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Response of Different Wheat Cultivars to Potash Application in Two Soil Series of Pakistan

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Abstract: A pot experiment was conducted to investigate the effect of K application on Shujabad and Missa soil series on six wheat cultivars. Nitrogen and P were applied @150 mg N and 75 mg P_2O_5 kg^{-1} with two levels of K (0 and 150 mg K_2O kg^{-1}) as muriate of potash. Relatively large quantities of shoot biomass were produced in Missa than Shujabad soil. Irrespective of soils and cultivars, the application of K increased shoot biomass of all the cultivars except NR-37. In Shujabad soil, Rawal-87 and in Missa soil Inqlab-91 had higher nitrogen while Sariab-92 and Chakwal-86 the minimum on Shujabad and Missa soils, respectively. The potassium contents of all the wheat cultivars increased with the addition of K fertilizer. Maximum K was found in Chakwal-86 while minimum in Sarib-92. It was observed that Sariab-92 had much less Cl^- content than the other cultivars, however its biomass increased with MOP application as compared to control whereas NR-37 had the maximum Cl^- contents. Nitrogen, P, Mg and S in most of the cultivars decreased over the control. The results showed that the behavior of wheat cultivars and their response to K application differed on two soils.

Key words: Soil series, wheat cultivars, K response, nutrient uptake

Introduction

Several measures, such as, an increase in gross cultivated area, multiple cropping, improved cultivars, better irrigation facilities, soil conservation and plant protection are contributing to higher crop yields. The use of fertilizers in balanced proportions is one of the main key elements of high crop yield. Studies on soil fertility using series/types as the basis for making fertilizer recommendations have been advocated (Sekhon *et al.*, 1987). Under intensive agriculture, substantial amounts of nutrients are removed from the soil in which the proportion of K is about 50 % (Bhargava *et al.*, 1985). They observed that at 60 kg K_2O ha^{-1} increase in the yield was from 6 to 8 kg^{-1} of applied nutrient in both rice and wheat during 1977-82 as against from 2 to 4 kg^{-1} in the earlier period. Prasad (1990) observed that the highest response of wheat to K was at 80 kg K_2O ha^{-1} in majority of the soils in India. The response ranged from 1.9 to 70.3 %. It has also been observed that yield response of wheat to added K was considerably higher in low K soils than in those of medium status (Roy *et al.*, 1989). Ranjha (1988) and Siddique *et al.* (1997) also observed positive effect of applied K fertilizer on wheat under Pakistan soil conditions. Accordingly, in this study the response of different wheat cultivars to K application in two soils has been investigated.

Materials and Methods

A pot experiment was conducted in the greenhouse at the National Agricultural Research Center (NARC), Islamabad in Rabi (winters) 1995. Six wheat cultivars viz., Chakwal-86, Rawal-87, Parwaz, Inqlab-91, Sariab and NR-37 were studied. Two soils, low in available K (ammonium acetate extractable) were selected for the study (Table 1). One of the soils belonged to Missa series (brown to dark brown, silt loam strongly calcareous) and the other to Shujabad soil series (deep, well drained, calcareous, moderately fine texture with cambic B-horizon). Missa soil has been developed from loess while Shujabad soil series from mixed alluvium material (Anonymous, 1976; Anonymous, 1986). Clay contents are higher in Shujabad compared to Missa soil series.

Soil samples for the pots were collected from the upper surface (0-15 cm); sieved and 7.0 kg was filled in each of the pots. The representative soil samples were analyzed for pH_s, EC_e, NH_4OAc-K (Anonymous, 1954) and $NaHCO_3$-P (Watanabe and Olsen, 1967). Nitrogen and phosphorus were applied at the rate of 150 mg N kg^{-1} soils and 75 mg P_2O_5 kg^{-1} soil. Two K treatments K_0 (no additional application of K) and K_1 (addition of K @ 150 mg K_2O kg^{-1} soil) were used. Urea, diammonium phosphate (DAP) and muriate of potash (MOP) were used as sources of N, P and K. All the P and K fertilizers were applied at sowing time while N was applied in three splits. The crop was irrigated with distilled water. The experiment was laid out in CRD factorial arrangement. The plant samples collected at tillering stage were analyzed for shoot biomass and N, P, K, Mg, Cl and S contents.

