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Improving Wheat Yield and Phosphorus Use Efficiency Effected by Range of Phosphorus Levels in Wheat Crop under Irrigated Condition

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ABSTRACT

Wheat (*Triticum aestivum L.*) is the main staple food of Pakistan. Our soils are phosphorus deficit. To study the effect of different levels of phosphorus on growth, yield and quality of wheat use efficiency is crucial for sustainable wheat production. Phosphorus (P) efficiency includes both P acquisition efficiency (PAE) and internal P utilization efficiency (PUE). Phosphorus (P) use efficiency PUE, particularly on alkaline soil. One wheat variety was used with RCBD design with three replications wheat field experiments was carried out at Riverine belt farmer field Dera Ismail Khan. Treatments consisted of the combination of (i) wheat crop and three rates of P fertilization (P25) (P50), (P75) kg/ha–1) (ii) broadcast method of P @ three rates of phosphorus @25, 50, 75 methods were used for P application Broadcast and Band placement drill. Whereas wheat plots treatments with band placement drill application showed that increase the phosphorus uptake efficiency, variations are attributed to variations in phosphorus use. This study was design to investigate for P use efficiency in wheat crop under irrigated condition. The findings showed that The data regarding plant height showed that under BPD Treatments, drilling application recorded increase in plant height T6 BPD,P @75 kg/ha-1 (101.2) cm. showed the highest plant height, followed T1 BPD @25 kg/ha-1 Broadcast, T2 FP Broadcast application while the least value was recorded in Treatment T3 FP,@75 kg/ha-1 (90) cm. placement illustrated the greater 1000 grain weight was recorded in T6 (45.41) in the drilling method of application while the minimum 1000 grain weight was recorded in T2 (38.22) g under broadcast application of P. P application at the rate of 50 kg P ha-1. The greater wheat grain yield, 5.2 ton ha 1 was attained with the use of Drill method of Phosphorus @75 kg/ha-1.while the lowest value was recorded in T1 FP@ 25 kg/ha1 (4.0).ton ha-1The average P concentration in the wheat grains were higher under high P supply in T6 BDP @75 Kg/ha-1(High P: 0.07 mg/kg-1 while the least concentration was recorded in Treatment FP, T1(Low P: 0.02 mg/kg-1).From these results it was concluded that phosphorus level of 75 kg ha-1 is best for maximizing productivity and quality of wheat crop under the climatic condition under irrigated Comprehensive assessment of the relationship between soil P, yield and PUE, 75kg/ha-1 application with Band placement drill performed best and DAP application with band placement drill@ 75 kg/ha-1 obtained greater wheat yield under irrigated condition.

INTRODUCTION

Although crops may typically use just 10–30% of the fertilizer P in the application year. (Syers et al., 2008), phosphorus (P) fertilizers have been routinely applied in many intensive cropping systems (Lott et al., 2011). In intensive cropping systems, increasing P efficiency has long been a major concern (Shenoy and Kalagudi, 2005; Schröder et al., 2011). Sattari et al. (2012) calculated that residual soil P from previous heavy fertilization would contribute significantly to future crop yield, with a significant lag time, because the majority of fertilizer P remains in the soil. Consequently, a greater plant's ability to utilize the remaining P effectively will be highly beneficial for crop yield. The depletion of rock phosphate as a P fertilizer supply and the growing consciousness.

P efficiency can be increased by improving P scavenging and uptake (P acquisition efficiency, PAE) and, more economically, by improving P utilization in the plant (P utilization efficiency, PUE) (Wang et al., 2010; Rose and Wissuwa, 2012; Veneklaas et al., 2012; Clemens et al., 2016). When P is limiting, plants have evolved highly specialized adaptive mechanisms, such as morphological, physiological, and molecular modifications, such as increased root/shoot ratio, increased root hairs, association with arbuscular mycorrhizal fungi (AMF), synthesis and release of phosphatases and organic acids, and enhanced expression of phosphate transporters (Richardson et al., 2009, 2011; Péret et al., 2011).

