The Pharma Innovation Journal 2019; 8(8): 244-247

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(8): 244-247

www.thepharmajournal.com
Received: 21-06-2019
Accepted: 25-07-2019

M Jothi
Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli, Tamil Nadu, India

P Keerthana
Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli, Tamil Nadu, India

S Gomathi
Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli, Tamil Nadu, India

B Priya
Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli, Tamil Nadu, India

T Ramesh
Assistant Professor (Agronomy), Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli, Tamil Nadu, India

S Rathika
Assistant Professor (Agronomy), Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli, Tamil Nadu, India

Correspondence
T Ramesh
Assistant Professor (Agronomy), Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli, Tamil Nadu, India

Effect of foliar spray of potassium on rice under sodic soil

M Jothi, P Keerthana, S Gomathi, B Priya, T Ramesh and S Rathika

Abstract
A field experiment was conducted at Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli during Late *Samba* season (Rabi) 2018-19 to study the effect of foliar application of potassium on rice under sodic soil. Treatments consisted of foliar spray of 2% KCl, 2% K_2SO_4, 2% KNO_3, soil application of K at 50kg/ha and control. Potassium at the rate of 50 kg ha^{-1} in the form of muriate of potash was applied in four equal splits as a blanket along with the nitrogen fertilizer during basal, tillering, panicle initiation and flowering stages. Foliar application of different potassium fertilizers *viz*, KCl, K_2SO_4 and KNO_3 was carried out at 2% concentration during tillering, panicle initiation and flowering stages in the respective treatments. Results of the experiment revealed that soil application of potassium at 50 kg/ha registered significantly taller plants (120.2cm), more number of tillers per hill (26), higher LAI (6.6), dry matter production (14149 kg/ha), more number of productive tillers (324/ m^2), more number of filled grains per panicle (188) and grain yield (5440 kg/ha) over foliar spray of 2% K_2SO_4 and control. However, it was comparable with foliar application of 2% KNO_3 and 2% KCl which recorded grain yield of 5260 kg/ha and 5000 kg/ha respectively. Higher agronomic efficiency of 28.6 kg grain / kg of K fertilizer applied were obtained with foliar spray of 2% KNO_3. With reference to return per rupee invested, soil application of potassium at 50 kg/ha in four equal splits as well as foliar spray of 2% KNO_3 at tillering, PI and flowering stages gave similar value (2.8). Thus, foliar spray of 2% KNO_3 at tillering, panicle initiation and flowering stages could be recommended as alternative potassium management strategy against soil application of potassium at 50 kg/ha for higher productivity, agronomic efficiency and benefit cost ratio of rice under sodic soil condition.

Keywords: Potassium, foliar spray, rice, sodic soil, KNO_3, KCl

Introduction
Rice is one of the most important cereal crops in the world. Rice ranks second among food grains, and half of the world's population depends on rice by getting the highest (26.2%) calories intake from it (FAO, 2009) [1]. India is the second largest producer in the world. India has the largest area of rice cultivation at global level (44 m ha). Salt-affected soils currently account for 8% of the world's total land area and the salt-affected agricultural land is predicted to double by 2050 for irrigated agriculture and some semi-arid areas (Rengasamy, 2006) [8]. Most of the salt stresses in nature is due to Na+ salts, particularly NaCl (Demiral, 2005). In India, area under the sodic soil condition is 37.8 lakh ha. In Tamil Nadu, 3.5 lakh ha of area is under sodic soil. The sodic soils are characterized by a disproportionately high concentration of Na in their cation exchange complex, contains more than 15% exchangeable sodium percentage and having high pH (>8.5) due to the presence of high concentrations of sodium carbonate.

