Research Article

Influence of farm yard manure and phosphorus application on yield and yield components of Wheat

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Abstract

To quantify the effect of farm yard manure (FYM) and phosphorus levels application on growth, yield and yield components of wheat, the experiment was conducted at Agronomy Research Farm The University of Agriculture Peshawar, during 2013- 2014. Randomized complete block design was used having split plot arrangement with three replications. Varieties were allotted to main plots, whereas FYM rates (2, 4 and 6 tons ha⁻¹) and phosphorus levels (30, 60 and 90 kg ha⁻¹) were allotted to sub plots. FYM and phosphorus levels significantly affected the plant height, days to anthesis, number of grains spike⁻¹, number of productive tillers m⁻², number of unproductive tillers m⁻², days to physiological maturity, thousand grain weight (g), grain yield kg ha⁻¹, biological yield kg ha⁻¹, and harvest index (%) of wheat varieties. Maximum number of days to anthesis (136), plant height (102 cm), number of productive tillers m⁻² (324), number of unproductive tillers m⁻² (14), days to physiological maturity (172), number of grain spike⁻¹ (53 grains), thousand grains weight (50 g), grain yield (4552 kg ha⁻¹), biological yield (12802 kg ha⁻¹) and harvest index (39%) were recorded in the plots treated with FYM at the rate of 6 tons ha⁻¹, whereas the 90 kg ha⁻¹ phosphorus gave maximum plant height (98 cm), days to anthesis (136), number of productive tillers m⁻² (311), number of unproductive tillers m⁻² (14), days to physiological maturity (172), number of grains spike⁻¹ (51 grains), thousand grains weight (48 g), biological yield (12250 kg ha⁻¹), grain yield (4372 kg ha⁻¹) and harvest index (40 %). Variety Atta Habib performs better than Siran 2010. Interaction between FYM and phosphorus were significantly affected the plant height, days to physiological maturity, grain yield. Maximum plant height (106 cm), days to physiological maturity (177), grain yield (4619 kg ha⁻¹) were recorded in plots treated with FYM at the rate of 6 tons ha⁻¹ and 90 kg ha⁻¹ phosphorus. It was concluded that FYM and phosphorus at the rate of 6 tons ha⁻¹ and 90 kg ha⁻¹ significantly enhanced the production of wheat.

Keywords: Wheat (*Triticum aestivum* L.); Varieties; FYM rates; Phosphorus levels; Yield and yield components.

Introduction

Wheat (*Triticum aestivum* L.) is the most required staple food crop of Pakistan participating 13.7% to the value added in agriculture and 3% to GDP. It is cultivated over an area of 8303 thousand hectares with the overall production of 25.21m tons including an average yield of 2833 kg ha⁻¹ [1]. The optimum yield at farmer's fields is far below then potential level [2]. Due to the increase in the population pressure day by day demand for wheat production in Pakistan is increasing and this requirement will have to be met by increasing the yield per unit area.

In order to get self-sufficiency in wheat, the latest production technologies of adequate inputs and agronomic practices are to be followed. Khyber Pakhtunkhwa soil is low in nutrients organic matter, nitrogen, phosphorous and zinc [3]. Chemical fertilizers are used at high level by the Farmers to copes with the problem of nutrients deficiency and low yield per unit area [4].

Manure application plays a very important role in promoting the fertility of the soil and its effect on the crop yield Manures are massive organic material produced by the plant and animals wastes. Decomposed organic matter and organic P fertilizer are believed to improve production of agriculture in long term sustainable way [5]. The modification of organic manure improves the soil organic carbon as compare to the application of the same quantity of nutrient as inorganic fertilizer [6].

Soil type, types of crops, water requirement, P fertilizer, management practices and time of application and climatic conditions of an area are important factors to be considered when attempting to formulate sound P-fertilizer source and application for maximum crops yield response [7]. Treating soil with FYM to increase soil fertility and productivity has been a common practice in

the history of humanity [8]. The combination of inorganic and organic fertilizer amendments like FYM, green manures and residue straw increase their effectiveness and improve the soil productivity. Yaduvanshi and Sharma (2008) [9] found that application FYM with chemical amendment improves the wheat yield and N, P, K, uptake in grain yield and biological yield.

Phosphorus is relatively immobile in the soil. Consequently, the application and placement of the phosphorus is expected to cause larger effects on phosphorus availability and crop yield. Applying phosphorus fertilizer along with the seed can increase wheat yield as compared to deep banding or broadcasting, even in the soils having high amount of phosphorus [10]. The effective placement of fertilizers can maximize both production and nutrient use efficiency.

