METHODS OF PHOSPHORUS APPLICATION AND IRRIGATION SCHEDULE INFLUENCING WHEAT YIELD

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Fertilizer use efficiency by different crops is low on alkaline calcareous soils. Water is crucial for Phosphorus (P) availability. A field experiment was conducted on sandy clay loam, alkaline calcareous soil with low total nitrogen and available P. P was applied to wheat by side-dressing and broadcasting while irrigating at crown root; booting; earing; anthesis; and grain development stages to improve wheat yield. It was observed that maximum wheat grain and straw yield 3.97 and 4.95 t ha^{-1}, respectively were obtained by side dressing P application along with four irrigations. Maximum P concentration in grain, straw and total P uptake was noted by side dressing P along with five irrigations. Grain yield was improved by side dressing over broad casting at all irrigation scheduling. Four irrigations (at crown root, booting, anthesis and grain development) proved better for grain production.
Keywords: Phosphorus fertilizer, irrigation schedule, wheat yield

INTRODUCTION

Phosphate availability in Pakistani soils is reduced due to alkaline soil conditions (pH > 7), high calcium contents (> 3 % $CaCO_3$) and large amount of calcium saturated clay. To maintain a given level of available phosphorus, it is necessary to apply adequate quantities of phosphatic fertilizers into the soil (NDFC, 2003).

The limited availability of irrigation water is another constrain for better crop yield in Pakistan. Every plant species requires certain range optimum soil water level for its growth. Soil water contents control the availability of essential nutrients to plants and also affect nutrient uptake and root growth (Olsenet *et al.,* 1961; Mirrch and Ketcheson 1973). Lower water content reduces P diffusion through soil to the root surface (Hira and Singh 1977). Morphological, physiological and biochemical changes caused by water stress in the plant substantially reduce crop yield (Sharma and Acharya, 1994).

P is relatively less mobile in soil. Its application through drilling improves its efficiency (Rudd and Barrow, 1973). P applied with first irrigation also beneficial (Ahmad and Bhatti,1978). Mixing P fertilizer with nominal quantity of FYM also improve PUE (Sharif *et al.*, 1974). Ranjha and Mehdi (1990) showed that immediate use of irrigation water after P application was key factor in improving P fertilizer use efficiency.

Keeping in view the above said points a field experiment was planned to improve P use efficiency by wheat crop with different methods of P application and irrigation at different growth stages of wheat.

MATERIAL AND METHODS

Soil

A field experiment was conducted at Postgraduate Agricultural Research Station (PARS) Faisalabad to improve P use efficiency by wheat on calcareous soil. Soil samples were collected from 0-20 cm depth and analyzed for physical and chemical properties by following standard methods of analysis.

Field Trial

Wheat (*Triticum aestivum* L.) cv.Inqulab-91 was sown as test crop with seed rate of 125 kg ha^{-1}. System of lay out was Split plot RCBD with 3 replications and 10 treatments, each treatment had two splits. Nitrogen, phosphorus and Potassium were applied @ 120,90 and 60 kg ha^{-1} as urea, DAP and SOP respectively .Half of nitrogen and whole of potassium were applied during seed bed preparation and other half of nitrogen was applied with first irrigation. Phosphorus was applied by two methods (1) side dressing (2) broadcast and irrigating according to following schedule.

1. Two irrigations at crown root and booting stages.
2. Three irrigations at crown root, booting and grain development stages.
3. Four irrigations at crown root, booting, anthesis and grain developments stages.
4. Five irrigation at crown root, booting, earring, anthesis and grain development stages.

The crop was harvested at maturity. Grain and straw yield data were recorded by harvesting the whole plot. Grain and straw samples were analyzes for P concentration in grain and straw and total P uptake was calculated. All the parameters (grain, straw, P concentration) were statistically analyzes using methods as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The soil of the experimental field was non saline, non sodic but alkaline in reaction and deficient in available P and organic matter. The calcium carbonate content was 5.6 % indicating that soil was calcareous in nature and sandy clay loam in texture.

