

Original Research Article

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Effect of Poultry Manure and Phosphorous on Phenology, Yield and Yield Components of Wheat

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ABSTRACT

Soil phosphorous (P) limitation is one of the most important obstructions to food production in Pakistan. An experiment was carried out at Agronomy research farm of the University of Agriculture, Peshawar during winter 2015 with an objective to estimate the effect of poultry manure (PM) and P on wheat performance. Experiment was laid out in randomized complete block design having four replications. Three levels of PM (1, 1.5, 2 tons ha⁻¹) and five levels of P (0, 50, 75, 100 and 125 kg ha⁻¹) were taken as treatments. Poultry manure and P significantly affected phenology, yield and yield components of wheat. More tillers m⁻² with maximum days to anthesis, maturity and maximum spike length, grains spike⁻¹, thousand grains weight, biological yield and grain yield were recorded in plots treated with PM @ of 2 tons ha⁻¹. With increase in P levels days to anthesis and maturity decreased. Maximum tillers m⁻², spike length, grains spike⁻¹, thousand grain weight and grain yield was recorded for P applied @ of 125 kg ha⁻¹ which was statistically similar to P applied @ of 100 kg ha⁻¹. Maximum biological yield was recorded with the application of 125 kg P ha⁻¹. Based on the experimental results it can be concluded that application of PM @ of 2 tons ha⁻¹ in combination with P @ of 100 kg ha⁻¹ resulted in higher productivity of wheat.

Keywords

Tillers m⁻², Spike length, Thousand grain weight, Biological yield

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Introduction

Wheat is staple diet of communities living in Pakistan. In order to continue its adequate supply, it is mandatory to improve per acre yield of the crop. Among the plant nutrients, Phosphorus (P) is critical to improve the yield of wheat as over 90 % soils in Pakistan are low in available P (Ahmed *et al.*, 1992). Moreover, with the passage of time, the adsorption of P gets firmer thus creating

difficulties in release to soil solutions. Consequently, efficiency of fertilizer P in calcareous soils remains comparatively low (Delgado *et al.*, 2002). There is need to make P fertilizer recommendations site specific as well as crop specific on scientific basis (Ahmed *et al.*, 1992). Wheat roots absorb P only from the soil solution (Johnston *et al.*, 1999). Despite its higher yield potential, yield per hectare is very low in Pakistan as compared to other wheat producing countries (Sarwar *et al.*, 2010). There are many reasons

of low yield but the most important is the injudicious use of phosphorus fertilizer. Phosphorus fertilization is very essential for exploitation of good yield of different crops (Rashid *et al.*, 1994). Phosphorus plays a vital role in several physiological processes viz photosynthesis, respiration, energy storage and cell division/ enlargement. It is also a structural component of many biochemical processes via nucleic acid (DNA and RNA enzymes and coenzymes) and also stimulates root growth and associated with early maturity of crops. Phosphorous is one of the most limiting plant nutrients in cropping system across the world (Shenoy and Kalagudi, 2005). P is unavoidable for Agriculture (Osava, 2007).

Optimum amount of P is necessary for higher yield, crop quality with healthy stalk growth, root growth and to get earlier maturity (Bugbee and Khera, 1999). Effectiveness and efficiency of P is more when applied at sowing (Rehman *et al.*, 2007). Presently the challenges faced by the researchers are to increase yield, decrease the cost of production and improve soil health.

To overcome these challenges, they have to consider combined use of natural and synthetic fertilizers, organic farming and timing of nutrients application (Huang *et al.*, 2007; Rasool *et al.*, 2007). In Pakistan, cost of fertilizers particularly phosphatic is increasing and most of the farmers are poor. This situation demands to determine some approaches through which efficiency of small amount of fertilizers added to the soil are improved (Twyford, 1994).

Nowaday's farmers are moving to add natural fertilizers to the soil for sustainable yield (Naeem *et al.*, 2009). Combined use of natural wastes (manures) and synthetic fertilizers can be a better way to maintain soil nutrient status and to promote sustainability in crop

production (Paul and Mannan, 2006). Integration of organic manures with synthetic fertilizers improves soil physical properties (bulk density, porosity, compaction), chemical properties (soil pH, carbon sequestration, organic N and P) and ultimately the crop yield (Rautaray *et al.*, 2003). An economical and effective approach to achieve sustainability in crop production system is the simultaneous use of organic and synthetic fertilizers (Gosh *et al.*, 2004). Application of P from natural fertilizers has almost same or better effect than applied from synthetic fertilizers.