Phosphorus availability to the crops is highly enhanced by the biological processes, especially in which the source is organic amendments as their major nutrient [11]. Phosphorus is an important nutrient and mostly wheat crop suffers from P deficiency during growth cycle on alkaline calcareous soils. Pakistan soils are low in available P and suffer from P deficiency [12] [13]. Plants require adequate P from the very early stages for growth and development. P reduces lodging of plants by providing strength to the steam in cereals. Phosphorus increases crop resistance to certain diseases. Phosphorus is important part for ribonucleic acid (RNA) and (DNA) formation which are responsible for genetic makeup and heredity transmission. It stimulates and promotes early growth and root formation. Grain yield and P accumulation by wheat are highest for higher P rates [14].

Keeping in view the above task, the present study was designed to investigate the effect

of FYM and phosphorus application on growth, yield and yield component of wheat.

Materials and Methods

To study the effect of farm yard manure (FYM) and phosphorus application on yield and yield components of wheat. A field experiment was carried out at Agronomy Research Farm of The Agricultural University, Peshawar ($34^{\circ} 00' N$, $71^{\circ} 30' E$, 510 MASL) during Rabi season 2013-14. The experiment was conducted in randomized complete block design with split plot arrangement having three replications. Two varieties (Siran-2010 and Atta Habib-2010) were allotted to main plots while FYM rates (2, 4 and 6 tons ha^{-1}) and phosphorus levels (30, 60 and 90 $kg ha^{-1}$) were kept in subplot including one control having no FYM and phosphorus was maintained throughout the experiment. Seed rate was applied at 120 $kg ha^{-1}$ on flat beds with row to row distance of 30cm. FYM was applied and mixed 20 days before sowing. Recommended dose of nitrogen was applied at the rate of 120 $kg ha^{-1}$ in the form of urea. Phosphorus was applied in the form of SSP. Half of the nitrogen and all the phosphorus was applied at the time of sowing while the remaining half nitrogen was applied at tillering stage. Irrigation was applied according to the need of the crop. All the other agronomic practices were applied uniformly to all the experimental treatments. Data were recorded by using standard methods on number of productive tillers m^{-2} , grains spike $^{-1}$, thousand grains weight and grain yield during the course of study. Number of productive tiller (m^{-2}) was recorded by counting the productive tiller in one-meter long row at three randomly selected places in each plot and was converted into m^2 area. Grains spike $^{-1}$ were calculated by selecting randomly samples of spikes, grains were counted and simply averaged. Thousands grain weight (g) calculated after threshing the seed and counted from each plot and weighed with the help of electronic balance.

Grain yield ($kg ha^{-1}$) calculated after harvested four central rows were sun dried, threshed, cleaned and weighed, and then were converted into $kg ha^{-1}$. Data was statistically analyzed according to the procedure described by [15] for randomized complete block design and means were separated by least significant differences test ($P \leq 0.05$) upon significant F test.

Results and Discussion

Productive tillers m^{-2}

Data on the number of the productive tillers (m^{-2}) are reported in Table 1. Statistical analysis of the data revealed that treatments, FYM, phosphorus, controls vs. rest were found significant. While the interaction between the (FYM x P), (V x T), (V x P), (V x FYM), (V x FYM x P) were found non-significant. Mean values for the treatments showed that maximum numbers of productive tillers m^{-2} (338) were showed in plots treated with 6 tons ha^{-1} FYM and phosphorus 90 $kg ha^{-1}$. Minimum numbers of the productive tiller m^{-2} (284) were showed in plots applied with 2 tons ha^{-1} FYM and 30 $kg ha^{-1}$ phosphorus. Individual mean values of FYM reveal that maximum number of productive tiller m^{-2} (324) were recorded in experimental plots treated with 6 tons ha^{-1} and lowest number of productive tillers m^{-2} (285) were recorded in plots applied with 2 tons ha^{-1} FYM. Phosphorus mean values indicated that the highest number of the productive tiller m^{-2} (311) were recorded in the plots treated with 90 $kg ha^{-1}$ phosphorus and the minimum number of productive tiller m^{-2} (297) were recorded in plots treated with 30 $kg ha^{-1}$ phosphorus. Variety Atta Habib gave highest number of the productive tillers m^{-2} (304) as compared to Siran 2010. Number of productive tillers m^{-2} for control plots (274 tillers m^{-2}) vs. rest plots (304 tillers m^{-2}). Productive tillers m^{-2} revealed that FYM and phosphorus levels had significant effected. The application of 6 tons ha^{-1} FYM gave

maximum number of productive tillers m^{-2} . FYM had greater capacity to increase that ability of the soil to hold water, improve the availability of nutrients and improve individual plant performance. Similar results were observed by [16] they reported high dose of FYM application produced more productive tillers m^{-2} . This increase in number of productive tillers might be due more decomposition of nutrients. Increase in phosphorus at the rate of 90 kg ha^{-1} significantly affected the productive tillers. Application of phosphorus fertilizer improved reproductive parts of plants. Phosphorus is essential for seed and fruit development, tillering and flowering of plants, resulting maximum number of productive tillers $^{-1}$. [17] studied that inorganic P fertilizer has proved that it enhance the number of productive tillers m^{-2} .

