American-Eurasian J. Agric. & Environ. Sci., 15 (12): 2461-2465, 2015
ISSN 1818-6769

DOI: 10.5829/idosi.aejaes.2015.15.12.12814

Response of Irrigated Wheat to Various Levels of Nitrogen and Phosphorus in Peshawar Valley

[1]*Ishaq Ahmad,* [1]*Yousaf Jamal,* [1]*Muhammad Ibrahim,*
[2]*Haji Muhammad,* [1]*Mukhtar Alam,* [1]*Inayat-ur-Rahman and* [1]*Hidayatullah*

[1]Department of Agriculture, University of Swabi, Khyber Pakhtunkhwa, Pakistan
[2]Department of Agriculture Extension, Malakand, Khyber Pakhtunkhwa, Pakistan

Abstract: To find out response of irrigated wheat to various levels of nitrogen and phosphorus in Peshawar valley, a field trial was conducted at Cereal Crop Research Institute, Pirsabak, Nowshera Pakistan, during 2013-14. Four levels of nitrogen and phosphorus in 2:1 were used. Various levels of NP (kg ha^{-1}) used were 90:45, 120:60, 150:75 and 180:90. Experiment was laid down in randomized complete block design with three replications having a plot area of 9 m^2 (5x1.8 m), having 6 rows 30 cm apart was used. All other agronomic practices were kept uniform for all plots. Different NP levels significantly affected all the noted parameters, except emergence m^{-2}. Days to anthesis, days to physiological maturity and plant height at maturity, significantly increased with increasing NP application. Highest NP level of 180:90 (kg ha^{-1}) took more days to heading (125 days) as compared to lowest NP level (90:45) which took 118 days. More days to physiological maturity (157) were observed for highest NP level (180:90), while least days to physiological maturity (148) were noted for lowest NP level (90:45). Highest level of NP application (180:90) produced taller plants (97 cm) as compared to lowest NP level (90:45) which produced dwarf plants (93 cm). Biological yield, grains $spike^{-1}$, thousand grain weight and grain yield were increased with increasing NP level up to 150:75 (kg ha^{-1}) and then decreased at highest level (180:90) of NP. Application of 150:75 (NP, kg ha^{-1}) produced 14.2% and 9.1% more biological and grain yields (14907 and 5533 kg ha^{-1}, respectively) as compared to lowest NP levels of 90:45 (1356 and 5070kg ha^{-1}, respectively). Grains $spike^{-1}$ and thousand grain weight were highest (48 and 47.7g, respectively) for NP application of 150:75 (kg ha^{-1}) while lowest (42 and 43.3g, respectively) for lowest NP application of 90:45 (kg ha^{-1}). Based on the experimental results, it was concluded that 150:75 (kg ha^{-1}) is the optimum level of nitrogen and phosphorus for optimum wheat productivity in Peshawar valley.

Key words: Nitrogen · Irrigated · Yield · Phosphorus · Peshawar

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop in the world with its unique protein characteristics that serves as an important source of food and energy [1] and the major staple food of the inhabitants of Pakistan [2, 3, 4]. Being a main staple food of rapidly increasing population of Pakistan, wheat occupies central position in agriculture policies of the country. Wheat is the basic component of human diet especially in Indo-Pakistan. It plays an important role in the national economy. Decrease in wheat production severely affects the economy of Pakistan and adds into the miseries of the people. Average yield of wheat in Pakistan has never crossed 30-35% of its yield potential produced under experimental conditions [5]. Wheat is cultivated on 37% cropped area of the country in which the contribution of Punjab is 77%, Sindh is 11%, Khyber Pakhtunkhwa is 9% and Baluchistan is 4%. The prosperity of Pakistan depends directly or indirectly on 9.096 m ha^{-1} with 24.0329 m tons production. With an average yield of 2657 kg ha^{-1} in irrigated areas and 1565 kg/ha in rainfed areas [6].

Increasing population, water logging and salinity are converting the arable land into non-agricultural uses [7] and these are considered as main obstacles to modern agriculture and ultimately affecting crop productivity. Moreover, population is increasing in the geometric ratio, while crop productivity increase is in arithmetic ratio [8]. Therefore there is a dire need to improve vertical crop

Corresponding Author: Muhammad Ibrahim, Department of Agriculture, University of Swabi, Khyber Pakhtunkhwa, Pakistan.

productivity rather than longitudinal increase. The vertical increase can be obtained by cultivating high yielding genotypes endowed with better agronomic practices and adequate package of production technology. Agronomic practices share is 70-80% in the discipline of crop productivity.

