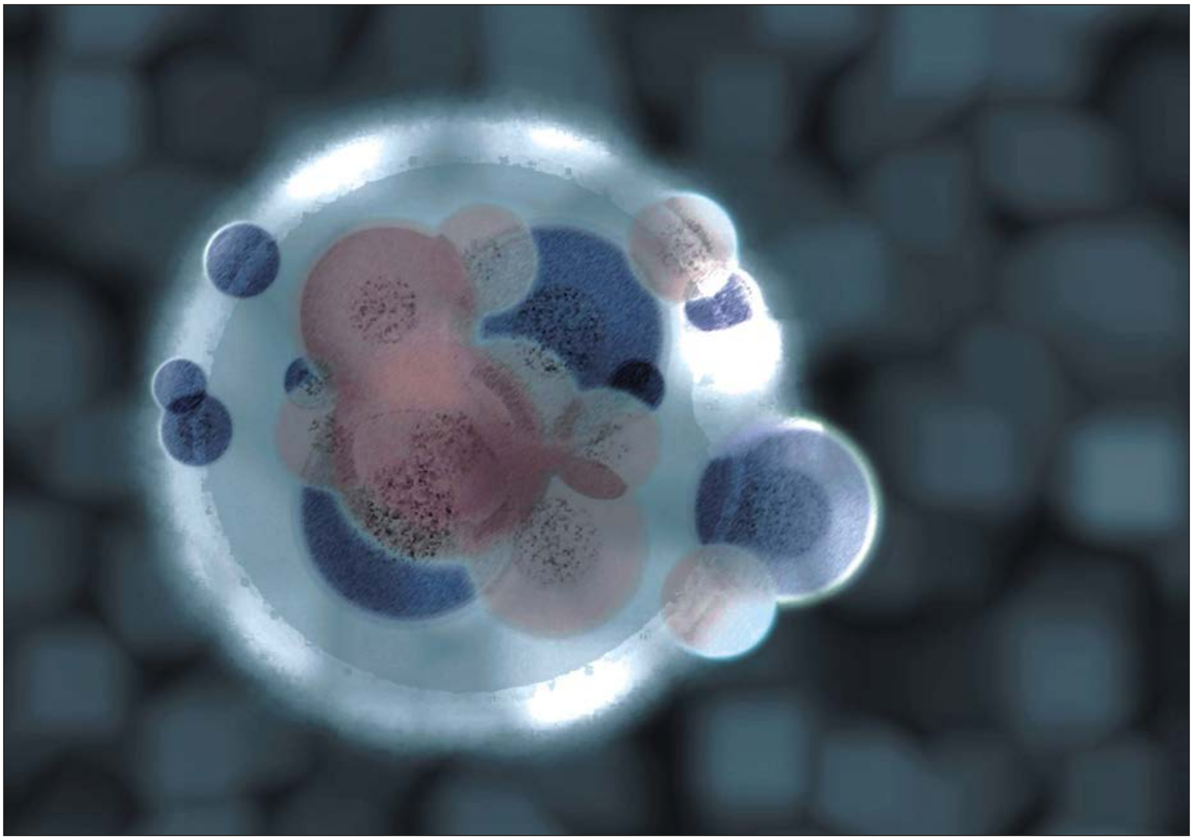

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Response of Wheat to Potassium Application in Six Soil Series of Pakistan

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Abstract: The number of productive tillers plant^{-1}, grain and straw yields in wheat were increased significantly by increasing K application except grain yield in the Wazirabad and the Sultanpur soil series and straw in the Kotli series which remained non-significant. K concentration in grain was improved by 100 mg K kg^{-1} except in the Sultanpur and Shahdara series where it increased upto 75 mg K kg^{-1}. While in straw it was increased upto 75 mg K kg^{-1} rate except the kotli series where it improved upto 50 mg K kg^{-1}. Potassium uptake by wheat crop was increased upto 50 mg K kg^{-1} except in the Pindorian and the Lyallpur soil series where it increased upto 75 mg K kg^{-1}.

Key words: Soil series, potassium, wheat

Introduction

Most of the cultivated soils in Pakistan have sufficient supply of available potassium for optimum plant growth (Bhatti, 1978). The need for K is not wide spread as that for N & P in Pakistan, it is most probably due to dominance of hydrous mica in the clay fraction (Ranjha *et al.*, 1993). In Punjab extensive trials in farmers field showed that average yield of cotton, rice and wheat with application of N P could be further increased by 9% with addition of K (National Fertilizer Development Centre, 1986). Similarly in NWFP over a period of ten years a few experiments conducted on wheat, rice and millet under farmers fields showed good response to potash fertilizer (Gurmani *et al.*, 1985). Applying K in addition to NP improved the net return over fertilizer cost by 23-120%. Each kg K_2O applied increased yield of wheat by 4 to 31 kg grain, rice by 7 to 17 kg and millet by 9.0 kg. In Sindh, K has been demonstrated to be 120 to 200 kg ha^{-1} for Sugarcane (Sharif, 1985). 165 trials on wheat under farmers field and found that 30 kg K ha^{-1} did not increase the grain yield over control (Malik *et al.*,1989). Among the tested levels the results were in favour of 90 kg ha^{-1} both for yield and grain to nutrient ratio. No response to 30 kg ha^{-1} might be due to the reason that its greater part was used to meet its fixation requiremnt. More K fertilizer will be needed to overcome K fixing capacity before it is available to plant (Saleem *et al.*, 1989). On the other hand some workers has noted in field experiments that crops particularly wheat did not response to applied K (Ranjha *et al.*, 1994). In view of the foregoing discussion the experiment was conducted to see the "Response of wheat to potassium application in six soil series of Pakistan".

