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Effect of K_2SO_4 and KNO_3 Foliar Application on Wheat Growth

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Abstract. A field experiment was conducted to investigate the effect of different concentrations of K_2SO_4 and KNO_3 foliar application (2 and 4%) on the growth of wheat (cv. Watan) at Soil Salinity Research Institute (SSRI) farm, Pindi Bhattian, Punjab, Pakistan during Rabi season, 2007. Treatments were: soil application K_2SO_4, KNO_3, 2 and 4% K_2SO_4, 2% KNO_3 + 2% K_2SO_4, 4% KNO_3 +2% K_2SO_4, 2% KNO_3 + 4% K_2SO_4 ,4% KNO_3+4% K_2SO_4. Treatments were assigned using randomised complete block design with three replications. The crop was harvested at maturity, data on tillering, plant height, spike length, number of grains/spike, 1000-grain weight, straw and wheat yields were recorded. Tillering, number of grains/spike, 1000-grain weight and wheat yield significantly ($P \leq 0.05$) increased by different levels of doses. 2% K_2SO_4 and 4% K_2SO_4 improved the tillering capacity of wheat compared with the control. The combination of 2% KNO_3 + 4% K_2SO_4 attained the highest grain yield (2825 kg/ha) which was statistically at par with 2% K_2SO_4 (2795 kg/ha). The lowest grain yield (2129 kg/ha) was received by the control (soil applied K_2SO_4). Grain yield after spraying was up to 31% higher than in the control.

Keywords: foliar application, K_2SO_4, KNO_3, *Triticum aestivum*, soil salinity

Introduction

Wheat (*Triticum aestivum* L.) is the principal food crop of Pakistan. It is not only a staple food grain for human in Pakistan but its straw and by products of flour milling and industries are important sources of feed for livestock (GOP, 2012-13). The fast growing population of our country makes it imperative to enhance wheat production accordingly. Wheat is cultivated on an area of 8693 thousand hectares with a total production of 25,286 thousand tonnes during year 2012-13 (GOP, 2012-13). A majority of Pakistani soils are calcareous in nature with pH greater than 8.5 that affects K availability (Ali *et al.,* 2005b). The major fraction of potash fertiliser directly applied to soil gets fixed by the clay fraction and becomes unavailable to crop plants (Ali *et al.*, 2007; 2005a). Further, the price of K fertilisers is getting higher day by day and becoming unaffordable to farmers (NFDC, 2005). The application of balanced fertilisers is one of the most important factors for increasing crop yields. In wheat cultivation, the farmers are bestowing much attention only to N fertilisation and very often P and K application are partially or completely ignored. This practice of imbalance and inadequate fertiliser application affects the soil productivity in general (Cassman *et al.,* 1996). The practice of correct dose and timely application of nutrients plays an important role in efficient use of fertilisers as well. Nutrient management practices determine the sustainability of the most intensively cropped system (Flinn and De Datta, 1984). Potassium utilisation by plants through foliar application is well recognised and is being practiced in agricultural advanced countries (Fernandez and Eichert, 2009). Foliar applied fertilisers often show a better efficacy which may help to reduce the required dose. Therefore, this study was planned to compare different concentrations of K_2SO_4 and KNO_3 for foliar application to obtain optimum wheat yield under different wheat planting techniques.

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Materials and Methods

A field experiment was conducted to investigate the effect of foliar application of K (2 and 4% KNO_3, 2 and 4% K_2SO_4, 2% KNO_3 + 2% K_2SO_4, 4% KNO_3 + 2% K_2SO_4, 2% KNO_3 + 4% K_2SO_3 ,4% KNO_3 + 4% K_2SO_4) on growth of wheat variety (cv Watan) direct seeded on ridges with Rabi drill at SSRI farm, Pindi Bhattian during Rabi season, 2007. Treatments were assigned using randomised complete block design (RCBD) with three replications. The treatments planned for this study were a control which received 70 kg K/ha (soil applied as K_2SO_4), 2% KNO_3 (7.6 g K /L) foliar spray at 30 and 50 days after sowing (DAS) i.e 5 kg K/ha using volume of