According to Wang et al. (2010), Rose and Wissuwa (2012) P efficiency can be increased by increasing P scavenging and uptake (P acquisition efficiency, PAE) and, more economically, by increasing P utilization in the plant (P utilization efficiency, PUE). Plants have evolved highly specialized adaptive mechanisms, such as morphological, physiological, and molecular modifications, such as increased root/shoot ratio, increased root hairs, association with arbuscular mycorrhizal fungi (AMF), synthesis and release of phosphatases and organic acids, and enhanced expression of phosphate transporters, to maximize access to soil P when P is limiting (Richardson et al., 2009,)

Significant genotypic variations in these traits have been demonstrated in numerous studies (Gahoonia at al 2004; Lynch, 2007), allowing for the breeding of P-efficient crop cultivars with higher PAE; however, the above-mentioned beneficial traits are frequently depressed by increased P supply (Ma et al., 2001; Shen et al., 2002; Teng et al., 2013). In many intensive cropping systems, the soil P content has exceeded crop needs due to excessive P fertilizer application (Sattari et al., 2012). Therefore, it would be beneficial to develop crop cultivars whose PAE mechanisms are not depressed under high-P conditions, as such crop plants could use more residual soil P and thus require less P fertilizer input.

MATERIAL AND METHODS

Field Experiment

Before the start of the experiment, soil was sampled from 30 cm depth and analyzed for various physical and chemical properties. The soil was non-saline (ECe= 1.9 dS m−1) and alkaline in reaction (pH= 8.1) with a clay loam textural class.

A field trial on winter wheat (*Triticum aestivum* L.), AZRC DK variety was sown at Riverine area farmer field D.I.Khan.

Experiment total area was kept at one hectare (Half hectare FP practice and Half Hectare BPD application) with 1 wheat variety was used. Plant to plant distance 30cm and row to row distance being standardized at 30cm. Under irrigated (supplemental irrigation; four times irrigation from heading to mid-grain filling stages) during one cropping seasons (and 2023–2024).. Land was prepared with 2-3 deep ploughing followed by rotavator operation. fertilizer applied to BPD Application Plots @ P,25,50,75 kg/ha-1 urea 120 kg/ha-1 Potassium 60 kg/ha-1.Zinc Sulphate 4kg/ha-1 Boron 1 kg/ha-1.N was applied on the surface of soil two split applications of irrigations. Zabardast urea by Engro fertilizer nitrogen (N) @ 120 kg/ha^{-1}

However in Broadcast application DAP, 25,50,75 kg/ha-1.N was applied on the surface of soil two split applications of irrigations. Zabardast urea by Engro fertilizer nitrogen (N) @ 120 kg/ha^{-1}.

Table 1

Lists the physical and chemical characteristics of the soils prior to sowing.

Parameters	Units	Values
PH (1:1) Ratio		8.1
EC	dSm^{-1}	1.9
AB-DTPA Method	mg/kg	1.32
NO_3-N	mg/kg	3.3
P	mg/kg	1.5
K	mg/kg	90
Bulk density	gcm^3	1.20
Organic matter	%	0.513
Textural Class	Clay Loam	

Experimental Design

The experiment was laid out completely randomized design RCBD with Three Replications. The three fertilizer teatments were applied P diammonium P application with band placement drill, DAP, P @ 25,50,75 kg/ha^{-1} and three P treatments were applied @ 25,50,75 with broadcast method in wheat field.

Statistical Analysis

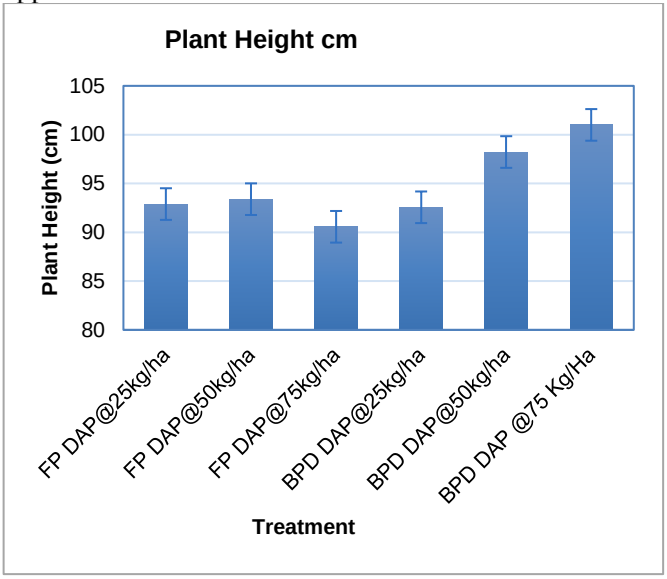
Using statistix 8.1 software for agronomic data analysis was perform at the 5% probability level the LSD test of the least significant differences was used to contrast the mean.(*steel,Torrie* & *Deekey*,1997).