Grains per spike

Data regarding grains spike $^{-1}$ are presented in the Table 1. Statistical analysis of the data showed that treatments, FYM, Phosphorus, control vs. rest were found significant. While the interaction between (V x P), (FYM x P), (V x FYM), (V x T), (V x FYM x P) were non significant. Mean values for the grains spike $^{-1}$ showed that highest numbers of grains spike $^{-1}$ (56) were recorded in the treatments having maximum level of FYM 6 tons ha^{-1} and 90 kg ha^{-1} phosphorus. Lowest grains spike $^{-1}$ (42) was observed in the treatments having 2 tons ha^{-1} FYM and 30 kg ha^{-1} phosphorus. Mean values for the FYM showed optimum grains spike $^{-1}$ (53) was found in plots treated with 6 tons ha^{-1} FYM, while lowest grains spike $^{-1}$ (46) was received in plots treated with 2 tons ha^{-1} . Phosphorus showed that the maximum grains spike $^{-1}$ (51) was received in plots treated with 90 kg ha^{-1} phosphorus and minimum mean value for the grains spike $^{-1}$ (45) was at 30 kg ha^{-1} of phosphorus. Variety Atta Habib showed maximum grains spike $^{-1}$ (51) as compared to

Siran (46). Grains spike $^{-1}$ for control plots ($31 \text{ grains spike}^{-1}$) vs. rest plots ($49 \text{ grain spike}^{-1}$). Data on grains spike $^{-1}$ had significantly affected by FYM, phosphorus levels. Maximum number of grains spike $^{-1}$ was noted at 6 tons ha^{-1} FYM, whereas minimum was recorded in control plots. This might be due to prolonged vegetative growth and continuous availability of the nutrients that finally enhanced the number of grains spike $^{-1}$. The finding is in line with [17]. Increase in FYM application improves the mineralization and physical condition of the soil. Phosphorus at 90 kg ha^{-1} gave maximum grains spike $^{-1}$. Application of phosphorus fertilizer enhanced reproductive parts. Phosphorus is essential for seed development, and resulting in maximum number of spike m^{-2} . Our results are in line with [18]. Who reported that promoting effect of P fertilizer on spike $^{-1}$.

Thousand grain weight

Data pretending thousand grains weight is presented in Table 1. Statistical analysis of the data showed that effect of phosphorus, control vs. rest varieties, treatments, FYM, (V x T) and (V x P) were found significant. While the interaction between (V x FYM), (FYM x P), (V x FYM x P) were non significant. Mean values for treatments revealed that maximum thousand grains weight (55 g) was recorded in plots treated with FYM 6 tons ha^{-1} and phosphorus 90 kg ha^{-1} . Minimum thousand grains weight (38 g) was observed in plots treated with 2 tons ha^{-1} FYM and at the rate of 30 kg ha^{-1} phosphorus. FYM showed maximum thousand grains weight (50 g) at the FYM rate of 6 tones ha^{-1} and the minimum thousand grains weight was (42 g) at the rate of 2 tones ha^{-1} FYM. While the phosphorus mean values revealed that the maximum thousand grains weight was (48 g) in the experimental units treated with 90 kg ha^{-1} phosphorus, whereas minimum thousand grains weight (43 g) was reported at 30 kg

ha⁻¹ phosphorus. Atta Habib gave the maximum thousand grains weight (47 g) whereas Siran produced (44 g) thousand grains weight. Thousand grains weight for control plots (31 g) vs. rest plots (45 g). Thousand grains weight is one of the most important yield contributing factors. Thousand grains weight was significantly affected by the FYM, phosphorus levels and varieties. Maximum thousand grains weight was noted in plots treated with 6 tons ha⁻¹ FYM. Increase in thousand grains might be due to maximum nutrients supply. [19] Reported that thousand grains weight will increase with better nutrients management. FYM applied 3 weeks before the sowing of the crop produced maximum thousand grains weight. Maximum thousand grains weight was recorded in plots treated with 90 kg ha⁻¹ phosphorus. This may be due to the fact that phosphorus is most important nutrients required for seed and fruit formation. [18] Reported that maximum doses of P produced highest number of thousand grains weight which might be due to better root development and absorption of nutrients from soil. [20] Reported that phosphorus application promote grain development in wheat. Variety Atta Habib produced maximum thousand grains weight than variety Siran. This difference in both varieties may be because of the response to ecological conditions.

