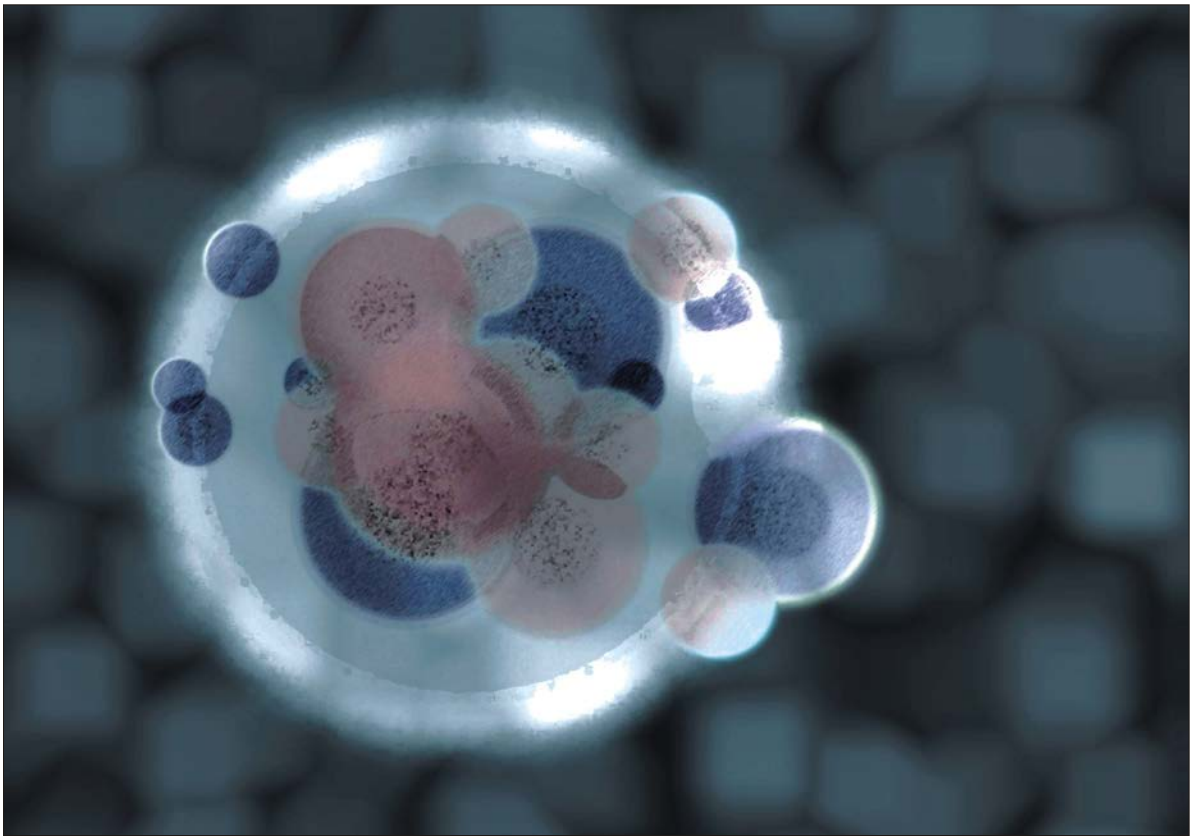

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Wheat Response to Applied Phosphorus in Light Textured Soil

[1]Shahzada Munawar Mehdi, [2]Muhammad Abid, [1]Muhammad Sarfraz, [3]Mudassar Hafeez and [3]Farhan Hafeez
[1]Soil Salinity Research Institute, Pindi Bhattian,
[2]University College of Agriculture, BZU, Multan, Pakistan
[3]University of Agriculture, Faisalabad, Pakistan