725 L of water, 4% KNO_3 foliar spray at 30 and 50 DAS i.e. 10 kg/ha, 2% K_2SO_4 (9.0 g/L) foliar spray at 30 and 50 DAS i.e 6.5 kg/ha by using 725 L water, 4% K_2SO_4 foliar spray at 30 and 50 DAS i.e 13 kg/ha, 2% KNO_3+2% K_2SO_4 foliar spray at 30 and 50 DAS, 4% KNO_3+2% K_2SO_4 foliar spray at 30 and 50 DAS, 2% KNO_3+4% K_2SO_4 foliar spray at 30 and 50 DAS and 4% KNO_3+4% K_2SO_4 foliar spray at 30 and 50 DAS. A basal dose of 80 kg P/ha was applied to all treatments at sowing. Nitrogen application (100 kg N/ha) was applied at two stages. Half of the nitrogen was applied at the time of first irrigation and the remaining half at tillering stage. The crop was irrigated with tube well water throughout the growth period. Necessary plant protection measures were done whenever required. The crop was harvested at maturity and data on tillering, plant height, spike length, number of grains/spike, 1000-grain weight, straw and wheat yields were recorded. Soil samples were analysed for particle size distribution by the hydrometer method (Gee and Bauder,1986), for $CaCO_3$ by acid neutralisation method (FAO, 1980) and for soil organic matter by the Walkley and Black procedure (Nelson and Sommers, 1982). Soil pH was measured in soil;water suspension (1:1 ratio). Electrical conductivity of the soil suspension was measured using a conductivity meter. Extractable P, K and Zn were determined using Ammonium Bicarbonate-Diethylene Triamine Penta Acetic Acid (AB-DTPA) extractant (Soltanpour and Workman, 1979). Total K % in plant samples was determined using wet digestion (nitric acid + perchloric acid in 2:1 ratio) (Rhoades, 1982). Data were analysed statistically and differences determined using the LSD test (Gomez and Gomez, 1984).The basic soil and water physicochemical analysis are mentioned in Tables 1-2, respectively.

Table I. Physicochemical analysis of the soil at SSRI farm

Parameters	Value
pH (1:1)	8.52
ECe (1:1) dS/m	5.32
Sodium absorption ratio (SAR) $(m.mol/L)^{1/2}$	18.87
$CaCO_3$ %	23.01
Organic matter (OM) %	1.02
Sand %	63
Silt %	17
Clay %	20
Texture class	Sandy loam

Table 2. Analysis of tube well water

Parameters	Value
pH	8.1
ECe (dS/m)	1.7
RSC (meq/L)	15.2
HCO_3 (meq/L)	17.5

RSC = Residual sodium carbonate.

Results and Discussion

Growth and yield. Data in Table 3 indicates that there was no significant effect of foliar application on spike length and straw yield under Rabi drill sowing. However, maximum average number of spike length (11.33) was recorded with 4 % K_2SO_4 foliar application and 4003 kg/ha straw yield was noticed in control. Foliar application of 4 % KNO_3 + 2% K_2SO_4 significantly, improved tillering capacity. Maximum plant height (95.33 cm) was also observed in 2% K_2SO_4 and lowest plant height in control. 2% K_2SO_4 and 4% K_2SO_4 improved the tillering capacity of wheat compared with control. The combination of 2 % KNO_3 + 4% K_2SO_4 attained the highest grain yield (2825.33 kg/ ha) which was statistically at par with 2% K_2SO_4 (2795 kg/ha). Ali *et al.* (2005b) reported that foliar application of 1.5% K_2SO_4 produced better paddy and straw yield as compared to KNO_3 and KCl alone. Many researchers had reported the positive response of K_2SO_4 foliar application to rice and wheat crops as well as higher plants (Ali *et al.,* 2007; 2005; Ranjha *et al.,* 2002; Ramos *et al.,* 1999; Malik *et al.,* 1988).

