INT. J. BIOL. BIOTECH., 12 (1): 113-117, 2015.

EFFECTS OF PHOSPHORUS LEVELS ALONE OR IN COMBINATION WITH FARM YARD MANURE ON GROWTH, YIELD AND NUTRIENT CONTENTS OF WHEAT IN RAINFED CONDITIONS

Shamim-ul-Sibtain Shah[1], Muhammad Ali Khan[2], Muhammad Attiqulah Khan[1], Khalid Farooq[1], M. Imran[2] and Zulfiqar Ali Gurmani[2]

[1]*Farm Operations & Services Program, National Agricultural Research Centre (NARC), Islamabad*
[2]*National Institute of Organic Agriculture, National Agricultural Research Centre (NARC), Islamabad*
Corresponding e-mail: sibtainshah@yahoo.com

ABSTRACT

A trial was conducted at National Agricultural Research Centre, Islamabad to assess the effects of different combinations of phosphorus (P) fertilizer with or without farmyard manure (FYM) on growth, yield and nutrient contents of wheat during 2010-2011. The chemical and organic fertilizers were well mixed before sowing the crop. The experiment was laid out under Randomized Complete Block design (RCBD). Single super phosphate as P source (@ 20, 30, 40 and 50 kg/ha) and farmyard manure @ 20kg/ha were applied. Statistically significant differences in biological yield and grain yield were recorded. Maximum wheat grain yield of 4580 kg/ha^{-1} was obtained where phosphorus was applied @ 50 kg/ha along with FYM. Minimum grain yield and biological yield were recorded with no fertilizer. On the basis of results, it is suggested that P @ 50 kg/ha^{-1} with FYM for wheat is relatively more suitable in rainfed conditions.

Key Words: Crop; Fertilizer; Grain; Nutrient content; Phosphorus; Yield

INTRODUCTION

Wheat (*Triticum aestivum* L.) is an important and major rabi food crop of Pakistan. Its area and production is adversely affected by drought, especially in rainfed areas of the Punjab province. Wheat yield is far below than the potential yield due to many factors of which sowing time being most important. Of the total cultivated area about 1043 million hectare is under rainfed conditions, where benefits of chemical and organic fertilizers are linked with timely rainfall. Our soils are generally low in fertility due to continue cropping, inadequate use of organic and chemical fertilizers. According to (Chaudhry and Thakur, 2007), soil fertility is a vital component of technology package for increasing crop production. Wheat is currently grown on 9.0M/ ha with annual production of 23.8 Mt. The present per capita consumption of wheat is 37.5 kg per annum (G0P, 2010).

Fertilizers constitute an essential input in modern agriculture and they help in realizing high crop yields. Phosphorus is considered second major element and deficient in Pakistan soils. Wheat productivity in the rainfed region is low due to scarcity of moisture at planting, low soil fertility and inefficient practices. Soils of the region are low in soil organic matter contents that affect soil fertility and soil moisture. Application of farmyard manure (FYM) ameriolates the soil permeability. Phosphorus is considered second major element and deficient in Pakistan soils (Awaad *et al*., 2009). Phosphorus fertilizer is an expensive input and its use efficiency by crops is poor (10-25%). The application of nitrogen fertilizer in combination with phosphorus improved protein content as well as protein quality of winter wheat in comparison with only nitrogen fertilizer application. Phosphorus increase tillering and vegetative growth. It is also involved in root development and in metabolic activities especially in synthesis of protein (Tanwar and Shaktawat 2003). An adequate supply of NPK and FYM are important to promote economically viable and environment friendly inventions for sustainable agriculture. FYM is considered good source of organic matter and plant nutrients and when incorporated into the soil (Akhtar *et al*., 2011). Application of phosphorus improves various growth parameters like plant height, fertile tillers/M^2 and yield parameters like seed yield. Furthermore, the favorable effects of inorganic fertilizers (NPK) under rainfed and irrigated conditions on crop development and yield components have been reported by Iqtdar *et al*., (2006), Manna *et al*., (2005), Alvarez *et al.*, (2004), Ibrahim *et al*., (2008). Application of FYM to soil has increased crop yields, improved soil fertility, increased soil organic matter, increased microbiological activities and improved soil structure for sustainable agriculture for further years (Blair *et al*., 2005). However, the proper combination of both organic and inorganic fertilizers have better effects on crop growth, development and yield components of wheat than alone, (Manna *et al*., 2005). The objectives of this study were to assess wheat yield components and biomass through phosphorus and farmyard manure fertilizers application under rainfed conditions.