RESULTS

Plant height (cm)

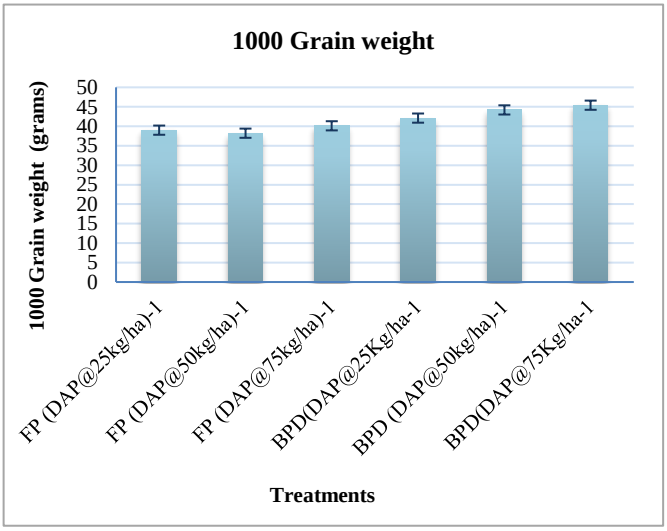
The data regarding plant height showed significant response under applied P different levels. The various level of Phosphorus also effect on the plant height. The maximum value of plant height was recorded in drilling application T6 BPD,P @75 kg/ha^{-1} (101.2) cm, followed T1 BPD @25 kg/ha^{-1} Broadcast, T2 FP Broadcast application by while the least value was recorded in Treatment T3 FP,@75 kg/ha-1 (90) cm.

Figure 1
Plant height (cm) under different phosphorus levels and application methods.



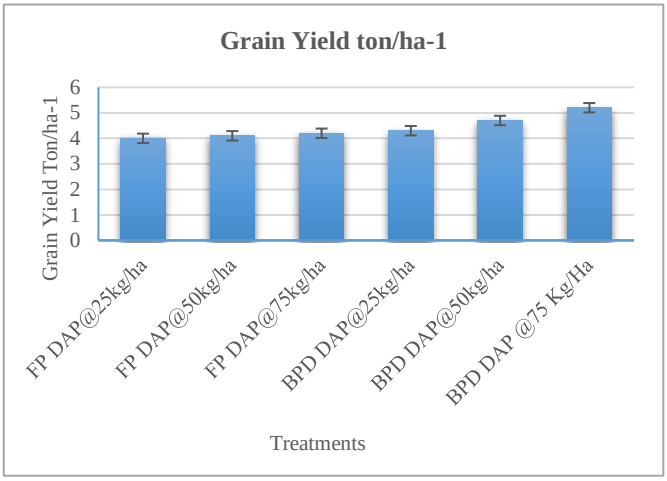
1000 Grain weight (grams)
Different P levels and application methods had significant positive effects on thousand garin weight attributing parameter of wheat Analysis result of 1000 grain yield are illustrated in (Figure No.3) the 1000 grain yield affected significantly by the different phosphorus levels and placement, placement illustrated the greater 1000 grain yield was recorded in BPD application T6 (45.41) while the minimum 1000 grain yield recorded in T2 (38.22) g under broadcast application of P. P application at the P 25 kg/ ha$^{-1.}$

Figure 3
1000 Grain weight under different phosphorus levels and application methods.



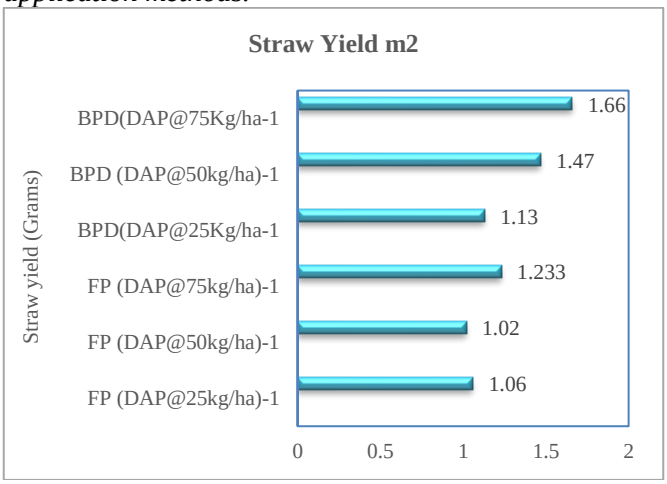
Grain Yield ton/ha^{-1}
Phosphorus use different levels considerably increased wheat productivity; growth, yield and (Figure No.8). The greater wheat grain yield, 5.2 ton/ ha-1 was attained with the use of Phosphorus @75 kg/ha-1.while the lowest value was recorded in T1 FP@ 25 kg/ha^{-1} (4.0).ton/ha^{-1}