Table 1. Basic Soil Analysis

Determinants	Units	Values
Sand	%	55
Silt	%	22
Clay	%	23
Textural class		Sandy clay loam
Organic matter	%	0.7
Available P	ppm	7.7
Saturation Percentage	%	35
$CaCo_3$	%	5.6
SAR		7.4
pHs		7.8
ECe	dS m^{-1}	2.3
CEC	$Cmol_c$ kg^{-1}	4.9
Available K	ppm	140
Available N	%	0.035
Soil Classification		Haplargids

Results regarding wheat grain, straw yield and total tillers m^{-2} are depicted in Table 2. Data revealed that maximum wheat grain (3.97 t ha^{-1}), straw (4.95 t ha^{-1}) yield and maximum total no. of tillers m^{-2} (427.3) were obtained by side dressing P along with four irrigations. Application of P with four irrigations performed comparatively better than five irrigations in both methods (side dressing, broad casting). Turk, Tawaha, 2001. reported that grain yield, straw yield, total biomass, total number of tillers m^{-2} were significantly greater with band placement than with broadcast method of P application.

The superiority of band placement was probably due to better fertilizer efficiency as developing roots are in intimate contact with P-enriched soil adjacent to fertilizer granules. Minimum yield of grain, straw and total number of tillers m^{-2} were obtained when no irrigation was applied with P application through side dressing and broad casting. Ahmed and Bhatti (1978) also reported the increased grain and straw yield of wheat by the application of P at first irrigation rather than sowing. This view is contrary to that of Sharif *et*

Table 2. Effect of P application methods on different growth parameters of wheat.

Irrigation	Side dressing				Broad casting				
	Total No. of tillers (m^{-2})	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Total No. of tillers m^{-2}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	% Efficiency
Irr.-0	285.7E	37.0BC	2.65C	3.77B	270.0F	35.7C	2.23C	3.71B	-
Irr.-II	381.7B	40.4AB	3.59AB	4.80A	315.0D	37.3BC	3.31B	4.53A	41
Irr.-III	423.7A	43.0A	3.76AB	4.91A	341.0C	39.4ABC	3.41AB	4.84A	46
Irr.IV	427.3A	43.1A	3.96A	4.95A	381.7B	42.2A	3.51AB	4.86A	53
Irr.-V	420.0A	42.4A	3.69AB	4.86A	330.0C	39.1ABC	3.47AB	4.61A	46

al. (1974) and Chauhdary (1976), who attributed superior response of fertilizer phosphate to premixing with FYM.

Data regarding P concentration of wheat grain and straw is shown in Table:3 reveal that maximum P concentration in grain and straw were noted 0.32 and 0.15 (%) respectively when we apply P through side dressing along with five irrigations but could not improve the P concentration significantly. This shows that when moisture contents increases in soil that will result in increase in p availability to the plant roots. Duivenbooden et al (1996) also reported P concentration in wheat grain between 0.25-0.49%. Minimum P concentration in wheat grain and straw were observed when no irrigation was applied and also led to establish a fact that low P concentration in straw than grain was due to more P translocation to grain at reproductive stage. The data presented in Table: 3 showed that maximum P uptake by grains and straw was obtained when five irrigations were applied along with side dressing of P but could not improve the P uptake significantly than treatments where four irrigations were applied and minimum uptake was noted in treatments with no irrigations. Alam (1995), while conducting pot experiment showed that application of 25mg P kg^{-1} increased the dry matter straw and grain yield as total P uptake at tillering and booting stages of wheat crop. These results are also in confirmatory with those of Yasin *et al.* (1998). Rogerio Borges *et al.* (2003), while conducting a field experiment showed that P uptake is more in case of P application through side dressing as compared to broadcast.

Table 3. P (%) concentration in grain, straw and P uptake by wheat.

Irrigations	Side dressing			Broad casting			
	P (%) in grain	P (%) in Straw	Total P uptake (kg ha-1)	P (%) in grain	P (%) in Straw	Total P uptake (kg ha-1)	% Efficiency
Irr.-0	0.183D	0.07BC	7.50D	0.190D	0.06C	6.47D	-
Irr.-II	0.223BCD	0.130ABC	12.93C	0.211CD	0.100ABC	11.54C	75
Irr.-III	0.230ABC	0.123ABC	14.67B	0.200CD	0.110ABC	12.18C	92
Irr.IV	0.310AB	0.140AB	19.24A	0.266ABCD	0.126ABC	15.54B	148

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