Present studies were, hence, undertaken to test the hypothesis whether the low-priced foliar KNO_3 application on fine basmati rice can equally or increasingly affect the growth, yield and economic returns in comparison to conventional soil incorporated K_2SO_4.

MATERIALS AND METHODS

The present study was conducted to evaluate the efficacy of foliar application of potassium on growth and yield of fine rice "Super Basmati". The experiment was performed during 2010 at Rice Research Institute (PARC Rice unit area), Kala Shah Kaku, Lahore. The trail was laid out using RCBD with three replications. The net plot size was 2.5 m x 5 m. The seed for raising seedlings was sown in 1st week of June and the seedlings were transplanted manually on 1st week of July. Row to row and plant to plant spacing was maintained at 20 cm. All other agronomic practices were adopted uniformly. The treatments were as T1 = soil application of K_2SO_4 @70 Kg ha^{-1}, T2 = foliar application of KNO_3 @0.5% solution (T_2), T3 = foliar application of KNO_3 @1% solution, T4 = foliar application of KNO_3 @1.5% solution, and T5 = foliar application of KNO_3 @2% solution. Phosphorus dose of 90 Kg ha^{-1} was applied at sowing whereas N @ 90 Kg ha^{-1} was applied in two split doses, i.e. half dose at land preparation and 2nd half dose at 1st irrigation. The data were recorded for final plant height (cm), productive tillers m^{-2}, grains panicle^{-1} (g), panicle length (cm), biological yield (t ha^{-1}), 1000 grain weight (g) and paddy yield (t ha^{-1}). Ten plants from each plot were randomly selected to record the observations regarding plant height, grains panicle^{-1}, and panicle length.

The data were analyzed statistically using STATISTIX software and the differences among the treatments' means were compared by the least significant differences (LSD) test at 5% probability level (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Both soil incorporated K_2SO_4 and foliar KNO_3 application did not vary significantly in affecting plant height (Table 1). Plant height ranged 124.73-125.50 cm. These results corroborate the conclusion of Manzoor *et al*. (2008) that non-significant effect was determined on plant height with potassium application in total or split use.

Productive tillers (m^{-2}) were significantly affected by foliar potassium application (Table 1). Maximum number of productive tillers m^{-2} (409) was recorded at foliar KNO_3 application @ 2% solution which was statistically at par to that of foliar KNO_3 application @ 1.5% solution (403). Minimum number of tillers m^{-2} (364.67) was experienced by foliar KNO_3 application @ 1% solution. Arif *et al*. (2010) also concluded that the exogenous K application had a significant effect on tillering. Ali *et al*. (2005) recorded significant increase with foliar K application using different K sources than that of control where no K was applied.

No significant differences were found among the soil incorporated and foliar K treatments on panicle length and number of grains panicle^{-1}. Panicle length and number of grains panicle^{-1} ranged 24.60-27.66 and 45.67-62.07, respectively. However, maximum panicle length (27.66 cm) was attained when KNO_3 was foliar applied @ 2% solution, but, it was statistically alike to that of other treatments. Minimum panicle length (24.60 cm) was recorded at foliar KNO_3 application @ 1% solution. These results are contrary to those of Manzoor *et al*. (2008) who found significant effect on panicle length with K application using two split doses. Number of grains panicle^{-1} ranged from 45.67 to 62.07. Manzoor *et al*. (2008) found significant increase in number of grains panicle^{-1} resulted from increased potash uptake efficiency when applied potassium at maximum tillering stage on 25 DAT and panicle initiation stage on 45 DAT.

Both soil incorporated K_2SO_4 and foliar KNO_3 @ 1.5 and 2% solutions application significantly influenced thousand grain weight (Table 1). Foliar KNO_3 application @ 2% solution resulted in the highest thousand grain weight which was statistically at par to that of foliar KNO_3 application @ 1.5% solution. Minimum thousand grain weight (17.63 g) was recorded at foliar KNO_3 application @ 1% solution. A significant difference for thousand grain weight was also reported by Arif *et al*. (2010) and Manzoor *et al.* (2008) with the exogenous K application. Biological yield was significantly affected by potassium application either soil incorporated K_2SO_4 or foliar KNO_3 application (Table 1). Maximum biological yield (19.19 t ha^{-1}) was produced from foliar KNO_3 application @ 2% solution. It was followed by foliar KNO_3 application @ 1.5% solution. Minimum bio

