EFFECT OF PHOSPHORUS APPLICATION TIME ON YIELD AND P USE EFFICIENCY BY WHEAT CROP

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ABSTRACT

A study was conducted to see the effect of phosphorus application time on the yield of wheat (cv. Inqalab-91) in the Department of Soil Science, University of Agriculture, Faisalabad during 2000-2001. Before sowing of wheat, soil samples from 0 to 15 cm and 15 to 30 cm were taken and analyzed. Three P treatments (T_1 = control - no P, T_2 = full P applied at sowing and T_3 = half P at sowing and half at booting stage) were tested with four replications using randomized complete block design. The dose of N, P and K were 150, 120 and 60 kg per hectare, respectively. The results showed that full P applied at sowing proved better and gave statistically higher yield (3528 kg/ha) than split application of P (2982 kg/ha). The control treatment (2877 kg/ha) was statistically at par with split application but lower than P application at sowing. The data also revealed that uptake and P use efficiency was higher in split application of P as compared to full P application at sowing.

KEYWORDS: *Triticum aestivum*; phosphate fertilizers, application time; efficiency; yield; Pakistan.

INTRODUCTION

Besides many other factors which affect the crop productivity, fertilizer plays a vital role in increasing crop yields. Commonly used fertilizers are nitrogen, phosphorus and K^+. Phosphorus is the second major nutrient after N for plant growth. It plays a fundamental role in large number of enzymatic reactions that depend on the energy transfer or phosphorylation (15). Recovery of applied P reported in the literature is low (0.02-0.5%) in alkaline calcareous soils of Pakistan and this has been attributed to its rapid rate of fixation that refers to converting the applied available P into hardly available forms (3).

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Due to the alkaline and calcareous nature of Pakistani soils, most of the native and applied P is unavailable to the growing plants. The lower availability is caused by its fixation either on colloidal complexes or formation of sparingly soluble compounds (14). For many crops, only 5 to 15 percent of applied P fertilizer is utilized by the first crop (3). Efficiency of P utilization by wheat could possibly be improved by varying its time and method of application. Purnomo and Black (12) studied the effect of P application time to wheat and found no response on dry matter yield. Malik *et al.* (10) found a declining trend in P status of soil with time. Hamid and Sarwar (6) found that P applied at tillering stage was more effective for improving grain yield than P applied at planting stage. Rehman (13) concluded that all yield components of wheat were affected significantly by application at sowing and split application at different growth stages. Alam *et al.* (1) found that P application at sowing as well as at first irrigation gave statistically similar yield of berseem.

This study was planned to determine the optimum time of P application for higher wheat yield and P use efficiency.

MATERIALS AND METHODS

Effect of phosphorus application time on wheat (cv. Inqalab-91) was studied in the Department of Soil Science, University of Agriculture, Faisalabad during 2000-2001. Before sowing of wheat, soil samples from 0 to 15 cm and 15 to 30 cm depths were taken and analyzed for textural class (11), pH, ECe, CEC and ammonium extractable K^+ by the method described by US Salinity Laboratory Staff (2), nitrogen by Gunning and Hibbard's method of sulphuric acid digestion and distillation with micro Kjeldahl's apparatus (8) and Olson P (17). The results of basic soil analysis is given in Table-1.

Table 1. Physical and chemical characteristics of experimental soil.

Parameters	Soil depth	
	0-15 cm	15-30 cm
Textural class	Sandy clay loam	
EC (dS/m)	2.17	1.92
PH	7.8	8.05
CEC ($cmol_c$/kg)	4.70	4.61
Total nitrogen (N) (%)	0.036	0.032
Available phosphorus (P) (mg/kg)	7.3	7.11
Available potassium (K^+) (mg/kg)	108.00	108.00

Three treatments were tested viz. T_1 = control (no P), T_2 = full P applied at sowing and T_3 = half at sowing and half at booting stage, with four replications. The system of layout was randomized complete block design with net plot size of 10 x 10 feet. Phosphorus was applied by broadcast in the field. Half of N (as urea) was applied at sowing and half at booting stage, full K (as KCl) at wheat sowing while P was applied according to above treatments. The dose N, P and K^+ was 150, 120 and 60 kg per hectare, respectively. Crop was sown in October, 2000. At maturity, biomass, grain and straw yields were recorded. Grain and straw samples were collected and analyzed for N (7,8), P and K^+. Uptake of these nutrients was also calculated. Following parameters were derived by using following formulae:

$$\textit{Harvest index (HI\%)} = \frac{\textit{Grain yield (kg/ha)}}{\textit{Total yield (kg/ha)}} \times 100$$

$$\textit{Nutrient physiologial (PEI) efficiency Index} = \frac{\textit{Grain yield (kg/ha)}}{\textit{Uptake of nutrient (g/ha)}}$$

Statistical analysis of the data was carried out (15) and Duncan's multiple range test (5) was applied to compare the means.