Table 1: Physico-chemical properties of soil used for the experiment

	Soil series	
Characteristic	Missa	Shujabad
pH	7.8	7.4
Ec_e (dS m^{-1})	0.9	1.1
Olsen-P (mg kg^{-1})	7.6	11.6
NH_4OAc- K (mg kg^{-1})	54.0	58.0
Organic matter (%)	0.8	0.5
Sand (%)	10.9	22.0
Silt (%)	76.9	57.0
Clay (%)	12.2	21.0
Textural class	Silt loam	Silt loam

Result and Discussion

Effect on plant biomass: Fresh shoot biomass was more in Missa soil than Shujabad soil (Fig. 1). Response to K application appeared varietal specific in both the soils, although they behaved differently under different soils. Increase in biomass occurred in NR-37and Parwaz cultivars in Shujabad soil. Except NR-37, biomass production increased in all the wheat cultivars grown in Missa soil. Increase in biomass was more pronounced in Missa soil

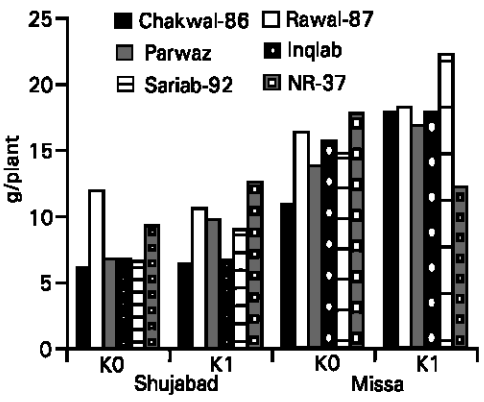

Fig.1: Effect of K and soil series on biomass of different wheat cultivars at tillering stage