Abstract: A field experiment was conducted to evaluate the response of wheat crop to phosphorus fertilization in sandy loam soil. Soil samples were collected before sowing of wheat crop and analysed for physical and chemical properties of the soil. There were six treatments i.e., 0, 30, 60, 90, 120 and 150 kg P_2O_5 ha^{-1} with three replications. A basal doses of N and K_2O at the rate of 140 and 60 kg ha^{-1}, respectively was also applied. The whole of P, K and ½ of N was applied at the time of sowing and remaining ½ of N was applied at the time of 1st irrigation. The system of layout was Randomized Complete Block Design. The net plot size was 6×4 m. Fertilizer sources of NPK were urea, TSP and SOP, respectively. Wheat variety inqulab-91 was sown as test crop. The data of 1000-grain weight, grain and straw yield was recorded and grain and straw samples were collected and analysed for P concentration. The results showed that 1000-grain weight, grain and straw yields significantly increased with each level of P_2O_5 application up to 120 kg ha^{-1} and yield at 150 kg P_2O_5 ha^{-1} remained at par with 120 kg P_2O_5 ha^{-1}. Phosphorus concentration in grain and straw and P uptake by wheat also significantly increased in all the treatments except control. Soil analysis after wheat harvest showed a built-up in Olsen-P at higher P levels.

Key words: Wheat, phosphorus, soil, light, textured, yield

INTRODUCTION

Phosphatic fertilizers can play a major role towards improving crop yields but a major constraint in achieving the proven crop potential is imbalance use of fertilizers, particularly low phosphorus use as compared to nitrogen. Phosphatic fertilizers are applied to increase the production of crops, but a major significant portion of phosphorus retained in the soil through its fixation. Moreover P availability is markedly influenced when phosphatic fertilizers are applied in contrasting environment. Pakistani soils being low both in N and P require the application of N and P in appropriate quantities (Khalil *et al*., 1994). Malik *et al*. (1992) reviewed the management of phosphorus for wheat production in Punjab. He reported that response of wheat to different levels of phosphorus 0, 50, 100, 150, 200 and 250 kg ha^{-1}. The result showed that increasing levels of phosphorus increase the wheat yield from 22-39% that is from 50 to 250 kg P_2O_5. Sarfraz *et al*. (1998) conducted field experiments at AARI Faisalabad to determine the effect of P fertilization on yield and P uptake of wheat and berseem crops. The P levels were tested for 0, 50, 100 and 150 kg P_2O_5 ha^{-1} along with a basal dose of N (120 kg ha^{-1} for wheat and 25 kg ha^{-1} for berseem). The experiments were conducted for three years. The results showed that P application increase the grain and straw yield of wheat and fresh and dry matter yield of berseem fodder. The P concentration in grain and straw of wheat and in dry matter of berseem increased significantly with increasing levels of P. The P uptake in wheat grain and straw and total P uptake in wheat and berseem fodder increased significantly with increasing levels of phosphorus. The optimum level determined from three years data was 100 kg P_2O_5 for both the crops. Rashid *et al*. (1997) also conducted field experiment to find out soil P level for obtaining optimum wheat yield and to quantify the amount of P fertilizer to develop this level. The experiments were conducted on the same site continuously for the three years. Various levels of P_2O_5 (0, 25, 50, 75, 100, 125 and 150 kg ha^{-1}) were applied with 120 kg N and 60 kg K ha^{-1} in each season. They indicated that 8.0 mg P kg^{-1} in various soils is sufficient for reaping optimum wheat yield and 50-75 kg P ha^{-1} is required to maintain this optimum level of available P. Ardell *et al*. (2002) conducted four year field trial on wheat. Five P fertilizers rates (0, 69, 137, 206 and 275 lbs P_2O_5 per acre) were applied as one-time applications. The results from this study show the need for higher rates of P fertilizers application to optimized wheat yields. Wheat yield increased with increasing rates of P fertilizers. They also found that If soil P is deficient in a production