Poultry manure (PM) is a rich source of macro (N, P, K) and micro (S, Fe) nutrients and also has a better effect on soil health (Sims and Wolf, 1994). It serves as an organic matter for the soil, improves soil biological life and enhanced soil water holding capacity (Deksissa *et al.*, 2008). Mineralization of PM is higher than other natural manures (cattle, pig) thus it readily releases its nutrients when added to the soil for plant uptake (Brady and Weil, 1999). Sharply and Smith (1991) indicated that crop yield significantly improved with the addition of PM because it contains basic nutrients necessary for healthy crop growth. Application of poultry manure increases carbon content, water holding capacity, aggregation of soil, and decreases bulk density (Egerszegi, 1990). P availability of PM to plants is more and quicker than other natural manure (Garg and Bahla, 2008).

Materials and Methods

Experimental site

The experimental site (34°00'43.2"N 71°28'00.4"E) was Agronomy Research Farm of the University of Agriculture Peshawar, Pakistan. Peshawar is located at 34oN latitude, 71oE longitude with an altitude of 350m above sea level and has a sub-tropical climate.

Soil description

Soil of experimental site was alkaline (pH 8.02) and calcareous in nature, low in organic matter (0.845 g kg^{-1}), non-saline (EC (1:1) 0.87 d S m^{-1}), low in available nitrogen (0.04 g kg^{-1}) and phosphorous (4 mg kg^{-1}) with near sufficient in potassium (80 mg kg^{-1}). The texture of the soil was silty clay loam having 40% clay, 51.3% silt and 8.7% sand. Canal water was available for irrigation (Saleem *et al.*, 2015).

Experimental details

The experiment was designed in randomized complete block design (RCBD) with split plot arrangement keeping three replications. A sub plot size was 18 m^2 including 6 rows, 4 m long and 0.75 m apart. Wheat variety (SIRAN) was sown with 30 kg ha^{-1} seed rate. The treatments consisted of three levels of poultry manure (1, 1.5 and 2 tons ha^{-1}) and four levels of P (50, 75, 100 and 125 kg ha^{-1}). A control treatment was also included in the experiment. Poultry manure was applied two weeks before sowing and full Phosphorus dose was applied during seedbed preparation. Ploughing of field was done when proper field capacity level was reached with cultivator directly followed by rotavator. Field was irrigated when needed considering the weather conditions particularly rainfall. All cultural practices carried out for better crop growth and development were kept same to all treatments.

Procedure for recording data

Data regarding tillers m^{-2} was calculated by counting the number of tillers in two central rows of each plot and converted into tillers m^{-2} . Days to anthesis was recorded from sowing till date when anthers appeared in 80% plants in each subplot. Days to maturity were recorded by counting the number of days from sowing to date when 80% plants showed maturity symptoms in each sub plot. Spike length of ten spikes randomly selected in each

plot was measured from base of first spikelet to the tip of terminal spikelet excluding awn and was averaged for mean spike length (cm). Ten spikes were randomly selected in each plot; their grains were counted and averaged. Biological yield was calculated by harvesting four middle rows in each plot, tied into bundles, sun dried, and weighed to determine biological yield. Cleaned thousand grains were randomly taken from each treatment and weighed on electronic balance to determine its weight. Four central rows harvested for biological yield were threshed, cleaned, and weighed to estimate grain yield. The data was converted into kg ha^{-1} .

Statistical analysis

The recorded data was statistically analyzed using the procedure outlined by Jan *et al.*, (2009) for RCB design. Upon significant F-test, means were compared using least significant difference (LSD) test at $P \leq 0.05$.