Potassium (K) acts as a very essential and important nutrient for the plant growth and development. It plays essential roles in stomata movement, energy transfer, phloem transport, cation-anion balance and stress resistance (Wang *et al*., 2013 and Salami and Saadat, 2013) [12, 9]. It also helps in photosynthesis, carbohydrate distribution and starch synthesis in storage organs which in turn helps in higher grain yield (Imas and Magen, 2007; White *et al*., 2010 and Philip *et al*., 2012) [4, 14, 6]. Potassium is one of the limiting factors for increasing rice yield in rice producing soils (Yang *et al*., 2003) [15]. Unavailability of K is major constraints in sodic soil mainly due to the conversion of exchangeable to non-exchangeable potassium in alkaline soil. Potassium availability to plants is very low during soil application of potassic fertilizer. Under alkaline field conditions, plants suffer a deficiency of potassium mainly because of the excess of Na+ in the rooting medium, which acts as an antagonist and decreases the availability of potassium. Thus, under salinity stress, plants face the problem of K deficiency.

In this circumstance, potassium application through foliar spray may be beneficial to rice crop in sodic soil. Foliar application of K can be beneficial when K uptake via the root zone is limited mainly due to cation competition in sodic/saline soils with high Na (Weinbaum *et al*., 2002) [13]. It is necessary to evaluate different sources of potassium fertilizers viz., potassium nitrate, potassium sulphate and potassium chloride as foliar spray on the growth, yield and agronomic efficiency of rice under sodic soil. Keeping these aspects in view, a field experiment was carried out at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli during late *Samba* season of 2018-19.

Materials and Methods

A field experiment was conducted at Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli during Late *Samba* season (Rabi) 2018-19 to study the effect of foliar spray of potassium on rice growth, yield agronomic efficiency under sodic soil. Experimental farm is situated at 10^0 45, latitude, 78^0 36, longitude at an altitude of 85 m above mean sea level. Soil of the experimental field was alkaline in reaction (pH - 8.8), clay and moderately drained. The initial soil status was low in available nitrogen (229 kg/ha) medium in available phosphorus (14.5 kg/ha) and medium in available potassium (168 kg/ha). Medium duration rice variety TNAU TRY 3 was grown during the cause of investigation.

Experiment was laid out in randomized block design with four replications. Treatments consisted of foliar spray of 2% KCl, 2% K_2SO_4, 2% KNO_3, soil application of K at 50 kg/ha and control. Potassium at the rate of 50 kg ha^{-1} in the form of muriate of potash was applied in four equal splits as a blanket along with the nitrogen fertilizer during basal, tillering, panicle initiation and flowering. Foliar spray of different potassium fertilizers *viz*, KCl, K_2SO_4 and KNO_3 was carried out at tillering, panicle initiation and flowering stages in the respective treatments. Observations on growth, yield characters and yield were recorded. Agronomic efficiency was computed by using the formula suggested by Yoshida (1981) [16]. Economics were worked out based on the input cost, labour wages and produce price based on the market value prevailed. The data on various characters studied were analyzed statistically as per the procedures suggested by Gomez and Gomez (1984) [2].

Results and Discussion

Growth parameters

Application of potassium either soil or foliar spray had significantly influenced growth parameters of paddy. Significantly taller plants (120.2cm), more number of tillers per hill (26), higher LAI (6.6) and dry matter production (14149 kg/ha) were recorded with soil application of potassium at 50 kg/ha than other treatments. However, it was comparable with foliar spray of 2% KNO_3 which registered plant height of 118.3 cm, tillers per hill (25), LAI (6.1) and dry matter production of 13668 kg/ha. Foliar spray of 2% KCl was the next best treatment. Increment in growth parameters of rice under soil application of potassium in four equal splits was mainly due to that potassium plays an essential role in plant functions, needed for osmo regulation, enzyme activation, regulation of cellular pH, cellular cation-anion balance, regulation of transpiration by stomata, and the transport of the products of photosynthesis and ultimately increased the growth parameters of rice. These results are in accordance with the findings of Zaman *et al.* (2015) [17]. Increase in growth attributes of rice due to foliar spray of KNO_3 at critical stages could be ascribed to the overall improvement in plant growth, vigour and production of photosynthates owing to increased availability, absorption and translocation of nutrients in plant. These results are confirmed with the findings of Ravi *et al.* (2007) [7].

