RESPONSE OF WHEAT TO POTASSIUM FERTILIZATION UNDER FIELD CONDITIONS

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Fertilizers constitute an integral part of improved crop production technology. In countries like Pakistan, the nutrient use is imbalanced, particularly for potash, which is requirement of Pakistan soils, as increasing cropping intensity is continuously exhausting soils of the K reserves. Therefore a field experiment was conducted at Soil Salinity Research Institute, Pindi Bhattian during (2000-2001) in salt-affected (pH 8.6, EC 5.2 dS m"1 SAR, 24.6 and K^{ext} 86 mg kg") sandy loam soil on wheat to observe its response to applied K-fertilizer. Five treatments (0, 75, 150,225,300 kg KzO ha") were tested in the presence of 140 kg ha"N and 110 kg ha"1 PzOs. The crop was irrigated with tube well water and all the cultural practices were kept uniform for each treatment. The results indicated that 225 kg ha" KzO application increased significantly number of tillers plant", number of grains spike", 1000-grain weight, grain and straw yield. The highest yield was recorded at 225 kg ha"1 of potash application. Increase in rate from 225 kg KzO ha' decreased all the growth parameters studied. Potassium application significantly affected uptake of nitrogen and phosphorus in straw as well as grain of wheat. Similarly Application of potassium significantly affected sodium concentration in both grain and straw of wheat, maximum concentration being at control. Potassium concentration increased by increasing rate of potash application up to 225 kg KzO ha"1 Post harvest soil tests indicated that there was a build up of K with increasing dose of K fertilizer.
Keywords: Wheat, growth, yield, potassium, field condition

INTRODUCTION

Plants need large quantities of potassium, the uptake of which frequently exceeds the uptake of nitrogen. Not only the plant tissues had higher K+ content than the other cations but K+ regulates effectively many physiological and biochemical processes (Bajwa, 1994). Potassium deficiency typically occurs in highly weathered tropical (Oxisols, Ultisols) and coarse textured soils. Most soils of the great alluvial flood plains in Asia once regarded high in extractable K+, plus the K+ supply from irrigation water, meant that K+ will rarely be a limiting factor in irrigated rice and wheat crop production (De Oetta and Mikkelsen, 1985), but its deficiency is being spread over fine-textured soils. The introduction of modern crop production technologies includinq the use of dwarf, early maturing and nitrogen responsive varieties not only have increased the crop yields but also have increased demand for nutritional inputs, especially of potassium. The role of potash in crop production has been reported by many workers (Javed and Muhammed, 1991; Jalil *et al., 1992;* Hussain *et al.,* 1993; Ranjha *et et.,* 1995). Initially simple experiments with various doses of Nand P along with one or two levels of K indicated positive but inconsistent responses to K application. The reason being that there were only certain areas where potash application was remunerative. Realizing the importance of K+ in plant nutrition and its high removal from soil by crops, present study was conducted to see the effect of potassium on yield and nutrient uptake of wheat.

MATERIALS AND METHODS

A field experiment was conducted during 2000-2001 at Soil Salinity Research Institute, Pindi Bhattian. The field (pH 8.6, EC_e 6.2 dS m", SAR 24.2) was sandl loam in texture and had extractable-K 86 mg kg' , available N 0.02 %, available P 5.4 mg kg"1 and organic matter 0.4 %. Potassium was applied at five levels viz. 0 (T_1), 75 (T_2), 150 (T_3), 225 (T_4), 300 (T_5) kg KzO ha"1 as KCI with a common dose of 140 kg Nand 110 kg PzOs ha"1 as urea and OAP, respectively. Half of N and full PzOs and KzO were applied at the time of sowing. The remaining half dose of N was broadcasted with 1st irrigation (25 days after sowinq). The experiment was laid out on randomized complete block design with 4 replications. Wheat variety Inqalab-91 was tested using seed rate of 125 kg ha"1. All the recommended agronomic practices were followed during growing period. The grain and straw yield was recorded at the harvest of crop. The representative plant samples from each plot were collected and analyzed for K+ and Na" contents. Similarly soil samples were collected at the termination of experiment. The soil and plant samples were analyzed according to the method given in Hand-book NO.60 (US Salinity Lab., Staff, 1954), except total N (Jackson, 1962) and extractable phosphorus (Watanabe and Olsen, 1965) in soil. Plant and soil data were analyzed statistically following Analysis of Variance technique (Steel and Torrie, 1980) and treatment means were compared using the Ouncans' Multiple Range Test.