Wheat being the staple food occupies about 37% of the cropped area and consumes 45% of the total fertilizer used in the country. However, it remained stagnant for the last many years [9]. Land used for crop production in Pakistan is approximately 22 million hectares that is mostly calcareous in nature. About 90% soils are deficient in nitrogen (N) and phosphorus (P) and 40% in potassium [10]. Among the factors that influence wheat yield, fertilizers play an important role. Application of phosphates fertilizer in balanced proportion at proper time and method of application had a great impact on crop yield [11, 12]. However, plant species and even varieties within species vary in their behavior to acquire and utilize phosphorus for grain production. This property of wheat cultivars grown in Pakistan has not been fully explored. In solution culture study of some wheat varieties were found differ in P acquisition [13]. Similarly in another field study differences in P utilization efficiency among wheat variety were reported [14]. Comparison of wheat varieties to fertigation applied P sources showed some variation among varieties for yield and P fertilizer efficiency [11]. The soils of Pakistan having calcareous alkaline nature are generally deficient in P. Plant nutrition is the science that studies the effect of elements on plant growth and development, determines the forms and conditions of availability and uptake and establishes the ranges of beneficial and detrimental effects [15]. Among the mineral elements, nitrogen (N) is one of the major plant nutrient applied in the form of chemical fertilizers. It is essential for formation of amino acids, the building blocks of proteins [16]. Phosphorus is another essential plant mineral involved in formation of nucleic acid, phosphorus and ATPs [17]. Phosphorus counter balances the effect of excessive nitrogen by hastening plant maturity, improving grain quality and retarding excessive vegetative growth [18]. When the soil is deficient in phosphorus, the response of crop to nitrogen would also be reduced [19, 20]. However, the judicious use of these elements in the form of fertilizers can increase yield from 30-47% [21].

The present study was therefore, planned to investigate the optimum and balance doses of nitrogen and phosphorus using wheat as test crop.

MATERIALS AND METHODS

A field experiment entitled “Response of irrigated wheat to various levels of nitrogen and phosphorus” in Peshawar valley was conducted at Cereal Crop Research Institute (CCRI) Pirsabak, Khyber Pakhtunkhwa, Pakistan during November 2013-14. The experiment was conducted in Randomized Complete Block Design (RCBD) with three replication having plot area of 1.8m × 5 m. Each plot was consisted of six rows each of 5m length and a row spacing of 30 cm. Wheat variety Pirsabak-2013 was sown at a uniformed seed rate of 100 kg ha^{-1}. Four levels of nitrogen and phosphorus were used in 2:1 90:45, 120:60, 150:75 and 180:90 kg ha^{-1}. All the phosphorus and half of nitrogen were applied at sowing time. The remaining half nitrogen was applied with first irrigation after three weeks of sowing. All the agronomic practices were applied uniformly throughout the experiment.

The data were recorded on emergence m^{-2}, day to anthesis, day to physiological maturity, plant height (cm), productive tillers m^{-2}, grains $spike^{-1}$, biological yield (kg ha^{-1}), 1000 grains weight (g), grain yield (kg ha^{-1}). Data recorded were statistically analyzed by computer software Statistics 8.1. Means were separated using least significant difference (LSD) test.

RESULTS AND DISCUSSION

Emergence m^{-2}: Data regarding emergence m^{-2} of wheat are presented in Table 4.1. Statistical analysis of data revealed a non-significant ($P>0.05$) effect of different levels of phosphorus and nitrogen on emergence m^{-2} of wheat crop. The data showed highest emergence m^{-2} (21.8) for 120:60 (kg ha^{-1}) NP applications, while the lowest emergence m^{-2} (18.4) was observed by applying of 90:45(kg ha^{-1}) NP. Our results are in line with the findings of Ghosh *et al*. [22], who reported an increase was obtained in tillers m^{-2} for phosphorus primed wheat seed.

Days to Anthesis: Data relating days to anthesis of wheat are shown in Table 4.1. Statistical analysis of the data showed that different levels of NP had significantly ($P\leq 0.05$) affected days to anthesis. Increase in NP application linearly increased days to anthesis. The highest days to anthesis (125) were observed for 180:90 (kg ha^{-1}) NP applications. While, the lowest days to anthesis (118) were recorded in plots received 90:45 (kg ha^{-1}) NP. Our results are in contrast with the conclusions of Tahir *et al*. [20], they reported that optimum amount of phosphorous minimized days of plant growth.