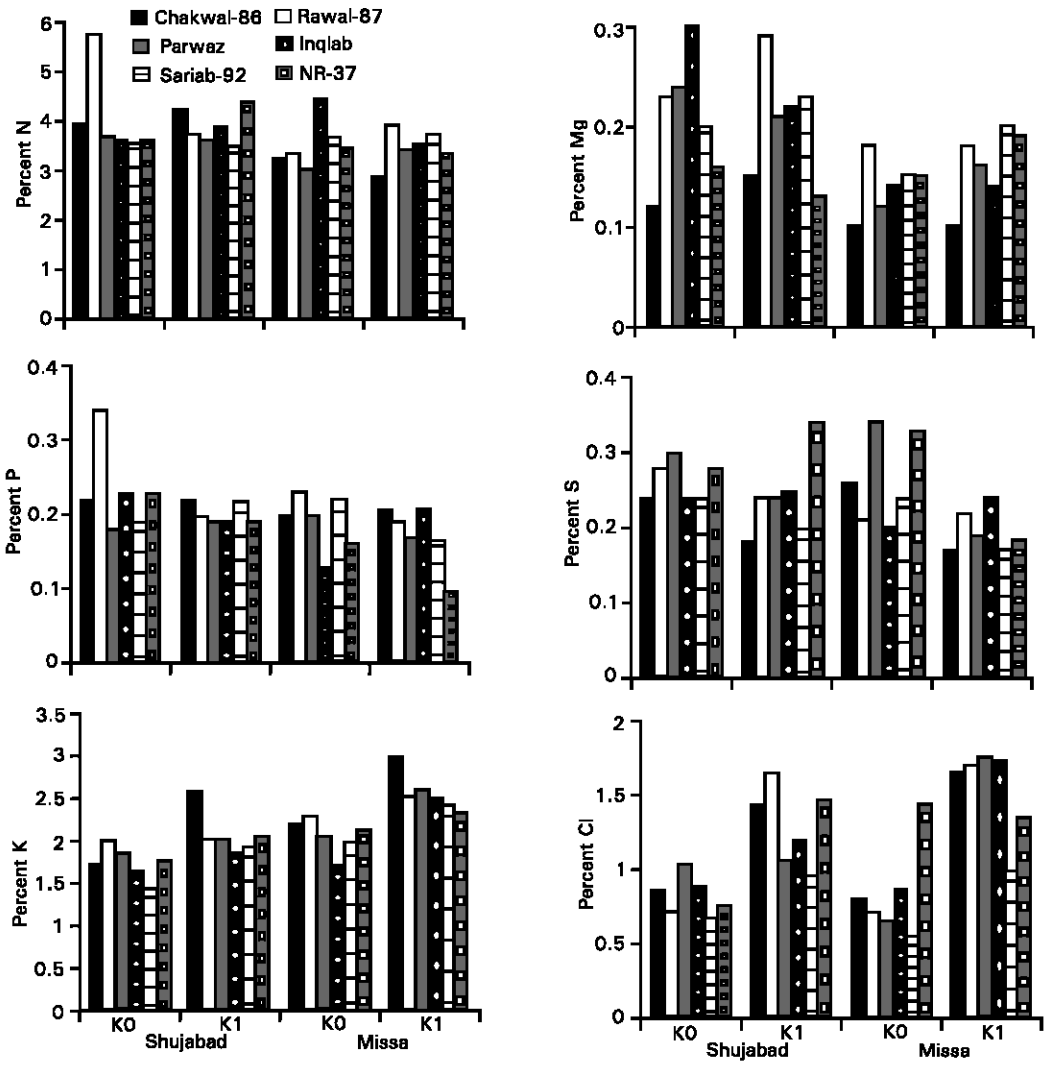

Fig. 2: Effect of K fertilizer and soil series on chemical composition of different wheat cultivars

than Shujabad soil. Wheat cultivars also differed in their response to K under the soils tested. It could be due the fact that both the soils developed from different parent material (Anonymous, 1976; Anonymous, 1986) and they varied in texture as well as capacity/intensity factors (Tisdale *et al.*, 1993). It implied different impact on plant growth. The response of cultivars might also be due to their inherent yield potential and thus cultivars with low yield potential have little or no response to K application. Irrespective of soils and cultivars, the application of K increased shoot biomass by 17 % at tillering stage compared with control treatment (K_0). Response to K was also more in Missa soil than Shujabad. Bhargava *et al.* (1985) and Roy *et al.* (1989) reported similar results. Sekhon *et al.* (1987) observed that different soils/series brought about differential response to fertilizer application for plant growth. Ranjha (1988) and Malik *et al.* (1989) observed similar response of K to potash treated soils compared to non-treated soils.

Effect on plant composition: Wheat cultivars differed in two soil series and under different K regimes for their nutrient acquisition (Fig. 2). Although different cultivars showed variable response to K application yet the potassium contents in all the wheat cultivars increased with the addition of K fertilizer. Maximum K contents were observed in Chakwal-86 while minimum in Sariab-92 (Fig. 2). Per cent increase was maximum in Chakwal-86 followed by Inqlab-91 > Sariab-92 > Parwaz > NR-37 Rawal-87. Potassium helps in translocation of assimilates (Tisdale *et al.*, 1993) thus contribute to the source sink relationship and hence to the growth of plants. Chloride content also increased in all the cultivars, which was due to presence of higher Cl^- ion in the soil where MOP was applied. Potassium and Cl^- ion both act as active osmotic agent thus regulates water relations of plants. Both these factors seem to be responsible for increased plant growth. Sariab-92 had much less Cl^- ion than the other cultivars and its biomass increased with MOP application than the control. In this cultivar N contents remained unaffected, Mg contents increased while P and S decreased. This behavior showed ion selectivity of the cultivar. Magnesium is a part of chlorophyll, its increased uptake in the presence of K fertilization might have increased its chlorophyll contents and therefore higher photosynthetic activity which lead to more biomass production. Such cultivars therefore, could be used in breeding/selecting of wheat varieties for salt affected soils containing excessive amount of Cl^- ion. Soil type, clay contents and mineralogy may have affected the uptake of potassium by plants (Deol *et al.*, 1987; Ranjha, 1988). In Missa soil series the uptake of K was high which might be due to more micaceous

minerals in the former soil than the latter one (Anonymous, 1976; Anonymous, 1986). Hence, it released more K which resulted in higher uptake of K by the plants. Patel *et al.* (1989) and Ranjha (1988) reported similar results.

Varietal behavior regarding to the other nutrients also differed on both the soils when K fertilizer was applied. Nitrogen, P, Mg and S in most of the cultivars decreased over the control. This might be due to increase in growth with K application (dilution effect). In Shujabad soil series Rawal-87 and in Missa soil series Inqlab-91 had higher nitrogen contents in plant tissue. The minimum nitrogen contents were observed in Sariab-92 in Shujabad soil and Chakwal-86 in Missa soil. It is due to increase in biomass (Fig. 1) as a result of K application.

It is concluded that wheat cultivars performed differently in two soil series and K regimes. This experiment shows that detailed studies are needed for selecting different cultivars/varieties for various regions and soil types in order to get optimum crop yield.

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