Corresponding Author: Dr. Shahzada Munawar Mehdi, Soil Salinity Research Institute, Pindi Bhattian, Pakistan

system, applying P fertilizer on the soil surface will help to alleviate P deficiency even without incorporation. Harbison *et al*. (2003) performed 40 field experiments, to observe the responses of wheat (33 sites), to applied phosphorus fertilizers were measured in 2000 and 2001. Up to seven rates of P fertilizer were compared at each site. P levels ranged from 10-60 mg P kg^{-1}. Thirty two of the forty sites responded markedly and economically to applied P fertilizer (optimum rate of P>10 kg P ha^{-1} and at some very low P sites up to 40 kg P ha^{-1}). It was found that grain yields at optimal P in wheat varied from 0.9-7.6 t ha^{-1} and yield responses to applied P varied from 0-3.4 t ha^{-1}. Keeping in view the importance of phosphorus, a field study was carried out with the objective to determine the optimum level of phosphorus for improving wheat yield.

MATERIALS AND METHODS

A field experiment was conducted to see the effect of different rates of phosphorus on wheat yield. Composite soil samples were taken from 0-15 and 15-30 cm depths before sowing of wheat and were analyzed for physical and chemical characteristics (Table 1). Phosphorus was applied at the rate of 0, 30, 60, 90, 120 and 150 kg P_2O_5 ha^{-1} along with a basal dose of N and K_2O at the rate of 140-60 kg ha^{-1}, respectively. Half of the nitrogen was applied before sowing of wheat and remaining half nitrogen was applied with first irrigation. Wheat variety Inqulab-91 with seed rate 125 kg ha^{-1} was sown as test crop. The system of layout was Randomized Complete Block Design (RCBD) with four replications. Plot size was kept 6×4 m. All the management practices were carried out as and when required. The data of 1000-grain weight, grain and straw yields of wheat were recorded at the time of harvesting. Grain and straw samples of wheat were taken for P analysis. Phosphorus concentration in grain and straw of wheat, P uptake by grain and straw and total uptake by wheat crop were calculated using the following formula:

Total P uptake (kg ha^{-1}) = P Conc. (%) in plant part (dry matter) x yield (t ha^{-1})×10

All the soil analyses were done according to the methods given in Hand Book No. 60 (US Salinity Lab Staff, 1954) except texture by Moodie *et al*. (1959), Olsen P (Watanabe and Olsen, 1965). The data were subjected to statistical analysis by using ANOVA technique (Steel and Torrie, 1980). The treatment means were compared by using Duncan Multiple Range (DMR) test at 5% probability level (Duncan, 1955).

Table 1: Original soil analysis

Parameters	0-15 cm depth	15-30 cm depth
pH_s	7.85	7.80
EC_e(dS m^{-1})	3.28	2.98
SAR (m mol $L^{-1})^{½}$	12.80	11.58
Available P (mg kg^{-1})	3.10	2.80
Extractable K(mg kg^{-1})	105.00	87.00
OM (%)	0.41	0.35
Texture	Sandy loam	

RESULTS AND DISCUSSION

The data indicated that soil was sandy loam in texture, non-saline, non-sodic, low in organic matter content and Phosphorus content and medium to adequate in K content (Table 1).

Table 2 indicated that all the three parameters were increased significantly with increasing rates of P application. The maximum 1000-grain weight was recorded in T5 (120 kg P_2O_5 ha^{-1}), which remain at par with T6 (150 kg P_2O_5 ha^{-1}) and minimum in control where no phosphorus was applied. Similarly maximum grain and straw yields were recorded at 120 kg P_2O_5 ha^{-1} rate which were statistically at par with 150 kg P_2O_5 ha^{-1} and minimum in control. All other treatments differed significantly from each other in case of 1000 grain weight, grain and straw yields. Similar results were reported by Malik *et al*. (1992), Sarfraz *et al*. (1998), Ardell *et al*. (2002), Harbison *et al*. (2003) and Qaisar *et al*. (2005).

