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Short Communication

Response of wheat to phosphate and potash fertilizers in a newly developed tube well irrigated soil of Rodh Kohi

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Abstract

The present study was carried out to check the response of wheat to phosphate and potash fertilizers in a newly developed tube well irrigated soil of Rodh Kohi area of Dera Ismail Khan District. The seven treatments including Control, Phophorus (P) at 60, Phosphorus + Potassium (PK) at 60-30, 90-30, 90-60, 120-60 and 120-90 kg ha^{-1} were used to check the response of different agronomic traits, yield and physico – chemical properties of soil. The experiment was laid out in randomized complete block design with three replications. Nitrogen was kept constant at 150 kg ha^{-1}. The results showed significant ($p < 0.05$) influence of treatments on spike length, biological and grain yield while plant height showed non – significant response to these treatments. The maximum plant height (63.60 cm), spike length (10.87 cm), biological yield (2.68 t ha^{-1}) and grain yield (1.50 t ha^{-1}) were observed in PK at 120-60 kg ha^{-1}. Physico – chemical characteristics were non significantly affected by the application of treatments except SAR which was reduced from 13.67 to 10.33 in control and treatment receiving NPK at 150-120-90 kg ha^{-1}, respectively. The Phosphorus and Potash content of the soil was significantly increased by the application of various treatments.

Keywords: *Inorganic fertilizers, yield, wheat, soil properties, Rodh Kohi*

Rodh Kohi (Spate Irrigation) is a unique system of irrigation, in which the flash floods from the mountains is trapped in the foothill plains and used for raising crops. The approximate area globally under the spate irrigation system is 2.0 - 2.5 million hectare (ha). In Pakistan, it covers nearly 1.5 million ha which is the largest in the world (Mehari, 2005). Dera Ismail Khan district of Khyber PakhtunKhaw has a vast area under this system of irrigation in Pakistan. Rodh Kohi system is fully dependent on the rainfall in the catchment area. The distribution of water is based on head to tail rule, with earthen check dams to divert the flow of water from the main channel to the sub channels and then to fields. But due to political influence, unpredictability of floods and less income from the land farmers of Rodh Kohi are looking for alternate options. Tube well installation is one of the options which is gaining popularity amongst the Rodh Kohi farmers. Though the farmers have option to grow more crops, vegetables etc. in a year but the tube well installation has led to certain problems as use of fertilizers which was not practiced before in the flood irrigation, buildup of salinity, sodicity etc. Mostly the soil having sodicity problem suffers from nutrient deficiency especially phosphorus and potassium. Phosphorus has been reported to be adsorbed or unavailable in the soil with higher $CaCO_3$, SAR etc. (Khan *et al*., 2010). Similarly, potassium deficiency may be observed due to Na:K ratio. Potassium has significant role in reducing the impact of Na (Saifullah *et al*., 2002).

Wheat (*Triticum aestivam* L.) is the most important crop of the Rodh Kohi area of Pakistan and is the major source of subsistence food for the population. It is the major source of energy and ranks first in the production among all the cereals grown in Pakistan. It contributes 14.4% to agriculture sector and 3.1% to the GDP. It is being grown on 9.05 million hectares, with an average yield of 2639 kg ha^{-1} in Pakistan (Anonymous, 2010), which is too low as compared to other wheat producing countries of the world. Wheat raised in the Rodh Kohi regions is without use of any inorganic fertilizers, due to replenishment of the nutrients through siltation by floods. To attain optimum yield under tube well irrigation will require the inorganic fertilizers, as the native fertility of the soil is low. The present study was carried out to investigate the effect of phosphatic and potassium fertilizers on the yield and soil properties of newly developed tube well irrigated Rodh Kohi soils.

To study the response of wheat to phosphate and potash fertilizers in a newly developed tube well irrigated soil an experiment was carried out at farmer's field during year 2010 -11. Wheat verity Sehar - 2006 was used as test crop. The experiment was laid out in randomized complete block design with three replications. Nitrogen was kept constant in all the plots at 150 kg ha^{-1}. While phosphorus and potash were used at a variable rate in different treatments as T_1 (control), T_2 (P at 60 kg ha^{-1}), T_3 (PK at 60 – 30 kg ha^{-1}), T_4 (PK at 90 – 30 kg ha^{-1}), T_5 (PK at 90 – 60

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kg ha^{-1}), T_6 (PK at 120-60 kg ha^{-1}) and T_7 (PK at 120-90 kg ha^{-1}). Nitrogen, phosphorus and poatsh were applied as urea, single super phosphate and sulphate of potash. Physico - chemical characteristics of composite soil sample was collected before the experiment. The composition of the original soil is given in Table 1. Soil samples from each plot were collected after harvesting of the crop for various parameters including soil texture (Gee and Bauder, 1982), soil pH (Gupta, 2006), electrical conductivity (Richards, 1954), total organic matter (Nelson and Sommers, 1982), phosphorus (Olsen *et al.,* 1954), extractable potassium (Helmke and Sparks, 1996) and bulk density (Blake and Hartage, 1986).