Table 4.1: Emergence m^{-2} days to anthesis, days to physiological maturity, plant height (cm) and Productive tillers m^{-2} of wheat as affected by different NP levels

N:P (kg ha^{-1})	Emergence m^{-2}	Days to anthesis	Days to physiological maturity	Plant height (cm)	Productive tillers m^{-2}
90:45	18.4	118 d	148 d	93 c	303 a
120:60	21.8	120 c	151 c	94 c	285 a
150:75	20.9	122 b	154 b	95 b	262 b
180:90	18.7	125 a	157 a	97 a	287 a
LSD ($P \leq 0.05$)	Ns	1.8	1.2	1.3	20.1

Mean values of the same category followed by different letters are significant at $P \leq 0.05$ level.

Table 4.2: Biological yield (kg ha^{-1}), Grains $spike^{-1}$, 1000 grain weight (g), grain yield (kg ha^{-1}) and Harvest index $(\%)^2$ of wheat as affected by different NP levels

N:P (kg ha^{-1})	Grains $spike^{-1}$	1000 grains weight (g)	Biological yield (kg ha^{-1})	Grain yield (kg ha^{-1})
90:45	22 c	43.3 c	13056 d	5070 b
120:60	44 b	45.5 b	14259 b	5267 ab
150:75	48 a	47.7 a	14907 a	5533 a
180:90	41 c	42.8 c	13611 c	4698 c
LSD ($P \leq 0.05$)	1.3	1.3	408.76	328.7

Mean values of the same category followed by different letters are significant at $P \leq 0.05$ level

Days to Physiological Maturity: Data pertaining days to physiological maturity of wheat are shown in Table 4.2. Statistical analysis of the data indicated that various N and P levels had affected day to physiological maturity significantly ($P \leq 0.05$). The maximum days to physiological maturity (157) were recorded by applying 180:90(kg ha^{-1}) NP. While, the minimum days to physiological maturity (148) was recorded by applying of 90:45(kg ha^{-1})NP. These findings are supported by the Khan [23] and Gill and Sindhu [24], who reported that enhanced day to maturity in wheat plants with higher amount of phosphorus.

Plant Height (cm): Data presented in Table 4.1 indicated that plant height (cm) of wheat at maturity. Statistical analysis of the data showed that different levels NP had significantly ($P \leq 0.05$) affected plant height (cm) at maturity. Increased NP application linearly increased plant height at maturity significantly. The highest plant height (97cm) was recorded by applying NP at the are of 180:90 (kg ha^{-1}), while the lowest (93cm) was observed by applying NP at the rate 90:45 (kg ha^{-1}). These findings are supported by Khan *et al*. [25], who reported that wheat plant height was increased with increasing the application of N and P_2O_5.

Productive Tillers m^{-2}: Data pertaining productive tillers m^{-2} of wheat are presented in Table 4.1. Statistical analysis of the data showed that different levels NP had significantly ($P \leq 0.05$) affected productive tillers m^{-2} of wheat. The maximum productive tillers m^{-2} (303) was recorded for 90:45(kg ha^{-1}) NP applications. While, the minimum productive tillers m^{-2} (262) was observed by applying of NP at the rate of 150:75 (kg ha^{-1}). These findings are in line with those obtained by Alam *et al.* [26], who found that with increasing single super phosphate (SSP) level from 0 to 150 mg P kg^{-1} of soil significantly increased number of productive tillers $plant^{-1}$ and grain yield over the control treatment.

Grains $Spike^{-1}$: Data regarding grains $spike^{-1}$ of wheat are presented in Table 4.2. Statistical analysis showed a significant ($P \leq 0.05$) effect of different NP levels had on grains $spike^{-1}$. A consistent increase in grains $spike^{-1}$ was observed with increasing NP application up to 150:75 (kg ha^{-1}) and further increase resulted in a decrease of grain $spike^{-1}$. The highest grains $spike^{-1}$ (48) was recorded for 150:75 (kg ha^{-1}) NP applications, while the lowest (41) was recorded for 180:90 (kg ha^{-1}) NP applications. Successive increase in P_2O_5 at each level of N showed a tendency to increase in number of grains per spike indicating the effectiveness of P_2O_5 towards seed formation and grain filling [27].