Table 3 showed that P concentration in grain and straw of wheat increased significantly with increasing rates of P application and maximum P concentration in grain and straw of wheat was noted in the treatment where 150 kg P_2O_5 ha^{-1} was applied and it was non significant with 120 kg P_2O_5 ha^{-1}, while minimum P concentration in grain and straw of wheat was observed in control. Phosphorus concentration in plants is related to P extraction power of roots from soil. Normally plant roots have wider contact with soil and feed well to above ground parts. This is true for extensive root system crops (Tisdale *et al*., 1997). As wheat has extensive root system which absorbed P from soil in which P in solution is available, resultantly more P concentration in grain and straw of wheat was observed with the increasing rates of P application. The reason might be that when P is applied to soil, its more concentration is available for plant absorption and with passage of time it undergoes to chemical reaction and due to its adsorption on different sites its availability becomes slow. These results are in line with Qaisar *et al*. (2005).

Table 4 indicated that P uptake in grain and straw of wheat and total uptake by wheat crop were significantly increased with increasing rates of P application and maximum P uptake was noted where, P was applied at the

Table 2: Effect of different rates of phosphorus application on 1000 grain weight (g), grain and straw yield (t ha^{-1}) of wheat

Treatments P_2O_5 (kg ha^{-1})	1000 grain weight	Grain yield	Straw yield
0	39.81E	2.11E	2.42D
30	41.89D	2.36D	2.56D
60	43.52C	2.73C	2.97C
90	44.54B	3.42B	3.58B
120	45.72A	3.64A	3.82A
150	45.93A	3.71A	3.90A

Mean sharing same letters are statistically non-significant at 5% level of probability

Table 3: Effect of different rates of phosphorus application on P concentration (%) in grain and straw of wheat

Treatments P_2O_5 (kg ha^{-1})	Grain	Straw
0	0.210D	0.076D
30	0.228C	0.084CD
60	0.233C	0.093BC
90	0.246B	0.097B
120	0.272A	0.113A
150	0.278A	0.118A
LSD	0.009965	0.1193

Mean sharing same letters are statistically non-significant at 5% level of probability

Table 4: Effect of different rates of phosphorus application on P uptake of grain, straw and total P uptake of wheat (kg ha^{-1})

Treatments P_2O_5 (kg ha^{-1})	P uptake by grain	P uptake by straw	Total P uptake by wheat (Grain+Straw)
0	4.43E	1.84D	6.27F
30	5.38D	2.15D	7.53E
60	6.36C	2.76C	9.12D
90	8.41B	3.47B	11.88C
120	9.90A	4.32A	14.22B
150	10.24A	4.52A	14.76A
LSD	0.3355	0.3684	0.5304

Mean sharing same letters are statistically non-significant at 5% level of probability

Table 5: Available P contents (mg kg^{-1}) of soil after wheat harvest

	Post wheat harvest	
Treatments P_2O_5 (kg ha^{-1})	0-15 cm	15-30 cm
0	2.28E	2.10E
30	6.12D	2.78D
60	7.94C	2.86CD
90	11.82B	2.98C
120	12.42B	3.28B
150	13.60A	4.10A
LSD	0.7186	0.1286

Mean sharing same letters are statistically non-significant at 5% level of probability

rate of 150 kg P_2O_5 ha^{-1} and this treatment was again statistically non-significant with 120 kg P_2O_5 ha^{-1} and minimum values were observed in control where no P was applied. P uptake is the multiplication of yield and its respective P concentration and as grain and straw yield and P concentration in grain and straw increased significantly with P application rates due to which P uptake by grain and straw was also increased significantly. The results are confirmed by the study of Qaisar *et al.* (2005).

The data showed that available P in soil was increased significantly with the increasing rates of P and maximum contents were noted where, P was applied at the rate of 150 kg P_2O_5 ha^{-1} (Table 5). Similar results were reported by Qaisar *et al.* (2005) and Tandon (1987) who summarized the results of 18 experiments and concluded that when half of the optimum rates of P were used, available P declined or showed little change at 60% sites and when applied optimum rates of P, a significant improvement in available P status was found.

CONCLUSION

In light textured soils low in organic matter and available phosphorus contents, maximum wheat yield can be obtained by applying phosphorus at the rate of 120 kg P_2O_5 ha^{-1}.

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