Table 1: Composition of original soil and tube well water

Parameter	Original Soil	Tube well Water
Textural class	Silty Loam	
Electrical conductivity (dS m^{-1})	3.92	2.40
pH	8.09	7.99
Organic matter (%)	0.71	
SAR	13.95	14
RSC (meq L^{-1})	--	1.31
Bulk density (g cm^{-3})	1.28	--
Phosphorus (mg kg^{-1})	5.49	--
Potassium (mg kg^{-1})	271	--
Ca + Mg (meq L^{-1})	--	5.4
CO_3	--	5.6

Agronomic parameters including plant height, spike length, biological yield, harvest index and grain yield were studied. Statistical analysis of the data were carried according to the procedure given by Steel *et al.* (1997).

Growth and yield parameters as influenced by the application of various doses of P and K

The results pertaining to the levels of phosphatic and potassium fertilizer showed variable effect on growth and yield parameters (Table 2).

Results regarding the plant height of wheat showed non significant effect of the treatments. The findings were in conformity with Khan *et al*. (2008) who also reported non significant effect of N and P fertilizers on plant height.

The results of the experiment showed significant variation in spike length of wheat. The maximum spike length was observed in T_6 (10.87 cm) followed by T_7 which was 10.70 cm. The control showed minimum length of spike (7.93 cm). Memon *et al.* (2011) also found the significant (p < 0.05) differences for spike length among various treatments of phosphorous and nitrogen. Also Khan *et al.* (2009) found linear increase in spike length with subsequent increase in each unit of N and P_2O_5.

The biological yield of wheat showed significant variation among the treatments. It was observed from the results that as the concentration of phosphorous and potash increased from control to T_6, the biological yield also increased from 2.18 t ha^{-1} to 2.68 t ha^{-1}. The minimum biological yield (2.18 t ha^{-1}) was recorded in control (Table 2). Abid *et al*. (2002) reported that application of P_2O_5 at 100 kg ha^{-1} significantly increased the growth and yield of wheat under saline sodic conditions. Khan *et al.* (2008) has found that the biological yield was influenced significantly by the application of N and P_2O_5. Khan *et al.* (2009) found that the crop showed obvious response to various levels of N and P_2O_5 fertilizers when applied at different ratios. Our findings are in close agreement to those reported by Ahmad *et al.* (1992) and Khan *et al.* (2009). Alam *et al*. (2003) has shown that the application of phosphorus fertilizer to wheat crop has significantly increased the biological yield. Biological yield was higher when phosphorus fertilizer was applied as compared to that where no P fertilizer was applied in case of wheat crop (Yaseen *et al*., 1998).

Harvest index is physiological efficiency of plants to convert the photosynthates into grain yield. Results showed that the different concentration of phosphorus and potash showed non – significant effect on harvest index.

Grain yield showed significant effect of variable rates of phosphorous and potash fertilizers. The maximum grain yield of 1.50 t ha^{-1} was observed on T_6 followed by T_7 which was 1.44 t ha^{-1}. The minimum grain yield (1.15 t ha^{-1}) was observed in control (Table 2). It was observed from the results that as the levels of phosphorus and potash fertilizers increased from control to T_6, the grain yield also increased. Hussain *et al.* (2002) also reported significant (p < 0.05) differences for grain yield among various treatments of phosphorous. Khan *et al*. (2005) reported significant increase in grain yield of maize with different levels of phosphorous applications under saline condition. According to Ahmed *et al.* (2010) it can be inferred that vigorous vegetative growth with application of P resulted an efficient photosynthetic rate that provided more food and consequently the grain yield increased. Keshavarz *et al*. (2004) found that potassium application and the yield of cotton balls showed that maximum yield was obtained with the use of 125 and 100 kg ha^{-1} K_2O under saline and non - saline conditions, respectively. Potassium is involved in the water economy of plants. It is well established that plants adequately supplied with potassium can utilize the soil moisture more efficiently than potassium deficient plants.

Potassium uptake in to the cell may contribute to osmotic potential of cytoplasm which is prerequisite of osmotic water uptake (Mengel and Arneke, 1982).

Physico – chemical characteristics of soil as influenced by the application of various doses of P and K

The effect of various doses of phosphorus and potash fertilizers on the physico – chemical properties was non-significant for all the parameters (pH, EC, Organic matter and Bulk density) except Sodium Adsorption Ratio (Table 3). However, comparing with the physico – chemical characteristics of original soil (Table 1), all the parameters were decreased except organic matter which was increased.