Materials and Methods

A pot study was undertaken in six soil series of Pakistan which were free of salinity/sodicity, low in organic matter, three were calcareous viz the Lyallpur, the Sultanpur and the Shahdara, CEC ranged between 6-33 C mol Kg^{-1} (Table 1). Soil series samples were collected from field, brought to the greenhouse and filled at 3 and ½ kg in plastic pots.
Potassium was applied at 0, 25, 50, 75 and 100 mg K kg^{-1} soil. Seeds of wheat variety (LU 26 S) were sown in these pots. N and P_2O_5 were applied at 75 and 50 mg kg^{-1} soil respectively. The pots were arranged according to Completely Randomized Design (CRD) with three replications. Canal water was used for irrigation. Six grains per pot were sown which were thinned to three, 15 days after seeding. Irrigation water was applied when needed. The crop was harvested at maturity and yield contributing parameters were recorded. Samples of grain and straw were oven dried at 70°C and analyzed for K concentration. All the analyses were done according to the methods described in Hand book No. 60 (U.S. Salinity Laboratory Staff, 1954). All the data were analysed statistically using Completely Randomized Design (Steel and Torrie, 1980).

Results and Discussion

Growth parameters: Number of productive tillers plant^{-1}, grain and straw yields (Table 2, 3) increased significantly by K application over control except grain in the Wazirabad, the Sultanpur and straw in the Kotli series which remain unaffected. The increase in number of productive tillers plant^{-1} was non-significant in last four treatments in the Sultanpur series, in the last three treatments in case of Pindorian, Wazirabad, Shahdara, Lyallpur soil series and in last two treatments in Kotli series. The grain yield was increased by increasing K application rates upto 50 mg K kg^{-1} except in the Pindorian series in which it increased up to 75 mg K kg^{-1}. Similarly straw yield was increased upto 50 mg K kg^{-1} rate except the Kotli series where it was non-significant. The increase in grain and straw might be due to small volume of soil in pots, hence plant responded to K application. The non-significant increase in number of productive tillers plant^{-1}, grain and straw yields by K application is attributed to the adequate amount of K already present in all the series. The nitrogen and phosphorus levels used were equal in all the pots due to which the addition of K could not increase the yield particularly at higher application rates i.e. 75 and 100 mg K kg^{-1} soil. At these rates availability of K was more than the requirement of the plants and to increase yield further it is necessary to add more N and P.Similar results were reported by Malik *et al*. (1989).

Potassium concentration in grain and straw: Potassium concentration in grain and straw (Table 4) increased by increasing its application rate in all the series except the Kotli series where as non-significant effect was noted in grains. However the degree of response varied. Significant increase in K concentration was recorded upto 100 mg K kg^{-1} soil in the Pindorian, the Wazirabad and the Lyallpur soil series where as the Sultanpur and the Shahdara responded upto 75 mg K kg^{-1}. In straw this parameter increased upto 50 mg K kg^{-1} rate in the Kotli series upto

Table 1: Chemical characteristics of surface and subsoil of the selected soil series

Series	Horizon	Depth (cm)	$CaCO_3$ (%)	Organic matter (%)	CEC C mol Kg^{-1}	Ph_s	Ec_e dSm^{-1}
Kotli	Ap	0-15	0.3	1.12	31.0	7.7	0.4
	B	15-45	0.9	0.84	33.0	7.6	0.3
Pindorian	Ap	0-15	0.7	0.52	8.0	7.7	1.4
	B	15-45	0.8	0.44	9.0	7.8	0.8
Wazirabad	Ap	0-15	-	0.33	7.0	7.6	0.5
	B	15-45	-	0.26	6.0	7.7	0.4
Lyallpur	Ap	0-13	7.1	0.65	11.0	7.8	0.74
	B	13-28	7.1	0.45	9.4	7.9	0.34
Sultanpur	Ap	0-10	11.0	1.13	12.4	7.9	0.84
	B	10-29	11.0	0.66	11.6	8.0	0.82
Shahdara	Ap	0-17	12.0	0.55	11.4	8.1	0.86
	C	17-26	11.0	0.24	6.6	8.1	0.90