Chlorophyll content was measured using SPAD meter and it was significantly higher (37.66) under foliar spray of 2% KNO_3 over control. However, it was comparable with other foliar spray as well as soil application of potassium. This may be due to that K^+ has reversed the negative effects of NaCl on chlorophyll and also better membranes status and due to better antioxidant activity under KNO_3 application (Gupta and Haung, 2014) [3]. Potassium and nitrogen supplemented in the form of KNO_3 might have improved the variables affected by high salinity and also corrected both K and N deficiencies. Addition of KNO_3 successfully ameliorated leaf chlorophyll and carotenoid contents of plant grown in salt stress

In general, soil application of potassium at 50 kg/ha in four equal splits recorded higher growth parameters than foliar spray and control. Soil application of MOP at 83.3 kg/ha in four equal splits at critical stages would have increased K availability and absorption led to higher growth parameters. Whereas, in foliar spray, the quantity of potassium fertilizer applied was only 30 kg/ha. Among the sources of potassium, foliar spray of 2% K_2SO_4 produced lesser growth parameters than other sources. Minimum plant growth characters were obtained with control.

Table 1: Effect of foliar spray of potassium on growth parameters of rice

Treatment	Plant height (cm)	Tillers population (Nos./hill)	LAI	DMP (kg/ha)	Chlorophyll content (SPAD reading)
T_1-2% KCl	114.3	22	5.3	13130	36.79
T_2-2% K_2SO_4	111.4	22	4.7	12476	36.40
T_3-2% KNO_3	118.3	25	6.1	13668	37.66
T_4-Soil application of K (50 kg /ha)	120.2	26	6.6	14149	37.30
T_5-Control	103.9	19	4.3	11451	33.80
SEd	3.64	0.63	0.22	476	1.40
CD (P=0.05)	7.95	1.4		1038	3.05

Yield parameters

Yield parameters of rice were significantly varied with different sources of potassium fertilizer application. Soil application of K at 50 kg/ha produced significantly more number of productive tillers (324/ m^2), more number of grains per panicle (198) and filled grains per panicle (188) than other treatments. However, it was comparable with foliar spray of 2% KNO_3 which registered productive tillers of 305/m^2, 198

numbers of grains per panicle and 188 filled grains per panicle. Soil application of potassium at 50 kg/ha in four equal splits at critical stages would have increased the K availability to rice resulted in higher photosynthesis, increased enzyme activity, improved synthesis of protein, carbohydrates and fats and translocation of photosynthates to grains collectively improved the yield contributing parameters.

Foliar spray of 2% KCl produced 296 tillers/m^2 and was comparable with 2% K_2SO_4 (278/m^2). Control plot registered the lowest productive tillers (258 tillers/m^2), filled grains per panicle (135) than other treatments. More number of ill filled grains per panicle (13) was obtained with control plot and less number of ill filled grains per panicle was recorded under foliar spray of 2% K_2SO_4(8). Soil application of potassium at 50 kg/ha, foliar spray of 2% KNO_3 and 2% KCl treatments produced similar number of ill filled grains per panicle (10). Soil application of K at 50 kg/ha recorded more fertility of 95% than other treatments. This was followed by foliar spray of 2% KNO_3 (94%) and 2% KCl (93%). Lower fertility was recorded in control (89%).

Among the foliar spray of potassium sources, 2% KNO_3 produced 18.2% higher productive tillers, 32.5% more filled grains and 5% higher in fertility percentage over control. Increased yield attributes might be attributed to the fact that foliar application of 2% KNO_3 met the N requirement along with K of the crop during critical stages resulting in greater availability, absorption and assimilation of carbohydrates and translocation to the flowering part of rice. Further, such increase in yield attributes may be owing to altered physiological and reproductive growth of the crop induced by foliar spray of KNO_3 through enhanced activities of enzymes and photosynthetic efficiency. This achievement confirms the finding of Kundu and Sarkar (2009) [5].