Results and Discussion

Tillers m^{-2}

Poultry manure (PM) and Phosphorus (P) levels significantly affected tillers m^{-2} (Table 1). The interaction of PM and P levels was found non-significant for tillers m^{-2} . Mean effect of P levels indicated that highest tillers m^{-2} was recorded in plots which was treated with PM @ of 2 t ha^{-1} while lowest tillers m^{-2} was recorded in plots treated with 1 ton ha^{-1} PM. Enujeke (2013) reported that application of poultry manure increased plant growth because more nutrients were made readily available and easily absorbable by receiving plants leading to faster growth and development and ultimately to more tillers m^{-2} . Our findings are supported by Ibrahim *et al.*, (2008). Means of P levels showed that highest tillers m^{-2} was recorded in plots treated with 125 kg ha^{-1} P which was statistical similar with 100 kg ha^{-1} P while lowest tillers

m⁻² was recorded in 50 kg ha⁻¹ P treated plots. Increase in growth parameters in different crops while increasing P rate is earlier reported in many studies from different parts of the world (Opala *et al.*, 2009; Rast *et al.*, 2010; Rasavel and Ravichandran, 2013). Fageria *et al.*, (2003) and Fageria and Baligar (2005) reported that tillering capacity was considerably affected by P application.

Our results are supported by Tahir *et al.*, (2004) who documented that P application increase tillers m⁻² in wheat crop. Significant difference was recorded in control vs rest plots for tillers m⁻².

Days to anthesis

Days to anthesis of wheat crop as affected by poultry manure and phosphorus levels is reported in Table 1. Statistical analysis of the data revealed that poultry manure had no significant effect on days to anthesis while phosphorus levels significantly affected days to anthesis. Interaction of poultry manure and phosphorus remained non-significant for days to anthesis. Planned mean comparison showed that early anthesis was observed in plots which were treated with P at the rate of 125 kg ha⁻¹ which was statistically non-significant with 100 kg ha⁻¹ P treatment while delayed anthesis was observed in 50 kg ha⁻¹ P treatment. The increased rate of Phenological development with increasing P fertilization has been seen in other studies on different crops (Amanullah and Khan, 2010; Khalil *et al.*, 2010; Amanullah and Khalid, 2015). As P deficiency decrease both root and shoot development (Amanullah and Stewart, 2013) and phosphorus uptake (Amanullah and Inamullah, 2016b), which causes a delay in phonological development (Amanullah *et al.*, 2014; Amanullah and Khalid, 2015). Significant difference was recorded in control vs rest for days to anthesis.

Days to maturity

Data pertaining days to maturity of wheat crop as influenced by poultry manure and phosphorus levels are presented in Table 1. Statistical analysis of data showed that PM and P levels significantly affected days to maturity. Interaction of PM and P levels remained non-significant for days to maturity. Mean effect of PM levels showed that more days to maturity was observed in plots which was treated with PM @ of 2 t ha⁻¹ while less days to maturity was observed for 1 t ha⁻¹ PM. It might be due to high content of essential nutrients present in poultry manure which accelerates vegetative growth and delays maturity.

Our results are in line with Dannis *et al.*, (2002) who reported that poultry manure have high content of essential nutrients as compared to others organic sources and accelerate vegetative growth when applied at sowing time leading to late maturity. Planned mean comparison of P levels indicated that early maturity was observed in 125 kg ha⁻¹ phosphorus plot which was statistical at par with 100 kg ha⁻¹ phosphorus plot while delayed maturity was observed in 50 kg ha⁻¹ phosphorus plot. This might be due to the reason that P application improved root growth which enhanced nutrients uptake and resulted in early maturity. Root and shoot development with P uptake decreased with P deficiency (Amanullah and Stewart, 2013) which might cause a delay in Phenological development (Amanullah *et al.*, 2014; Amanullah and Khalid, 2015; Amanullah *et al.*, 2016b). Control vs rest plots showed significant difference for days to maturity.

Spike length (cm)

Data regarding spike length of wheat crop as affected by poultry manure and phosphorus levels are reported in Table 2.