MATERIALS AND METHODS

The trial was conducted during 2011-2012 at National Agricultural Research Centre (NARC) Islamabad, Pakistan in a randomized complete block design (RBCD) with four replications having nine treatments (with untreated control) in the presence and absence of phosphorus and farmyard manure. Prior to the application of fertilizers, the composite soil samples were collected from each site and centre at a depth of 0-30 cm and analyzed for physico-chemical characteristics of soil (Table 1). The piece for land for experiment was thoroughly prepared with disk plow and cultivator. Wheat variety GA 2002 was planted by Wintersteiger wheat planter on November 20. 2011, with row spacing 25cm and seed rate of 100 kg/ha^{-1}. All the phosphorus and farmyard manure were applied one day before sowing and mixed with soil. Weeds were controlled manually. Farmyard manure was applied @ 20kg/ha. Data on various morphological and yield traits, i.e., total biomass, 1000-grain weight and grain yield were recorded. At maturity (130 days after planting), plants were manually harvested at random from central rows from each plot, to estimate plant height, total biomass / plot and grain yield / plot. Grains were taken from each plant, cleaned and weighed. Then, yield was computed on a per-hectare basis. The following treatment comparisons were made: T0 = Control, T1 = P@ 20 kg/ ha, T2 = P@ 30 kg/ha, T3= 40 kg/ha, T4 = P@ 50kg/ha, T5 = FYM @ 20 kg/ha, T6 = 20 kg/ha + FYM, T7 = 30 kg/ha P + FYM, T8 = 40kg/ha P + FYM, T9 = 50kg/ha P + FYM. Single supper phosphate was used as a source of phosphorus. The data were subjected to standard analysis of variance using MSTATC, a computer software package

Table 1. Soil characteristics of experimental field (pre-sowing).

Texture	pH	O.M. %	Olsen-p (mg kg^{-1})	Total nitrogen (%)
Sandy loam	7.78	0.95	9.66	1.94

O.M. = organic matter, and P = phosphorus

Table 2. Effect of phosphorus alone or in combination with FYM on growth and yield of wheat (GA2002).

Treatments	Root dry biomass (g/m^2)	Productive tillers/m^2	Above ground dry biomass (kg/m^2)	1000 grain weight (g)	Grain yield (kg/ha)
Control	26.5 f	214 b	1.22 d	34.1 b	3618 c
P@20kg/ha^{-1}	33.1 e	235 b	1.38 c	42.6 ab	3690 c
P@30kg/ha^{-1}	38.4 de	238 b	1.42 bc	39.8 ab	3742 c
P@40kg/ha^{-1}	39.0 cd	234 b	1.36 c	42.9 ab	3824 c
P@50kg/ha-^{1}	44.5 abc	262 b	1.44 bc	43.0 ab	3858 c
P@20kg+FYM	43.2 bcd	260 b	1.45 ab	46.3 ab	3943 bc
P@30kg+FYM	44.8 ab	255 b	1.43 bc	45.4 a	4024 bc
P@40kg+FYM	45.2 ab	272 b	1.51 bc	46.3 a	4355 ab
P@50kg+FYM	49.6 a	315 a	1.62 a	48.4 a	4580 a
LSD $_{0.05}$	**5.51**	**41.88**	**0.11**	**10.94**	**417.67**

Figures followed by similar letter in a column are not significantly different from each other at $p < 0.05$.

Table 3. Effect of phosphorus alone or in combination FYM on growth on Nitrogen and Phosphorus concentrations of wheat (GA-2002).

Treatments	Root Nitrogen %	Seed Nitrogen %	Seed Phosphorus %
Control	1.2 a	1.5 a	0.38 e
P@20kg/ha^{-1}	1.3 a	1.6 a	0.41 de
P@30kg/ha^{-1}	0.9 a	1.3 a	0.43 cde
P@40kg/ha^{-1}	1.2 a	1.7 a	0.45 bcde
P@50kg/ha-^{1}	1.3 a	1.7 a	0.49 bc
P@20kg+FYM	1.3 a	1.7 a	0.44 cde
P@30kg+FYM	1.4 a	1.7 a	0.47 bcd
P@40kg+FYM	1.15 a	1.8 a	0.52 b
P@50kg+FYM	1.6 a	1.9 a	0.59 a
LSD $_{0.05}$	1.0389	0.8507	0.0770

Figures followed by similar letter in a column are not significantly different from each other at $p < 0.05$.

RESULTS AND DISCUSSION

Growth and Yield

All the fertilizer treatments increased root dry biomass, number of tillers, above ground biomass and grain yield parameters as compared to control. Though P chemical fertilizer treatments differed among themselves in different parameters, yet were a little comparable to that when full P with FYM applied.