Grain yield

Data regarding to grain yield are reported in the Table 1. Analysis of the data revealed that effect of varieties, treatments, control vs. rest, FYM, phosphorus (FYM x P) were found significant, while the interactions between (V x T), (V x FYM), (V x P), (V x FYM x P) were non-significant. Mean values revealed that maximum grain yield kg ha⁻¹ (4619) reported in treatments treated with 6 ton ha⁻¹ FYM and 90 kg ha⁻¹ phosphorus. Minimum grain yield kg ha⁻¹ (3243) was observed in experimental plots

treated with FYM at the rate of 2 tons ha⁻¹ and phosphorus at the rate 30 kg ha⁻¹, while the effect of the FYM showed that the highest grain yield kg ha⁻¹ (4552) was observed in the plots with 6 tons ha⁻¹ FYM, whereas the minimum grain yield kg ha⁻¹ (3719) was recorded in the plots allotted to 2 tons ha⁻¹ FYM. Phosphorus mean values showed that the highest grain weight kg ha⁻¹ (4372) was observed in study units treated with 90 kg ha⁻¹ and minimum grain yield kg ha⁻¹ (3952) was observed in study units with 30 kg ha⁻¹ phosphorus. Mean values for the varieties showed that the variety Atta Habib gave maximum grain yield kg ha⁻¹ (4302) and Siran variety gave the minimum grain yield kg ha⁻¹ (4048). Data of the grain yield kg ha⁻¹ for Control plots was (3068 kg ha⁻¹) vs. rest (4175 kg ha⁻¹). Statistical analysis of the data on grain yield showed that FYM, phosphorus, varieties and control vs. rest were significant. In case of FYM the maximum grain yield kg ha⁻¹ was recorded in the experimental units treated with 6 tons ha⁻¹ FYM. Maximum grain yield associated with efficient nutrients availability, maximum mineralization which may lead to maximum dry matter production and improve grain yield. Our results were similar to those of [21] who stated that nitrogen enhance grain yield. Analysis of the data showed that maximum grain yield was observed in experimental plots treated with 90 kg ha⁻¹ phosphorus. This may be due that Phosphorus play important role in physiological processes, energy storage, Photosynthesis, respiration, cell division and cell enlargement. It promotes and improves the yield and quality of crop. [22] and [18], these results coincide with [14] who reported that grain yield increased with increase in P rates. Variety Atta Habib produced maximum grain yield when treated with 6 tons ha⁻¹ FYM and 90 kg ha⁻¹ phosphorus as compared to variety Siran. This is because that variety Atta Habib

produced more number of spikes and maximum number of grains spike⁻¹. Our results are in line with [23], who reported

that maximum grain yield was recorded in variety Atta Habib.

Table 1. Productive tillers m⁻², grains spike⁻¹, 1000 grains weight (g) and grain yield (kg ha⁻¹) as affected by FYM and phosphorus in wheat.

Treatment	Productive tillers m ⁻²	grains spike ⁻¹	1000 grains weight (g)	Grain yield (kg ha ⁻¹)
Varieties				
Siran (2010)	303	46	44b	4048b
Atta Habib	304	51	47a	4302a
LSD (0.05)	ns	ns	0.04	.00895
FYM (t ha⁻¹)				
2	285c	46c	42b	3719c
4	302b	48b	43b	4255b
6	324a	53a	50a	4552a
LSD (0.05)	2.10	0.70	0.77	45.14
Phosphorus (kg ha⁻¹)				
30	297c	45b	43b	3952c
60	303b	50ab	44b	4202b
90	311a	51a	48a	4372a
LSD (0.05)	2.10	0.70	0.77	45.14
Control	274	31	31	3068
Interaction				
FYM x P	ns	ns	ns	*
V x FYM	ns	*	ns	ns
V x P	ns	ns	ns	ns
V x FYM x P	ns	ns	ns	ns

Means followed by different letter (s) within each category are significantly different using LSD test at $P \leq 0.05$. ns= non-significant

Conclusion and Recommendations

It was concluded from the above results that Variety Atta Habib performed better as compared to Siran 2010. FYM applied at the rate of 6 tons ha⁻¹ improved yield and yield components of wheat. Phosphorus applied at the rate of 90 kg ha⁻¹ gave the higher yield of wheat. Interaction between variety Atta Habib, FYM applied at 6 tons ha⁻¹ along with 90 kg P ha⁻¹ gave higher yield and yield components of wheat.

On the basis of the above conclusions it is recommended that variety Atta Habib, 6 tons ha⁻¹ FYM along with 90 kg ha⁻¹ phosphorus should be applied for obtaining maximum yield and yield components of wheat.

Authors' contributions

Design the experiment: S Baqa & AZ Khan. Data collection and analysis: Inamullah, Imran & AA Khan. Technical help, data analysis and revision of the manuscript: Imran. Downloaded the related review, data collection and interpretation of the data: S Anwar & B Iqbal. Technical help and correction of the manuscript: S Yar khan & A Usman.

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