Figure 8
Grain Yield ton/ha-1 under different phosphorus levels and application methods



Straw Yield m^2
Analysis result of Straw yield are illustrated in (Figure.2) the Straw yield affected significantly by the different phosphorus levels and placement. P application placement illustrated the greater Straw yield BPD application T6 (1.66 g) was recorded while the lowest value was found in Broadcast method of application T2 (1.02g).

Figure 2
Straw Yield under different phosphorus levels and application methods.



Phosphorus content in wheat grains mg/kg^{-1}
The average P concentration in the wheat grains were higher under high P supply in T6 (BDP @75 Kg/ha^{-1}) (High P: 0.07mg/kg^{-1} while the least concentration was recorded in Treatment T1 Low P: 0.02 mg/kg^{-1}). Reported that Manolov, I. et al. (2003). The combination and application of N P nutrients uptake as deep placement significantly produced higher grain yield of wheat crop.

Soil NPK

Different Phosphorus level and application of Phosphorus methods treatments caused a significant increase in soil available phosphorus during the experiment. (Figure No.4). Phosphorus content in soil was significantly increase in BPD @ 25, 50, 75 kg/ha^{-1} treatments over FP Practice. The maximum phosphorus content in soil was recorded in treatment T6 (6.0) mg/kg^{1} while the lowest value was recorded in FP @ 25 kg/ha^{-1} treatment T1 (2.0) mg/kg^{1}. (Figure No. 4).Nitrate NO3-N content of the soil is also significantly increase BPD treatments the greatest value was recorded in the treatment T6, (11.2) mg/kg^{-1} while the lowest in the treatment T1 FP Treatment. (3.9) mg/kg^{-1} (Figure No.5).The Soil Potassium content also increased in BPD treatments significantly. The maximum Potassium content value was observed in treatment T6 (98) mg/kg^{-1}. While the least value was recorded in Treatment FP value was (90) mg/kg^{-1} .Similar finding reported by Manolov, I. et al. (2003). The combination and application of NP nutrients uptake as deep placement significantly produced higher grain yield of wheat crop.

Figure 4

Wheat grains under different phosphorus levels and application methods.

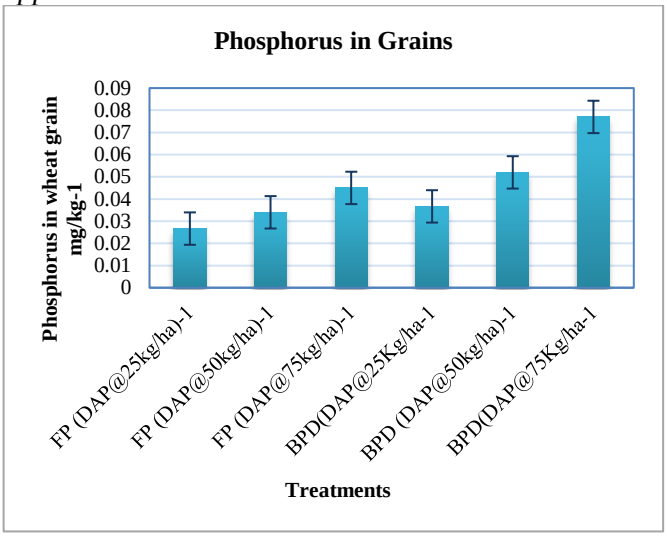


Figure 5

Soil Phosphorus under different phosphorus levels and application methods.

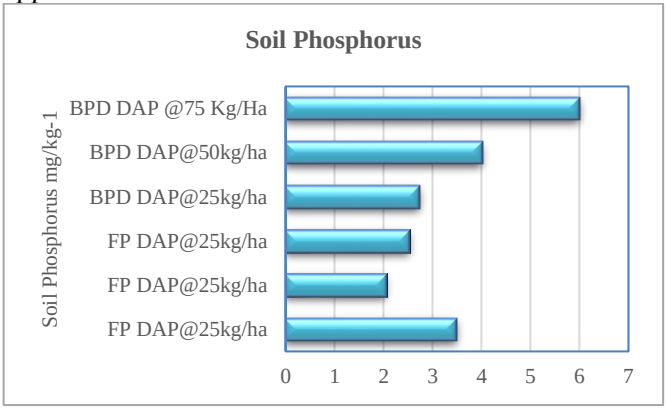


Figure 6

Soil Nitrate No3-N under different phosphorus levels and application methods.