Table 2: Effect of foliar spray of potassium on yield attributes of rice

Treatments	No. of productive tillers/m^2	No. of grains/panicle	No. of filled grains /panicle	No. of ill filled grains/ panicle	Fertility %
T_1- Foliar spray of 2% KCl	296	188	178	10	93
T_2- Foliar spray of 2% K_2SO_4	278	155	147	8	91
T_3- Foliar spray of 2% KNO_3	305	191	181	10	94
T_4-Soil application of K (50 kg /ha)	324	198	188	10	95
T_5-Control	258	148	135	13	89
SE.d	9.4	5.6	5.3	0.5	-
CD (P=0.05)	20.5	12.3	11.5	1.0	-

Grain yield

Grain yield of paddy was significantly influenced by potassium application. Soil application of potassium at 50 kg/ha in four equal splits recorded significantly higher grain yield (5440 kg/ha) over foliar spray of 2% K_2SO_4 and control. However, it was comparable with foliar application of 2% KNO_3 and 2% KCl which recorded grain yield of 5260 kg/ha and 5000 kg/ha respectively. Soil application of potassium in four splits during critical stages reduced the ill effects of Na in soil and increased the growth and yield parameters and finally grain yield. Among the foliar spray, 2% KNO_3 showed superiority than other resources and registered 19.5% higher grain yield than control. This was followed by foliar spray of 2% KCl (13.6%), and 2% K2SO4 (9.7%). The greater grain yield might be due to absorption of nutrient at peak time with optimum rate at critical stages of rice as a result maximum mobilization of photosynthates from source to sink and ultimately yield contributing characters like, filled grain/panicle, test weight and improved grain yield. These results are in corroborates with the findings of Wahab Khan *et al.* (2012) [11] who reported that foliar application of 2% KNO3 increased the grain of rice to the tune of 10.85% over soil application of K.

Table 3: Effect of foliar spray of potassium on grain yield, agronomic efficiency, net return and benefit cost ratio of rice

Treatments	Grain yield (kg/ha)	Agronomic Efficiency (kg grain/kg of K fertilizer)	Net Return (Rs/ha)	Benefit Cost Ratio
T_1- Foliar spray of 2% KCl	5000	20.0	68738	2.7
T_2- Foliar spray of 2% K_2SO_4	4830	14.3	66430	2.6
T_3- Foliar spray of 2% KNO_3	5260	28.6	74300	2.8
T_4-Soil application of K (50 kg /ha)	5440	12.4	76851	2.8
T_5-Control	4400	-	58060	2.5
SEd	260	-	-	-
CD (P=0.05)	566	-	-	-

Control treatment recorded 23.6% lesser grain yield than soil application of K. One of the major reasons of salinity (NaCl) negative effects is the competence between Na+ and K+ in the rhizosphere zone, which leads to the nutrient imbalance in the plant tissues, and then low production (Zhu, 2001) [18].

Agronomic efficiency

Higher agronomic efficiency of 28.6 kg grain / kg of K fertilizer applied was obtained with foliar spray of 2% KNO_3. This was followed by foliar spray 2% KCl, which registered agronomic efficiency of 20.0 kg grain / kg of K fertilizer applied. Foliar application of 2% K_2SO_4 produced lesser agronomic efficiency of 14.3 kg grain / kg of K fertilizer applied. Higher agronomic efficiency under foliar application was mainly due to use of lesser quantity fertilizers and higher grain yield under this treatment. Soil application of potassium at 50 kg/ha the lowest agronomic efficiency of 12.4 kg grain / kg of K fertilizer applied mainly because of less availability due to Na^+ competition as well as higher quantity of fertilizer usage.

Economics

Soil application of potassium at 50 kg/ha in four equal splits recorded higher net return (Rs. 76851/ha) than other treatments. Favorable effect of soil applied potassium on higher grain yield of rice was the reason behind additional gross and net return. This was followed by foliar application of 2% KNO_3 (Rs. 74300/ha) and 2% KCl (Rs. 68738/ha) and 2% K_2SO_4 (Rs. 66430/ha). Control treatment recorded the lowest net return of Rs.58060/ha. With reference to BCR, soil application of potassium at 50 kg/ha in four equal splits and foliar spray of 2% KNO_3 at tillering, PI and flowering stages registered similar value (2.8). This was followed by foliar spray of 2% KCl (2.7) and 2% K_2SO_4 (2.6). Control gave lesser BCR of 2.5. Foliar application of 2% KNO_3 incurred lesser cost as well as produced higher grain yield was reason behind higher economics of rice. Similar findings were reported by Tran Thuc Son *et al.* (2012) [10] who found that higher net income was achieved under foliar spray of KNO_3 in paddy.