Table 2: Effect of different concentrations of phosphorous and potash on the agronomic characters of wheat

Treatment	Plant height (cm)	Spike length (cm)	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
NPK at 150-0-0	57.93 ± 0.35	7.93 ± 0.32c	1.15 ± 0.02f	2.18 ± 0.012e	52.75
NPK at 150-60-0	60.97 ± 1.29	8.03 ± 0.29c	1.25± 0.02e	2.23 ± 0.038e	56.05
NPK at 150-60-30	59.53 ± 0.71	8.33 ± 0.54c	1.32 ± 0.03d	2.32 ± 0.006d	56.90
NPK at 150-90-30	59.73 ± 2.83	8.60 ± 0.17bc	1.35 ± 0.009cd	2.33 ± 0.018d	57.94
NPK at 150-90-60	59.13 ± 0.98	9.50 ± 0.15b	1.38 ± 0.009c	2.44 ± 0.018c	56.56
NPK at 150-120-60	63.60 ± 1.42	10.87 ± 0.18a	1.50 ± 0.032a	2.68 ± 0.038a	55.97
NPK at 150-120-90	60.17 ± 1.30	10.70 ± 0.38a	1.44 ± 0.03b	2.60 ± 0.025b	55.39
LSD	NS	0.956	0.052	0.073	NS

Means followed by same letters in each column are statistically similar at 5% probability

Table 3: Soil physico - chemical characteristics of soil as affected by the application of P and K fertilizers

Treatment	pH ± SE	EC ± SE (dS m^{-1})	OM ± SE (%)	SAR ± SE	BD ± SE g cm^{-3}
NPK at 150-0-0	7.72 ± 0.006	3.25 ± 0.006	0.82 ± 0.006	13.67 ± 0.33a	1.22 ± 0.012
NPK at 150-60-0	7.73 ± 0.009	3.22 ± 0.012	0.84 ± 0.007	12.33 ± 0.88ab	1.46 ± 0.258
NPK at 150-60-30	7.73 ± 0.006	3.23 ± 0.018	0.82 ± 0.007	12.00 ± 0.58bc	1.21 ± 0.009
NPK at 150-90-30	7.74 ± 0.003	3.23 ± 0.003	0.83 ± 0.006	11.33 ± 0.88bcd	1.19 ± 0.058
NPK at 150-90-60	7.72 ± 0.003	3.23 ± 0.006	0.84 + 0.006	11.00 ± 0.58bcd	1.24 ± 0.058
NPK at 150-120-60	7.73 ± 0.011	3.22 ± 0.019	0.81 ± 0.009	10.67 ± 0.88cd	1.23 ± 0.033
NPK at 150-120-90	7.74 ± 0.009	3.25 ± 0.007	0.82 ± 0.012	10.33 ± 0.33d	1.22 ± 0.067
LSD	N.S	N.S	N.S	1.361	N.S

Means followed by same letters in each column are statistically similar at 5% probability

Results regarding the Sodium Adsorption Ratio (SAR) after the harvesting of wheat showed significant differences amongst various treatments. It was found from the results that as the level of phosphorus increased from control to T_7, the value of SAR decreased from 13.67 to 10.33. The maximum value of SAR (13.67) was recorded in control followed by T_2 which is 12.33. The minimum SAR value (10.33) was observed on T_7 (Table 3). The decrease in the SAR value may be attributed to the use of single super phosphate fertilizers which contains 46% gypsum. Hassan and Ahmad (1988) reported that the SSP fertilizers were effective in reducing the SAR value. Yaduvanshi and Swarup (2005) found in a long term experiment that use of inorganic fertilizers slightly decreased SAR from 29.0 to 18.7.

Soil phosphorus and potassium concentrations as influenced by the application of various doses of P and K

The results showed that the concentration of soil phosphorous increased as the levels of P applied increased from control to T_6. The maximum (6.67 mg kg^{-1}) P value was observed in T_6 followed by T_7 which was 6.55 mg kg^{-1}. The minimum P value (5.35 mg kg^{-1}) was observed in control (Table 4). Our results are in close conformity with Adeniyan *et al.* (2011) who found better result of available P in soil by the addition of NPK commercial fertilizers as compared with control.

Results showed that the application of different treatments significantly affected the K content of soil after the harvest of wheat crop. The highest value of K was found in T_6 (389.33 mg kg^{-1}). The minimum K value (262.33 mg kg^{-1}) was observed in T3 which was at par with T_2, T_1, T_4 and T_5. These findings were in accordance to the Bhattacharyya *et al.* (2007) who observed that the application of fertilizer significantly increased the exchangeable K content over control.

Table 4: Soil phosphorus and potash as affected by the application of P and K fertilizers

Treatment	P ± SE (mg kg^{-1})	K ± SE (mg kg^{-1})
NPK at 150-0-0	5.35 ± 0.051c	272.67 ± 1.76c
NPK at 150-60-0	6.37 ± 0.009b	266.67 ± 20.2c
NPK at 150-60-30	6.36 ± 0.047b	262.33 ± 8.69c
NPK at 150-90-30	6.47 ± 0.009ab	273.00 ± 1.53c
NPK at 150-90-60	6.40 ± 0.167b	273.00 ± 1.53c
NPK at 150-120-60	6.67 ± 0.054a	389.33 ± 12.7a
NPK at 150-120-90	6.55 ± 0.061ab	307.67 ± 1.45b
LSD	0.219	28.58

Means followed by same letters in each column are statistically similar at 5% probability

Conclusion

Use of inorganic fertilizers in the tube well irrigated area were effective in improving the growth and yield parameters of wheat. The phosphorus and potassium content of soil has been increased by the application of P and K fertilizers at different rates. The use of K fertilizers was effective in reducing the impact of Na in soil. It was found from the study that use of single super phosphate was also effective in reducing the SAR of the soil.

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