RESULTS AND DISCUSSION

1. Biological, grain and straw yields of wheat

Biological, grain as well as straw yields were influenced by phosphorus application time significantly. Application of P at sowing produced significantly more grain, straw and biomass yields as compared to other treatments (Table 2). The application of P in splits (T_3) did not increase these parameters and was equal to control. These results confirm the findings of Purnomo and Black (12) and disagree to those of Hamid and Sarwar (6). Overall results indicated that P application in splits did not prove better or equal to conventional method of P application at sowing.

Table 2. Effect of phosphorus application time on biological, grain, straw yields (kg/ha) and harvest index of wheat.

P application time	Biomass yield	Grain yield	Straw yield	Harvest index (%)
T_1 - Control (no P)	9129b	2877b	6252 b	31.3
T_2 Full P at sowing	10628a	3528a	7100a	33.2
T_3 = Half P at sowing and half at booting stage	8993 b	2982b	6011 b	33.1

Means sharing similar letter(s) do not differ significantly at P = 0.05

2. Harvest index

The data (Table 2) revealed that HI did not reach the level of significance statistically. All the treatments showed more or less similar behaviour for HI. Maximum HI (33.2%) was observed in T_2 followed by T_3 (33.1%). Control treatment exhibited minimum HI (31.3%).

3. Phosphorus concentration and uptake

The results (Table 3) indicated that wheat grains and straw obtained maximum phosphorus concentration (6.5 and 2.9 g/kg), in T_3 (P applied in two splits). Minimum phosphorus concentration was observed in control. It means that P application increased P concentration in grains but where the yield was high P concentration was low. It might be due to the dilution effect. T_3 (split application of P) increased P uptake than T_2 in both grain and straw. Results also revealed that plots with P showed significantly higher P uptake than plots without P application (Table 3). Higher amount of P uptake (37.4 kg/ha) was observed with split application.

Although the grain, straw and biomass yields were significantly higher in full P at sowing as compared to split application but P uptake was higher in split application than P applied at sowing and the difference was significant. The reason of low P uptake in this treatment was lower P concentration in grain and straw. It might be due to dilution effect of growth as grain yields were higher. However, these results do not tally with the results of Hamid and Sarwar (6).

Table 3. Effect of time of phosphorus application on the P concentration (g/kg) and uptake in wheat.

P application time	P concentration (g/kg)		P uptake (kg ha)		
	Grain	Straw	Grain	Straw	Total
T_1 = Control (no P)	3.1 c	1.16 bc	9.5 c	7.4 c	16.9 c
T_2 = Full P at sowing	5.0 b	1.96 b	17.9 b	13.4 ab	31.3 ab
T_3 = Half P at sowing and half at booting stage	6.5 a	2.9 a	19.6 a	17.8 a	37.4 a

Means sharing similar letter(s) do not differ significantly at P = 0.05.

4. Grain N, P and K^+ physiological efficiency index (PEI)

PEI tells about the absorption, accumulation and utilization of these nutrients for grain production. The results (Table 4) clearly indicate that PEI for N, P and K^+ was influenced by the time of phosphorus application. Lowest value of PEI for N (0.17 kg/g) and P (0.08 kg/g) was found in P applied in splits. The results further revealed that efficiency of N and P utilization was increased in T_2 and T_3. Keshwa and Singh (9) reported that wheat grain yield was significantly and positively correlated with uptake of nitrogen and phosphorus. Phosphorus application also enhanced K^+ use efficiency.

Table 4. Effect of time of phosphorus application on physiological efficiency index (PEI) of N, P and K^+ in grain of wheat.

P application time	N	P	K
		(Kg g)	
T_1 = Control (no P)	0.42 a	0.19 ab	3.5 b
T_2 = Full P at sowing	0.23 b	0.12 b	5.4 a
T_3 = Half P at sowing and half at booting stage	0.17 c	0.08 c	4.5 ab

Means sharing similar letters do not differ significantly at P = 0.05.

CONCLUSION

The application of phosphorus at sowing proved better than P application in two splits (at sowing and booting stage) but nutrient use efficiency was better with split application of P.

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