1000 Grains Weight (g): Data pertaining 1000 grains weight of wheat are shown in Table 4.2. Statistical analysis of the data indicated that different NP levels had significantly ($P \leq 0.05$) affected 1000 grains weight of wheat. Increase in NP application till 150:75 (kg ha^{-1}) consistently increased 1000 grains weight. The highest 1000 grains weight of wheat (47.7 g) was observed for 150:75 (kg ha^{-1}) of NP applications, while the lowest (42.8) was recorded with 180:90 (kg ha^{-1}) NP application. These results are in agreement with the finding of Brennan [28] and Samad [29], who reported that maximum NP fertilizer utilization resulted in highest yield due to maximum accumulation of photosynthesis.

Biological Yield (kg ha^{-1}): Data regarding biological yield (kg ha^{-1}) of wheat are shown in Table 4.2. Statistical analysis showed that different levels of NP had significantly ($P \leq 0.05$) affected biological yield (kg ha^{-1}). The highest biological yield (14907 kg ha^{-1}) was noted for 150:75 (kg ha^{-1}) NP applications, while the lowest (13056 kg ha^{-1}) was recorded for 90:45 (kg ha^{-})^{1} NP applications. Mean value of the data showed that increase in NP application consistently increased biological yield kg ha^{-1}. The better growth and higher biological yield with increasing N levels can be attributed to the most important functions of the N in enhancing the vegetative growth [16]. Phosphorus seemed to have an additive effect on crop growth provided it was supplied in a balanced proportion to that of applied N [30].

Grain Yield (kg ha^{-1}): Data regarding grain yield of wheat are presented in Table 4.2. Statistical analysis showed that different NP levels had significantly ($P \leq 0.05$) affected wheat grain yield. Increase in NP application linearly increased grain yield till the application of 150:75 NP (kg ha^{-1}) and after that a decline was noted. The highest grain yield (5533 kg ha^{-1}) was observed with 150:75 (kg ha^{-1}) NP applications, while the lowest (4698 kg ha^{-1}) was recorded by applying of 180:90 (kg ha^{-1}) NP. Further increase in NP beyond 150:75 kg ha^{-1} resulted in decline of grain yield. Increase in grain yield with increasing NP application might be an outcome of more NP availability for plant growth which resulted in more grains spike^{-1} and thousand grain weight that resulted in an increase in grain yield. This finding is supported by the findings of Batten *et al*. [31], who found that high-yield winter wheat varieties had high requirements with regard to phosphorus; hence this plant should be cultivated on soils rich in phosphorus or else adequately supplemented with high rates of this element. And this finding is also supported by [32]. They reported that nitrogen alone caused variable increase in yield but addition of phosphorus to different levels of nitrogen resulted in further significant yield increase.

CONCLUSIONS AND RECOMMENDATION

Various growth and yield parameters were significantly influenced by different N:P levels (kg ha^{-1}). Among the four application, (150:75 NP kg ha^{-1}) showed maximum values for grains spike^{-1} (48), biological yield (14907 kg ha^{-1}), 1000 grain weight (47.7 g) and grain yield (5533 kg ha^{-1}). Similarly application of NP at the rate of 180:90 kg ha^{-1} resulted in maximum days to anthesis (125), day to physiological maturity (157) and plant height (97 cm).

From the above conclusions, NP application at the rate of 150:75 kg ha^{-1} is recommended for maximum yield and yield components of irrigated wheat crop at Peshawar valley.