Table.1 Tiller m⁻², days to anthesis and maturity of wheat crop as affected by poultry manure and Phosphorus levels

Treatment	Tiller m ⁻²	Days to anthesis	Days to maturity
Poultry Manure(tons ha⁻¹)			
1	264 b	135	166 b
1.5	268 b	135	164 c
2	278 a	135	167 a
LSD (0.05)	8	Ns	0.95
Phosphorus Levels (kg ha⁻¹)			
50	260 b	135 a	164 a
75	267 b	134 b	164 a
100	275 a	131 c	161 b
125	280 a	131 c	161 b
LSD(0.05)	7.3	0.92	0.86
Control	255	137	169
Rest	270.28	134	164
Interaction	Ns	Ns	Ns

Means sharing same letter(s) for a parameter in a column are statistically similar at 5% level of significance. ns= non-significant

Table.2 Spike length (cm), grains spike⁻¹, thousand grains weight (g), biological yield (kg ha⁻¹) and grain yield (kg ha⁻¹) of wheat crop as influenced by poultry manure and phosphorus levels

Treatment	Spike length (cm)	Grains spike ⁻¹	Thousand grain weight (g)	Biological yield (kg ha ⁻¹)	Grain yield (kg ha ⁻¹)
Poultry Manure(tons ha⁻¹)					
1	9.52 b	45 b	41.55 b	8690 b	3115 b
1.5	9.95 a	46 b	43.45 a	9022 a	3540 a
2	10.2 a	49 a	44.56 a	9280 a	3655 a
LSD (0.05)	0.4	2.5	1.7	325.8	246.6
Phosphorus Levels (kg ha⁻¹)					
50	9.45 b	46 b	40.15 c	8422 d	2880 d
75	9.65 b	47 b	42.51 b	8850 c	3112 b
100	10.25 a	50 a	44.72 a	9290 b	3445 a
125	10.4 a	51 a	45.32 a	9639 a	3551 a
LSD(0.05)	0.5	3	2.1	290.55	210.4
Control	9.25	44	39.55	7906.65	2665
Rest	9.91	47.7	43.18	9027.57	3328
Interaction	ns	Ns	ns	ns	Ns

Means sharing same letter(s) for a parameter in a column are statistically similar at 5% level of significance. ns= non-significant

Results showed that PM and P levels had a significant effect on spike length of wheat crop. Interaction of PM and P levels remained non-significant for spike length. Among levels of PM highest spike length was recorded for 2 t ha⁻¹ of PM which was statistical similar with plots treated with PM at the rate of 1.5 t ha⁻¹ while lowest spike length was recorded for 1 t ha⁻¹ PM treatment. This could be due to the availability of both micro and macro nutrients from PM which enhanced plant growth and spike length also. Our results are supported by findings of Shahid *et al.*, (2015). Planned mean comparison of P levels showed that highest spike length was recorded for 125 kg ha⁻¹ P treatment which was statistical similar with 100 kg ha⁻¹ P treated plots while lowest spike length was recorded in plots fertilized with 50 kg ha⁻¹ P. According to Rahman *et al.*, (2011), higher P level increases the availability of P and Zn that had considerably helpful effect on growth, yield and yield contributing parameters (Hao *et al.*, 2009). Control vs rest showed significant variation for spike length of wheat crop.

Grains spike⁻¹

Different levels of poultry manure and phosphorus had cause significant variations in grains spike⁻¹ as reported in Table 2. Interaction between PM and P levels was found non-significant for grains spike⁻¹. When averaged across phosphorus levels, data indicated that highest grain spike⁻¹ was recorded for plots which were treated with PM at the rate of 2 t ha⁻¹ while lowest grains spike⁻¹ was recorded for treatment of 1 t ha⁻¹ of PM. The highest grains spike⁻¹ due to PM might be due to greater rate of nitrogen which had not only increased the dry matter but also more partitioning toward the grains which consequently enhanced number of grains spike⁻¹. Incorporation of poultry manure into soil increased the soil fertility and ultimately

the yield components of wheat. Our outcomes are supported by Shahid *et al.*, (2015). Mean effect of P levels showed that highest grains spike⁻¹ was recorded for 125 kg ha⁻¹ P level which was statistically at par with 100 kg ha⁻¹ P treatment while lowest grains spike⁻¹ was recorded in plot which treated with 50 kg ha⁻¹ P. Better root system development due to P application enhanced water and nutrients uptake which readily translocate towards developing sink might be the possible reasons for more grains per spike. Our findings are in line with those of Kaleem *et al.*, (2009) who documented that grains spike⁻¹ significantly increased with the application of P. Significant difference was found in control vs rest for grains spike⁻¹ of wheat crop.