RESULTS AND DISCUSSION

Effect of potassium application on growth parameters

The results showed that plant height, number of tillers/plant, and 1000-grain weight were significantly affected by increasing potassium rates from zero to 225 kg K_2O ha' (Table 2). Increase in K level beyond 225 kg ha" decreased all the three parameters most probably due to nutrient imbalance caused by excess of ~otassium and antagonistic effect of K+ on Ca^{2+} or Ca + + Mg^{2+}.

Table 1 Physical and chemical characteristics of soil

Characteristics	Unit	Value
Textural class	Sandy loam	
Saturation percentage	%	31.0
pH.	-	8.6
EC_e	dS m'	5.2
SAR	(mmol L-')oS	24.6
Gypsum requirement (GR)	ton\acre\6 inch	1.3
Lime	%	2.9
Organic matter	%	0.4
Total nitrogen (N)	%	0.02
Available phosphorus (P)	mg kg-'	5.4
Extractable potassium (K)	mg kg-'	86

The grain yield is a function of combined contribution of various yield components, which have direct relationship to the growing conditions and practices adopted to manage the crop. A significant increase in grain yield was observed with an increase in the levels of K application (Table 2). The highest grain yield (427 t ha') was obtained at 225 kg K_2O/ha followed by 300 kg K_2O ha" (3.91 t ha"), 150 kg ha" (2.86 t ha"), 75 kg ha" (2.81 t ha') and control (2.12 t ha"). The increase in grain yield might be due to more uptake of potassium from the salt affected soil where potassium fertilizer was applied that counteracted the toxic effect of unwanted ions like Na". Similar findings were reported by Fageria *et al.* (1990) and Azam (1993) in wheat.

The data on straw yield (Table 2) of wheat showed significant increase in yield with the application of K fertilizer. The highest yield (4.57 t ha') was recorded at 225 kg K_2O ha" followed by 300 kg K_2O ha" (4.57 t ha-\ while the lowest was reported at control (1.79 t ha'). The minimum straw yield with control might be due to Na" toxicity and less uptake of potassium in plants in salt-affected soils (Muhammed, 1986). Increased straw yield with the application of potassium fertilizer in salt-affected soil was also supported by the findings of Gulshad (1985) in rice and Azam (1993) in case of wheat.

Table 2 Effect of potassium fertilization on growth parameters of wheat

Treatment								
	N	P_2O_5	K_2O					
T,	140	110	0	61.26 d	3.18 c	35.76 d	1.79 d	2.12 d
T_2	140	110	75	65.42 c	4.23 b	38.72 c	3.17 c	2.81 c
T_3	140	110	150	71.50 b	4.60 b	39.06 c	3.47c	2.86 c
T_4	140	110	225	79.17 a	6.95 a	42.11 a	4.57 a	4.27 a
T_5	140	110	300	78.00 a	6.50 a	40.56 b	4.00 b	3.91 b

Table 3 Effect of potassium fertilization on chemical composition of wheat

	Nitrogen (%)		Phosphorus (%)		Potassium (%)		Sodium (m mol kg^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T,	1.44 d	0.300 c	0.204 b	0.032 b	0.271 d	1.836 d	106.00 a	161.25 a
T_2	1.84 c	0.455 b	0.443 a	0.037 a	0.406 c	2.020 c	91.23 b	140.35 b
T_3	1.87 bc	0.492 ab	0.461 a	0.038 a	0.470 b	2.118 b	89.41 b	132.00 b
T_4	2.17 a	0.530 a	0.466 a	0.040 a	0.614 a	2.214 b	88.69 b	135.50 b
T_5	2.03 ab	0.462 b	0.466 a	0.040 a	0.514 b	2.335 a	88.99 b	135~80 b