Table 1. Effect of soil incorporated potassium sulphate and foliar application of potassium nitrate on the growth and yield of rice

Treatment	Plant height (cm)	Tillers (m^{-2})	Panicle length (cm)	Grains panicle^{-1}	1000-grain weight (g)	Biomass (t ha^{-1})	Paddy yield (t ha^{-1})
T_1	125.50	364.67 c	26.15	51.03	20.43 ab	15.27 c	4.70 b
T_2	125.27	382.67 bc	26.54	47.40	19.07 bc	12.76 d	3.81 c
T_3	125.13	400.67 ab	24.60	45.67	17.63 c	13.25 d	3.76 c
T_4	124.83	403.00 a	27.38	59.47	21.07 a	19.19 a	4.97 ab
T_5	124.73	409.00 a	27.66	62.07	20.87 a	18.22 b	5.21 a
LSD	NS	19.183	NS	NS	1.4705	0.8847	0.4471

T_1 = Control (soil application of K_2SO_4 @70 Kg ha^{-1}); T_2= Foliar application of KNO_3 @0.5% solution; T_3= Foliar application of KNO_3 @1% solution; T_4 = Foliar application of KNO_3 @1.5% solution; T_5 = Foliar application of KNO_3 @2% solution; LSD = Least Significant Difference

Table 2. Economic analysis of foliar KNO_3 application against soil applied K_2SO_4

Treatment	Paddy yield (t ha^{-1})	Gross value (Rs. 1200/- per 40Kg)	Total expenses (Rs.)	Net income (Rs. ha^{-1})	BCR
T_1	4.70	141,000	89,777	51,223	1.57
T_2	3.81	114,300	86,509	27,791	1.32
T_3	3.76	112,800	87,341	25,459	1.29
T_4	4.97	149,100	88,173	60,927	1.69
T_5	5.21	156,300	89,005	67,295	1.76

T_1 = Control (soil application of K_2SO_4 @70 Kg ha^{-1}); T_2= Foliar application of KNO_3 @0.5% solution; T_3= Foliar application of KNO_3 @1% solution; T_4 = Foliar application of KNO_3 @1.5% solution; T_5 = Foliar application of KNO_3 @2% solution; BCR = Benefit-cost ratio

mass (12.76 t ha^{-1}) was yielded by foliar KNO_3 @ 1% solution which was statistically similar to that of foliar KNO_3 application @ 0.5% solution. Ali *et al*. (2007) also recorded higher biological yield from the treatments where K was applied either through soil or foliar.

Foliar application of KNO_3 @ 2% solution yielded maximum paddy yield (5.21 t ha^{-1}) which was statistically at par to that attained with foliar KNO_3 application @ 1.5% solution (4.97 t ha^{-1}). The yield obtained from foliar KNO_3 @ 2 and 1.5% solution was significantly higher as compared to all the other treatments including soil incorporated K_2SO_4. Minimum paddy yield (3.77 t ha^{-1}) was recorded with foliar KNO_3 application @ 1% solution that was statistically at par to that of foliar KNO_3 application @ 0.5% solution. Hence, foliar KNO_3 spray @ 1.5% and 2% solutions increased paddy yield by 5.74% and 10.85% in comparison to that of soil incorporated K_2SO_4. The increase in yield with foliar KNO_3 spray is credited to the increase in number of tillers m^{-2}, panicle length, grains $panicle^{-1}$ and thousand grain weight. Shah *et al.* (2009) found significant increase in grain yield with the application of K alone or in combination with rice straw. These findings are in consistency to those achieved by Ali *et al*. (2005) who recorded significant increase in paddy yield with foliar application by different K sources than that of treatments where no K was applied. The results are in partial agreement to those of Manjappa *et al.* (2008) who recorded significantly highest mean grain yield with foliar KNO_3 application when applied 60 days after planting. Kundu and Sarkar (2009) concluded that foliar application of Ca $(NO_3)_2$ followed by KNO_3 significantly affected growth parameters and yield attributes that ultimately enhanced paddy yield. Foliar spray of KNO_3 did not only increase the crop yield but also reduced the quantities of soil incorporated fertilizers (Ahmad and Jabeen, 2005).