Thus, foliar spray of 2% KNO_3 at tillering, panicle initiation and flowering stages could be recommended as alternative potassium management strategy against soil application of potassium at 50 kg/ha for higher productivity, agronomic efficiency and benefit cost ratio of rice under sodic soil condition.

References

1. FAO. FAO Statistical Yearbook, 2009. Country Profiles-WEB Edition, Statistics Division FAO-Food and Agriculture Surfed on April 08, at: http://www.fao.org/statistics/yearbook. 2009; 22(2): 6.
2. Gomez KA, Gomez AA. Statistically procedures for agricultural research. John Willy and Sons, 2nd Edition, 1984, 20-28.
3. Bhaskar Gupta, Bingru Huang. "Mechanism of Salinity Tolerance in Plants: Physiological, Biochemical, and Molecular Characterization," International Journal of Genomics. 2014; 2014(701596):18. https://doi.org/10.1155/2014/701596.
4. Imas P, Magen H. Management of potassium nutrition in balanced fertilization for soybean yield and quality – Global perspective. In: Proceedings of Region-al Seminar on Recent Advances in Soybean-based crop-ping system. National Research Centre for Soybean, Indore. 28-29 September, 2007, 1-20.
5. Kundu C, Sarkar RK. Effect of foliar application of potassium nitrate and calcium nitrate on performance of lowland rice (*Oryza sativa*). Indian J. Agron. 2009; 54:428-432.
6. Philip J White, Martin R. Broadley, Peter J. Gregory. Managing the Nutrition of Plants and People. Applied and Environmental Soil Science, 2012, 1155-1167.
7. Ravi S, Ramesh S, Chandrasekharan. Influence of foliar application of phytohormones and nutrients on yield and nutrient uptake of transplanted rice in Annamalainagar (TN), India. International Journal of Plant Sciences, Muzaffamagar. 2007; 2 (1):69-71.
8. Rengasamy P. World salinization with emphasis on Australia. J. Exp. Bot. 2006; 57:1017-1023.
9. Salami M, Saadat S. Study of potassium and nitrogen fertilizer levels on the yield of sugar beet in jolge cultivar. Journal of Novel Applied Sciences. 2013; 2(4):94-100.
10. Tran Thuc Son, Le Xuan Anh, Yoav Ronen, Harmen Tjalling Holwerda. Foliar Potassium Nitrate Application for Paddy Rice. Better Crops. 2012; 96(1):29-31.
11. Wahab Khan, Abdul A Mann, Riaz, Saleem, Muhammad, Majeed et al. Comparative rice yield and economic advantage of foliar KNO3 over soil applied K_2SO_4. Pakistan Journal of Agricultural Sciences. 2012; 49:481-484.
12. Wang MQ, Zheng Q, Shen, Guo S. The critical role of potassium in plant stress response. International journal of molecular sciences. 2013; 14(4):7370–7390.
13. Weinbaum SA, Brown PH, Johnson RS. Proc. IS on Foliar Nutrition, ISHS 2002. Tagliavini *et al.* (eds), Acta Hort. 2002; 594:59-64.
14. White PJ, Hammond GJ. King *et al.* Genetic analysis of potassium use efficiency in *Brassica oleracea*. Annals of Botany. 2010; 105(7):1199-1210.
15. Yang XE, Liu JX, Wang WM, Li H, Luo AC, Ye ZQ *et al*. Genotypic differences and some associated plant traits in potassium internal use efficiency of lowland rice (*Oryza sativa* L.). Nutr. Cycl. Agroecosyst. 2003; 67:273-282.
16. Yoshida S. Fundamentals of rice crop science. Int. Rice Res. Inst, 1981.
17. Zaman UZ, Ahmad M, Farooq S, Saeed M, Ahmad, Wakeel A. Potassium fertilization may improve stem strength and yield of Basmati rice grown on nitrogen-fertilized soils. Pakistan Journal of Agricultural Sciences, 2015, 52.
18. Zhu JK. Plant salt tolerance: regulatory pathway, genetic improvement and model systems. Trends Plant Sci. 2001; 6:66-71.