Potassium concentration in wheat was significantly affected by foliar application at various concentrations of K_2SO_4 (Table 4). The highest concentration (0.069 %) was recorded when 2% KNO_3 + 2% K_2SO_4 solution was sprayed which was statistically equal to 4% K_2SO_4, 4% KNO_3 + 2% K_2SO_4 and 2% KNO_3+ 4% K_2SO_4 (0.067, 0.066 and 0.065%, respectively). Rest of the treatments showed comparatively less K concentration in plant tissues being minimum (052%) in case of control. The K concentration in straw was also significantly affected by different K_2SO_4 and KNO_3 application treatments. Control and 4% KNO_3+ 4% K_2SO_4 spray again exhibited the lowest K concentration in wheat straw (Table 4). It may be due to cuticles that are permeable to water and ions (Gethard, 2010). Wazir *et al.* (2011) found that wheat yield was increased with foliar application of nutrients. The findings of this protocol are inline with this study. Ameer and Aziz (2013) investigated in their study that, foliar application of K reduced the toxic effects of sodium and increased grain yield due to reduction of salinity stress by foliar application under saline conditions.

Table 3. Effect of K_2SO_4 and KNO_3 foliar application on growth parameters, straw and grain yield of wheat at SSRI farm

Treatments	No. of tillers	Plant height (cm)	Spike length	No. of grain per spike	1000 grain weight (g)	Straw yield (kg/ha)	Grain yield (kg/ ha)
Control(Soil applied K_2SO_4	128.67^{cd}	85.33^{e}	9.33 NS	4533^{e}	48.37^{d}	4003 NS	2129^{e}
2% KNO_3	129.33^{cd}	94.33^{ab}	11.00	67.33^{abc}	48.73^{d}	3220.67	2485^{bcd}
4% KNO_3	132.00^{bcd}	89.00^{cde}	11.33	70.00^{a}	51.43^{c}	3281	2715^{ab}
4% K_2SO_4	127.67^{cd}	87.00^{cde}	10.33	61.33^{cd}	59.43^{a}	2705	2434^{cd}
2% KNO_3+2% K_2SO_4	139.67^{abc}	85.67^{de}	10.67	74.33^{a}	56.17^{abc}	3210	2718^{ab}
4% KNO_3+2% K_2SO_4	145.00^{a}	89.33^{cde}	10.33	69.00^{ab}	56.87^{ab}	3400	2392^{d}
2% KNO_3+ 4% K_2SO_4	144.67^{ab}	91.00^{bc}	10.00	57.33^{d}	52.20^{bcd}	3020	2825^{a}
4% KNO_3+4% K_2SO_4	123.33^{d}	90.00^{cd}	11.00	65.00^{bc}	54.77^{abc}	2857	2661^{abc}
LSD	9.7	2.5	NS	4.2	4.6	NS	203

Means followed by different letter (s) within the columns differ significantly at 5% level of significance; NS = non significant.

Table 4. Effect of K_2SO_4 and KNO_3 foliar application on potassium contents (%) at SSRI farm

Treatments	Potassium contents (%)	
	Wheat	Wheat straw
Control (Soil applied K_2SO_4)	0.052^{bc}	0.156^{d}
2% KNO_3	0.057^{b}	0.166^{bc}
4% KNO_3	0.063^{ab}	0.172^{b}
2% K_2SO_4	0.064^{ab}	0.177^{a}
4% K_2SO_4	0.066^{a}	0.169^{b}
2% KNO_3+2% K_2SO_4	0.069^{a}	0.179^{a}
4% KNO_3+2% K_2SO_4	0.067^{a}	0.163^{c}
2% KNO_3+ 4% K_2SO_4	0.065^{a}	0.182^{a}
4% KNO_3+4% K_2SO_4	0.060^{b}	0.158^{d}

Means followed by different letter (s) within the columns differ significantly at 5% level of significance.

These results indicated that foliar-applied K ameliorated the effect of salinity on wheat plants. Rahman *et al.* (2014) reviewed and suggested that the foliar plant mineral nutrients improved the vegetative and yield components of wheat in comparison with the soil applied nutrients. It is also very beneficial when roots are unable to absorb nutrients from soil due to the interference of various salt factors. So, foliar application can be considered as the beneficial practice as significant effect of potassium application has also been obtained by various researchers (Ahmad *et al.,* 2011; Ali *et al.,* 2005a; 2005b; Arabi *et al.,* 2002; Howard *et al.,* 1998).

Conclusion

The results of present study depicts that foliar application of K to wheat crop at 30 and 45 days after sowing is promising and registered 31% more grain yield than that of soil application of K (control) at the time of sowing.

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