Table 2: Effect of applied potassium on number of productive tillers $plant^{-1}$

	Potassium application rate mg K kg^{-1} soil				
	0	25	50	75	100
Kotli	3.67c	4.67bc	4.67bc	5.67ab	6.33a
Pindorian	3.67c	4.67bc	5.67ab	6.00a	6.33a
Wazirabad	3.33c	4.33bc	5.00ab	5.67a	6.00a
Lyallpur	4.00c	4.67bc	5.33abc	6.00ab	6.33a
Sultanpur	2.33c	4.67bc	5.67a	6.00a	6.00a
Shahdara	3.67c	4.33bc	5.33ab	5.67a	6.00a

Table-3 Effect of applied potassium on grain and straw yield (g pot^{-1})

	Potassium application rate mg K kg^{-1} soil									
Soil Series	0		25		50		75		100	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Kotli(Non-Calcareous)	7.88c	10.64	9.65b	11.59	10.56a	12.94	11.25a	13.15	11.28a	13.32NS
Pindorian (Non-Calcareous)	11.98d	13.83c	13.22c	14.54bc	14.89b	15.98ab	15.67a	17.52a	15.63ab	17.80a
Wazirabad (Non-Calcareous)	11.10	12.49c	12.86	14.21bc	14.04	16.08a	14.53	15.99a	14.53NS	15.78ab
Lyallpur(Calcaereous)	11.51c	12.94c	13.11b	14.37b	14.86a	15.84a	14.80a	16.07a	14.42a	15.53a
Sultanpur (Calcaereous)	12.67	13.83c	13.18	14.06b	15.10	15.64a	14.63	15.55a	14.19NS	14.79a
Shahdara (Calcaereous)	11.03c	11.69c	12.76b	13.35b	14.13a	15.28a	13.68ab	14.62a	13.33ab	14.76a

Table 4: Effect of applied potassium on potassium concentration in grain and straw (%)

	Potassium application rate mg K kg^{-1} soil									
Soil Series	0		25		50		75		100	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Kotli(Non-Calcareous)	0.457	1.31b	0.490	1.34b	0.513	1.44a	0.513	1.45a	0.517NS	1.49a
Pindorian (Non–Calcareous)	0.453d	1.37c	0.470c	1.37c	0.483b	1.40bc	0.490b	1.43ab	0.503a	1.46a
Wazirabad (Non-Calcareous)	0.423d	1.40c	0.445c	1.43c	0.450b	1.44bc	0.477b	1.48b	0.490a	1.55a
Lyallpur(Calcareous)	0.420b	1.50c	0.430b	1.54b	0.440b	1.54b	0.440b	1.57ab	0.480a	1.59a
Sultanpur(Calcareous)	0.370c	1.34c	0.400b	1.37bc	0.410b	1.39bc	0.420ab	1.40b	0.440a	1.47a
Shahdara (Calcareous)	0.360b	1.33d	0.360b	1.35cd	0.380b	1.38bc	0.410a	1.40ab	0.420a	1.43a

Table 5: Effect of applied potassium on its uptake by wheat crop

	Potassium application rate mg K kg^{-1} soil				
Soil Series	0	25	50	75	100
Kotli	175.75c	203.15b	240.16a	247.95a	257.15a
Pindorian	238.94c	260.94c	295.05b	326.67a	338.49a
Wazirabad	221.43c	260.22b	299.26a	305.57a	315.05a
Lyallpur	244.12c	278.50b	311.92a	317.56a	316.54a
Sultanpur	232.64b	249.02b	279.34a	279.53a	294.09a
Shahdara	194.81c	226.6b	263.97a	260.7a	266.6a

75 mg K kg^{-1} in the Pindorian, the Lyallpur, the Shahdara series and upto 100 mg K kg^{-1} rate in the Wazirabad and the Sultanpur soil series. Shakir (1984) reported similar results.

Potassium uptake by wheat crop: Potassium uptake by both grain and straw was pooled which is presented in Table 5. The results showed that by increasing K levels from 0 to 75 mg K kg^{-1} its uptake was increased significantly except in the Kotli, the Wazirabad, the Sultanpur and the Shahdara series where it increased upto 50 mg K kg^{-1} rate. When levels were increased from 75 to 100 mg K kg^{-1}, its uptake was not increased significantly in all the series. In general K uptake was increased by increasing K levels either significantly or non significantly which means total K uptake was directly proportional to the initial exchangeable K concentration of the soils. Similar types of findings were reported by Mengal (1982). The soils of arid and semi arid regions of Pakistan are relatively less weathered hence are potentially rich in K than comparable soils of humid areas (Sekhon, 1983). But the introduction of high yielding varieties and intensive cropping with heavy usage of nitrogen and phosphorus have made K fertilization necessary (Malik *et al*., 1989). These results leads to conclude that wheat response to K application varied with soil series and significant response to K application was recorded upto 75 mg K kg^{-1}.

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