Root dry weight

All the fertilized treatments had significantly higher root dry biomass as compared to control. (Table 2) Highest root dry biomass (49.6g) was obtained when P@ 50kg/ha^{-1} in combination with FYM was applied, it was followed by T4, when P was applied @ 50kg/ha (46.2g) and minimum dry root weight (26.5g) was obtained in control treatment. Application of farmyard manure and P develop root system and increase in vegetative growth may be attributed to better growth of wheat crop. It might be due to more availability of nutrients due to increased levels of P, which exerted beneficial effect with farmyard manure on vegetative growth. The increase in root dry weight may be due to adequate fertilizer nutrition is explainable in terms of possible better root development and increased translocation of carbohydrates from source to growing points in well fertilized plots. Our results are in agreement with the findings of Jan *et al*., (2010), however, they worked on wheat growth with nitrogen source and application time.

Number of productive tillers

Number of tillers was highest (315) when full recommended phosphorus was applied with farmyard. Minimum number of tillers (214) was observed in control treatment (Table 2). Moreover, because of better tilleringand plant growth, significantly higher numbers of tillers with P full fertilizer application with or without farmyard manure were observed. Application of full fertilizer P with FYM had maximum number of wheat tillers in the trial. This may be attributed to improvement of better vegetative growth. The increase in number of tillers with the increase in phosphorus levels with organic source can be attributed to the reduction in mortality of tillers and enabling the production of more tillers from the main stem. It might be due to role of P and FYM in metabolic activities, high root growth and increased up-take of nutrients. Previously, it was studied that FYM enhanced nutrient use efficiency by slow releasing of nutrients and reducing their losses (Muneshwar et al, 2001), the results were also in accordance (Jan and Noor, 2007)

1000-grain weight

Significant effect of the treatments was recorded on 1000-grain weight but all the treatments performed at par except control (Table 2). Maximum 1000-grain weight was produced (48.68g) by T9 treatment, where full P (50kg/ha^{-1} + FYM) was applied. This was followed by T4, where full P @ 50kg/ha^{-1}was the next best treatment, which produced 1000-grain weight (46.62g).Lowest 1000-grain weight (37.46) was recorded in control. Our results

are confirmed by the findings of Majumdar *et al*., (2007) however, they concluded that N with or without FYM significantly increased 1000-grain weight. Favorable effect of organic and inorganic fertilizers on 1000-grain weight may be due to the increased availability of plant nutrients, improvement of soil water holding capacity and reduction of volatization of nitrogenous fertililizerstoNH3 gas (Khan *et al*., 2009).

Total biomass (kg ha^{-1})

Significant biomass weights of different treatments were recorded and all the treatments performed at par expect control (Table 2). Maximum total biomass was produced (1.64kg) by T9 treatment, where full P (50kg/ha^{-1} + FYM) was applied, while minimum biomass weight (1.22kg) was recorded in control treatment. Non-significant difference was recorded among different treatments of phosphorus @ 20kg to 40kg, but these treatments also performed at par expect control. Due to better plant growth, application of fertilizer P with or without FYM significantly increased the biological yield of wheat crop in comparison with no fertilizer control and only FYM application. The findings were in confirmation with Shah and Ahmad (2006), who reported significant increase in the biological yield of wheat with the application of chemical fertilizer in combination with FYM.

Grain yield (kg/ha^{-1})

Data regarding grain yield/ha is presented in Table 2. The data showed that all the treatments produced significantly higher grain yield than control and because of better tillering and plant growth, significantly higher grain yield with full P fertilizer application with and without FYM were observed. Application of full fertilizer with FYM had maximum wheat grain yield (4894kg/ha^{i}) in the trial while minimum grain yield (3612kg/ha^{-1}) was recorded in control plots. These results are in line with the findings of Ibrahim et al., (2008).They reported that farmyard manure and different levels of compost have significantly increased wheat grain yield due to the improved soil physical conditions, enhanced soil fertility and improved stand establishment. On the other hand, application of FYM only and no fertilizer treatment had lower wheat grain yield that could be attributed to deficiency of required plant nutrients to wheat in these plots. Our results are in line with (Amanullah *el al*., 2010), however they worked on maize.

Nitrogen and Phosphorus content (%)

Root N, Seed-N also showed no significant variation with treatments (Table 3). Seed phosphorus, however increased significantly in 40 and 50 kg P/ha^{-1} + FYM treatment. Highest percentage grain nitrogen (1.9%) and phosphorus (0.61%) of grain was recorded when P@ 50kg/ha^{-1} was applied with farmyard manure. (Brown and Petrie, 2006), however, they worked out that improvement in crop yield nutrient accumulation is due to rhizospheric microorganisms.

Lesser percentage of grain nitrogen and higher root nitrogen on application of phosphorus with farmyard manure may be attributed to lowered mobilization of N from root to grain.