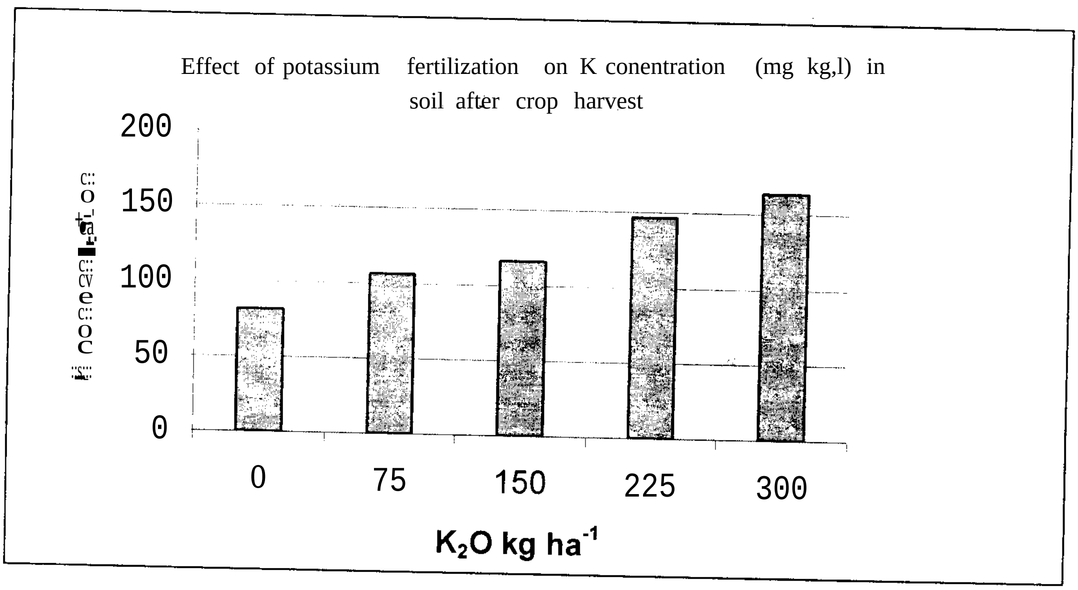
Effect of potash on chemical composition of wheat

Effect of potassium on nitrogen concentration (N %) in grains and straw

Potassium is known for its interaction, both antagonistic and synergistic with essential, macro and micronutrients (Dibb and Thompson, 1985). Potash application had significant effect in increasing the nitrogen content in both wheat grain and straw (Table 3). Although the nitrogen concentration in T_5 produced significant results over control, yet it resulted in lower nitrogen concentration in wheat grains than T_4 (225 kg K_2O ha^{-1}). This could be attributed to nutrient imbalance at highest level of potassium. Hassan *et al.* (1996) stated that the optimum production of wheat needed potassium application along with Nand P. He further observed increased N content in plant with K fertilization. These results are in good agreement with the findings of Wahab and Hussain (1957) and Khan and Akhtar (1996). Mengal and Aksoy (1971) also found that potash application favored the uptake of nitrogen showing synergistic effect of potassium on nitrogen uptake.

Effect of potassium on K concentration (%) **in grains and straw**

Potassium in wheat grains and straw increased significantly with increase in its rate from 0 to 300 kg K_2O ha^{-1}. The lower potassium concentration with T_1 (control) was due to lower concentration of soluble K in soil solution, hence lower uptake from soil lower in native K. The increase in K concentration of wheat grains and straw with potassium fertilizer treatments might be due to higher uptake of K by plants. Potassium addition increases potassium levels in plant tissues and about 80 to 90 % of the potassium absorbed by plants is found in straw (Terman *et al.*, 1975). Wheat and other cereal crops require as much K as N and in some cases the need for K exceeds N (Kemmler, 1983). He stated that K required by aerial parts of wheat ranges from 40 kg ha^{-1} to much more than 200 kg ha^{-1}. Zia *et al.* (1987) observed that K uptake increased with the application of Nand P fertilizers by wheat plants. Our results are also in good agreement with the findings of Sekhon (1982), Siddique *et al., (1996).*



Effect of potassium on P concentration (%) **in grains and straw**

Potassium fertilizer significantly affected the phosphorus contents (%) in wheat grain over control (Table 3). The average minimum concentration of P in wheat grains was found at T_1 (control). All the K fertilizer treatments affected similarly in P acquisition by grains, however had significant effect when compared with control. Das *et al.* (1970) studied four soils of Ludhiana and Jullandar and reported that application of K in combination with a basal dose of N and P resulted in higher concentration of both K and P in grains. Low phosphorus concentration in straw was due to dilution effect. These results are in line with the findings of those reported by Roy *et al. (1990).*

Na concentration in grain and straw of wheat

Soil salinity had a positive and significant while K had negative relationship with sodium uptake by wheat. Sodium concentration in grain and straw decreased significantly by increasing potassium rates, when compared with non-K treatment. Maximum concentration was found in control while all other treatments remained statistically similar among each other for Na+ concentration both in straw and grains. Addition of potassium reduced the toxic effect of sodium in plants and increased the K+/Na+ ratio in soil (Muhammed, 1986). So, addition of potassium had a beneficial effect under adverse soil conditions by reducing the accumulation of sodium in the plant tissues, consequently an improvement in the yield was obtained. Similar results *have* been reported by Azam (1993) in wheat.

Residual effect of K concentration

Monitoring of soil after crop harvesting showed that there was a build up of K in soil with the application of potassium and K concentration in soil was increased in the same fashion as the K application rate was increased.

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