***Economic analysis*:** The economic analysis (Table 2) showed the maximum net return of Rs. 67,295 ha^{-1} in T_5 treatment (foliar KNO_3 application @ 2% solution) with benefit-cost ratio of 1.76. It was close to T4 (foliar KNO_3 application @ 2% solution) and T1 (soil application of K_2SO_4 @ 70 Kg ha-1. Minimum net return and BCR (1.29 and 1.32) was recorded with T3 (foliar KNO_3 application @ 1% solution) and T2 (foliar KNO_3 application @ 0.5% solution), respectively.

***Conclusion*:** Under agro-ecological conditions of Kala Shah Kaku, foliar KNO_3 application @ 1.5% and 2% solutions can increase paddy yield by 5.74% and 10.85% in comparison to that of soil incorporated K_2SO_4. The increase in yield with foliar KNO_3 spray is attributed to the stimulating effects on tillers m^{-2}, panicle length, grains $panicle^{-1}$ and thousand grain weights. Foliar KNO_3 @ 1.5% and 2% solutions resulted in more net returns and BCR. It is recommended to apply foliar KNO_3 @ 1.5% and 2% solutions on 40 and 60 days after planting rice to increase net returns and enhance paddy yield.

REFERENCES

Ahmad, R. and R. Jabeen. 2005. Foliar spray of mineral elements antagonistic to sodium-a technique to induce salt tolerance in plants growing under saline conditions. Pak. J. Bot. 37:913-920.

Ali, A., I.A. Mahmood, F. Hussain and M. Salim.2007. Response of rice to soil and foliar application of K_2SO_4 fertilizer. Sarhad J. Agric. 23:847-850.

Ali, A., M. Salim, M.S. Zia, I.A. Mahmood and A. Shahzad. 2005. Performance of rice as affected by foliar application of different K fertilizer sources. Pak J. Agri. Sci. 42:38-41.

Anonymous. 2009-10. Economic Survey of Pakistan. Economic Advisory Wing, Finance Division, Islamabad, Pakistan.

Arif, M., M. Arshad, N.H. Asghar and S.M.A. Basra. 2010. Response of rice (*Oryza sativa*) genotypes varying in K use efficiency to various levels of potassium. Int. J. Agric. Biol. 12:926-930.

Cassman, K.G., P.C. Doberman, S. Cruiz, G.C. Gines, M.I. Samson, J.P. Descalsota, J.M. Alcantrara, M.A. Dizon and D.C. Olk. 1996. Soil organic matter and the indigenous nitrogen supply of intensive irrigated rice systems in the tropics. Plant and Soil 182:267-287.

Kundu, C. and R.K. Sarkar. 2009. Effect of foliar application of potassium nitrate and calcium nitrate on performance of lowland rice (*Oryza sativa*). Indian J. Agron. 54:428-432.

Manjappa, K., N. Katraki, S.V. Kelaginamani and V. Jowkin. 2008. Potash management in rainfed transplanted paddy in lowland rice soils. Karnataka J. Agric. Sci. 21:482-484.

Manzoor, Z., T.H. Awan, M. Ahmad, M. Akhtar anf F.A. Fiaz. 2008. Effect of split application of potash on yield and yield related traits of rice. J. Anim. Pl. Sci. 18:120-124.

NFDC. 2005. Fertilizer use related statistics. National Fertilizer Dev. Centre, Planning Div, Govt. of Pakistan, Islamabad.

Shah, P.K., M.A.M. Miah, A.T.M.S. Hossain, F. Rahman and M.A. Saleque. 2009. Contribution of rice-straw to potassium supply in rice-fallow-rice cropping pattern. Bangladesh J. Agri. Res. 34:6333-643.

Shehu, H.E., J.D. Kwari AND M.K. Sandabe. 2010. Effects of N, P and K fertilizers on yield, content and uptake of N, P and K by Sesame (*Sesamum indicum*). Int. J. Agric. Biol. 12: 845-850.

Steel, R.G.D., J.H. Torrie and D.A. Deekey. 1997. Principles and procedures of Statistics: A Biometrical Approach, 3rd Ed. McGraw Hill Book Co. Inc. New York, USA.