Highest grain phosphorus (0.61%) was recorded when 50 kg P was applied with farmyard manure. All the phosphorus and farmyard manure treatments increased grain phosphorus percentage were at par with control treatment. Increased seed P content has been reported by organic fertilizers by (Iqtdar *et al*., 2006).

Conclusion

It is recommended that Phosphorus fertilizer in combination with FYM may be used for yield enhancement of wheat in rainfed conditions.

REFERENCES

Akhtar N. A. Ali, Z. Ali, J. Iqbal, M.A Nadeem and A. Sattar (2011). Effects of integrated use of organic manures and inorganic fertilizers on grain Yield of Wheat. *J. Agri. Res.*, 49: 181-186.

Alvarez, R.H., S. Steimbach, S.M. Grigera, E. Cartier, G. Obregon. S. Torri and Farcia (2004). The balance sheet method as a conceptual framework for nitrogen fertilization of wheat in Pampeanagroecosystem. *Agron.* J., 96: 1050-1057.

Amanullah, M Asif and K Nawab (2010). Impacts of planting density and P-fertilizer source on the growth analysis of maize. *Pak. J. Bot*., 42: 2349-2357

Awaad, M.S., A.R. Azza and M.A Bayoumi (2009). Effect of farmyard manure combined with some phosphate sources on the productivity of canola plants grown on a sandy soil. *Re. J. Agric.Bio. Sci*., 5 (6): 1176-1181.

Blair. N.R., D. Faulkner, A.R. Till and P.R Poulton (2005). Long-term management impacts on soil C, N and physical fertility. *Soil and Tillage Res.*, 91: 30-38.

Brown, B.D. and S. Petrie (2006). Irrigated hard winter wheat response to fall, spring late season applied nitrogen. *Field Crops Res*., 96: 260-268.

Chaudhary, S.K. and R.B Thakur (2007). Efficient farm yard manure management for sustained productivity of rice-wheat cropping system. *Ind. J. Agri. Sci*., 77: 443-444.

G0P. (2010). *Economic survey of Pakistan*. Finance Division, Government of Pakistan, Islamabad.

Ibrahim, M., Anwar-ul-Hassan, M Iqbal and E.E .Valeem (2008). Response of wheat growth and Yield to various levels of composts and organic manure *Pak. J. Bot*., 40 (5): 2135-2141.

Iqtidar, H., K.M. Ayyaz and K.E. Ahmad (2006) Bread wheat varieties as influenced by different nitrogen levels. *J. Zhejiang Univ. Sci*., 7: 70-78.

Jan, M.T., M J. khan, A. khan M. Arif, M. Shafi and Farmanullah (2010). Wheat nitrogen indices response to nitrogen source and application time. *Pak. J. Bot*., 42(6): 4267-4278.

Jan A. and M. Noor (2007). Response of wheat to farm yard manure and nitrogen under rainfed conditions. *African Crop. Sci. Conf. Proc*., 8: 773-777.

Khan, A., M.T. Jan, K.B. Marwat and M Arif (2009). Organic and inorganic nitrogen treatments effects on plant and Yield attributes of maize in a different tillage systems. *Pak. J. Bot.*, 41(1): 99-108.

Majumdar, B., M. S. Venkatesh, K.Kumar and Patiram (2007). Effect of rock phosphate, superphosphate and their mixtures with FYM on soybean and soil- P pools in typic hapludalf of Meghalaya. *J. Indian Society of Soils Sci*., 55(2): 167-174.

Manna, M.C., A. Swarup, R.H. Wanjari, H.N. Ravanker, B. Mishra, M.N. Saha, Y.V. Singh, D.K. Sahi and P.A. Swarp (2005). Long-term effect of fertilizer and manure application on soil organic carbon storage, soil quality and yield sustainability under sub-humid and semi-arid tropical India. *Field Crops Res*., 93: 264-280.

Muneshwar, S., V.P. Sing, K.S. Reddy and M. Sing (2001). Effect of integrated use of fertilizer nitrogen farmyard manure or green manure on transformation of N, K and S and productivity of rice-wheat system on a vertisol. *J. Ind. Soc. Soil Sci*., 49: 430-4

Shah, Z. and M.I. Ahmad (2006). Effect of integrated use of farmyard manure and urea on yield and nitrogen uptake of wheat. *J. Agric. Biol. Sci*. 1: 60-65.

Tanwar.S.P.S and M.S.Shaktawat (2003. Influence of phosphorus sources levels and solubilizers on yield, quality and nutrient up-take of soybean (Glycine max) -Wheat (*Triticum- aestivum*) cropping systemin southern Rajasthan. *Indian J. Agric. Sci.*, 73: 3–7

(*Accepted for publication November 2014*)