Thousand grains weight (g)

Thousand grains weight of wheat crop as affected by different levels of PM and P are presented in Table 2. Statistical analysis of data revealed that both PM and P levels had a significant effect on thousand grains weight of wheat. Interaction of PM x P remained non-significant for thousand grains weight. Data across phosphorus levels showed that highest thousand grains weight was recorded in plots which were treated with 2 t ha⁻¹ PM while lowest thousand grains weight was recorded in plot treated with 1 t ha⁻¹ PM. The increase in grain weight may be due to the fact that chicken manure supplies direct available nutrients (i.e. N) to the plants and improvement of soil physical properties particularly in heavy clay soils result in heavy grains as reported by (Haris *et al.*, 2002). After least significant difference test for P levels data showed that highest thousand grains weight was recorded in plot which received P at the rate of 125 kg ha⁻¹ which was statistically similar with plots fertilized with 100 kg ha⁻¹ P while lowest thousand grains weight was recorded in plots which received 50 kg ha⁻¹ P. Kaleem *et al.*, (2009)

reported that application of P increased thousand grains weight in wheat crop. The increase in grain weight may be due to favorable effect of P on promoting vigorous plant growth. Also, P application improves root growth and health which in turn increases the absorption of nutrients and water from soil thus, increases grain weight. Control vs rest of wheat for thousand grains weight showed significant variation.

Biological yield (kg ha⁻¹)

Poultry manure and phosphorus levels significantly affected biological yield of wheat crop as reported in Table 2. Among levels of PM highest biological yield was recorded in plot which was treated with PM at the rate of 2 t ha⁻¹ while lowest biological yield was recorded in plot which received 1 t ha⁻¹ PM. The reason for this increase might be the efficient use of all available resources for plant and roots because of low and continued supply of nutrients as well as more water absorption (Swarup and Yaduvanshi, 2000). Mean effect of PM indicated that highest biological yield was recorded in plot which received 125 kg ha⁻¹ P which was statistically at par with 100 kg ha⁻¹ P while lowest biological yield was recorded for 50 kg ha⁻¹ P application. Phosphorous helps in development of strong and healthy root system which results in efficient uptake of essential nutrients required for maximum dry matter production. Absence of P in control plots did not develop healthy root system to facilitate better and timely absorption of nutrients and water thus led to lower dry matter production. Significant difference was recorded in control vs rest for biological yield of wheat crop.

Grain yield (kg ha⁻¹)

Data pertaining grain yield of wheat crop as influenced by different levels of poultry manure and phosphorus are presented in

Table 2. Interaction of treatments i.e. PM and P levels remained non-significant for grain yield. When averaged across poultry manure, data indicated that highest grain yield was recorded in plot which was treated with 2 t ha⁻¹ of PM which was statistically not different with 1.5 t ha⁻¹ PM while lowest grain yield was recorded in plot which received 1 t ha⁻¹ PM. Increase in wheat grain yield with PM and P application can be attributed to more number of tillers and grains (Pedro *et al.*, 2011) and more grain weight (Masoni *et al.*, 2007). Organic materials (like PM) enhance nutrient use efficiency by slow releasing of nutrients and reducing their losses (Neuens and Reheul, 2003). The addition of organic fertilizer increases phosphorus mobilization and soil microbial activities; it might also contribute in improving nutrition as well as crop root system which all contribute to higher grain yield. Planned mean comparison for P levels showed that highest grain yield of wheat was recorded for 125 kg ha⁻¹ P level which was statistically similar with 100 kg ha⁻¹ P followed by plot which received 75 kg P ha⁻¹ while lowest grain yield was recorded in plots treated with 50 kg P ha⁻¹. This could be the result of reduced plant senescence rate at the grain filling stage and longer duration of green leaf area duration with the application of phosphorus as observed by Colomb *et al.*, (2000). Also, P application enhanced root growth and developed strong root system to absorb more nutrients and water which resulted in more grain yield. Poor root system due to no P application in control plots might be the reason for lower grain yield. Our findings are similar to those of Mengel *et al.*, (1996). Control vs rest showed significant result for grain yield of wheat crop. It can be concluded from experimental results that application of Poultry manure @ of 1.5 tons ha⁻¹ along with Phosphorus @ of 100 kg ha⁻¹ improved Phenological parameters, yield and yield components of wheat crop.

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