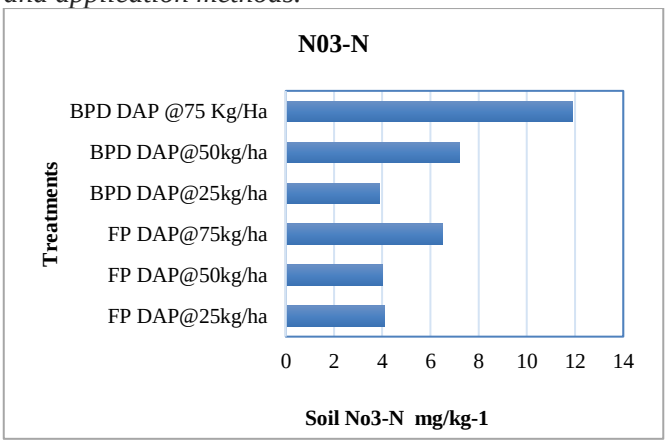
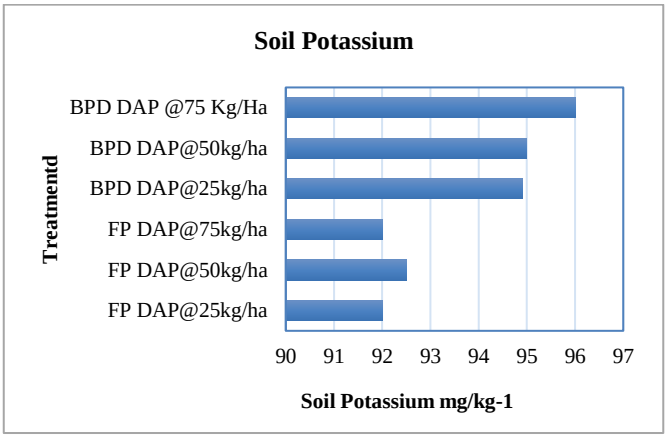


Figure 7

Soil Potassium



DISCUSSION

In the akaline soil, DAP applied with Band Placement drill @75 kg/ha^{-1} had the highest grain yield among the different P fertilizer levels. Global transfers of food and nutrients, especially the transfer from the arable land into towns, mean that farmers have to rely increasingly on external sources of nutrients to replace those lost from their fields by selling the produce. The soil nutrient capital is not an inexhaustible resource and must be replenished according to the nutrient withdrawal. With the obligatory need for intensification of crop production, the demand of crops for readily available soil nutrient is increasing day by day. The analysis data illustrated the effect of phosphorus and its placement on the growth and yield of wheat. While the, three different levels and two placements were applied and results of each component were compared. It was intensively observed, plant height and, and grain yield hectare^{-1}. Hussain, N. et al. (2008).reported that the significantly and obtained maximum yield at the rate of 75 kg P ha^{-1} by drill application. The extent of relationship of various crop parameters also showed the positive association with grain yield of the crop and result supported by Shah, K.H, et al. (2003). reported that the

deep placement of N and P fertilizers could improve the crop by producing tiller plants^{-1}, length of spikes, grain & straw yields Al-Rashidi, G.A. (2004): Robinson, I.L (2004) however in some other findings Joshi, O.P. and Billore, S.D. (2004)- revealed in banding application of fertilizer increased the number of grains yield and Grains spike^{-1}. Kostadinova, S. (2003).The combination and application of NP nutrients as deep placement significantly produced higher grain yield of wheat crop.

CONCLUSION

The study's findings suggest that, in comparison to the Farmer practice treatment, the efficiency of P significantly improved wheat crop growth and grain yield by Band placement drill method, yield attributes, grain and straw yield, and the economics of wheat cultivation. In comparison to broadcasting and Band placement drill methods, the results showed that band placement of P significantly increased wheat growth, yield. As a result, the best agronomical strategy for increasing wheat yield was determined to be combining the band placement method with P@ 75 kg ha^{-1} under irrigated conditions. Band Placement drill method also improve P use efficiency in wheat crop.

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