REFRENCES

1. Tunio, S.D., M.N. Korejo, A.D. Jarwar and M.R. Waggan, 2006. Studies on indigenous and exotic weed competition in wheat. Pak. J. Agric. Boil., 5(4): 1-8.
2. Chaudhary, M.H., S. Hussain, S.B. Khan, F. Hussain and J. Anwar, 1999. Food requirements of Pakistan in the first decade of 21’’ century –Role of wheat research in Punjab. Science Technology and Development, 18(2) April-June.
3. Anonymous, 2005. Agriculture: Economic survey of Pakistan, Ministry of finance. Government of Pakistan, pp: 9-20.
4. Malik, M.A., M. Irfan, Z.I. Ahmed and F. Zahoor, 2006. Residual effect of summer grain legumes on yield and yield components of wheat (*Triticum aestivum* L.) Pakj. Agri, Eng. Vet. Sci., 22(1): 9-11.
5. Iqbal, N.B.K., A. Maqbool and A.A. Shohab, 2005. Use o f the ARIMA Model for forecasting wheat Area and Production in Pakistan J. Agric. Soc Sci., 1(2): 120-122
6. Minfal, 2010. Agric. Stat. Pakistan. Govt. of Pakistan. Min. of Food, Agric. And Livest, Economic Wing, Islamabad, pp: 45-46.
7. Alam, M.M. and M.H. Khan, 1999. Yield attributes, yield and harvest index of three irrigated rice varieties under different levels of phosphorus. Advan. Biolog. Res., 3(4): 132-139.
8. Khan, P., M. Imtiaz, M. Aslam, S.K.H. Shah, N.M.Y. Memon and S. Siddiqui, 2010. Effect of different nitrogen and phosphorus ratios on the performance of wheat cultivar 'khirman. Sarh. J. Agric., 24(2): 13-19
9. Twyford, I.T., 1994. Fertilizer use and crop yields In: Proc. 4th Nat Cong Soil Sci, Islamabad, pp: 47-71.
10. Ahmad, N. and M. Rashid, 2004. Fertilizer and their use in Pakistan. Govt. of Pakistan. Planning and Development Div. NFDC. Islamabad.

11. Alam, S.M., S.A. Shah, A. Latif and Z. Iqbal, 2002. Performance of some wheat varieties to fertigation applied phosphorus sources. Pak. J. Soi. Sci., 11(2): 123-125.
12. Nisar, A., M.T. Saleem and I.T. Twyford, 1992. Phosphorus research in Pakistan - a review. In: Proceeding of symposium, On the role of phosphorus in crop production, NFDC Islamabad, pp: 59-92.
13. Nisar, A., M.T. Saleem and I.T. Twyford, 1992. Phosphorus research in Pakistan - a review. In: Proceeding of symposium "On the role of phosphorus in crop production" NFDC, Islamabad, pp: 59-92.
14. Covacevich, H.E. Echeverria and L.A.N. Aguirrezabal, 2007. Soil available phosphorus status determines indigenous mycorrhizal colonization into field and glasshouse grown spring wheat in Argentina. Appl. Soil Ecol., 35: 1-9.
15. Rasheed, M., A. Hakoomat and T. Mahmood, 2004. Impact of nitrogen and Sulphur application on growth and yield of maize (*Zea mays* l.) crop. J. of Res. Sci., 15(2): 153-157. Bahauddin Zakariya University, Multan, Pakistan.
16. MA, B.L., W. Yan, L.M. Dwyer, J. Fregeau-Reid, H.D. Voldeng, Y. Dion and H. Nass, 2004. Graphic analysis of genotypes, Environment, Nitrogen Fertilizer and their interaction on spring wheat yield. Agron. J., 96: 169-180.
17. Schachtman, D.P., R.J. Reid and S.M. Ayling, 1998. Phosphorus uptake by plants: from soil to cell. Plan. Physiol., 116: 447-453.
18. Theodorou, M.E. and W.C. Plaxto, 1993. Metabolic adaptations of plant respiration to nutritional phosphate deprivation. Plan. Physiol., 101: 339-344.
19. Tahir, M.A. and M. Bajwa, 1968. Effect of different levels of P2O5 on the yield of wheat varieties sown in green manured field. Res. Studies West Pakistan Agric University Lyallpur, 1: 3-9.
20. Tahir, M.A. and M. Bajwa, 1968. Effect of different levels of P2O5 on the yield of wheat varieties sown in green manured field. Res. Studies West Pakistan Agric University Lyallpur, 1: 3-9.
21. Pervez, K., M. Imtiaz, M. Aslam, S.K.H. Shah, M.Y. Memon and S.H. Siddiqui, 2008. Effect of different nitrogen and phosphorus ratio on the performance of wheat cultivar Khirman. Sarhad J. Agric., 24(2): 233-239.
22. Ghosh, D.C., B.P. Mandal and G.C. Malik, 1997. Growth and yield of wheat (*Triticum asetivaum* L.) as influenced by fertility level and seed-soaking agrochemicals. Indian J. Agric. Sci., 67(4): 144-146.
23. Khan, S., 1985. Effect of different levels of nitrogen and phosphate application on straw yields, days to maturity, germination and plant, height of blue silver. Sarh. J. Agric., 1: 39-41.
24. Gill, A.M.S. and Sindhu, 1983. Study of agronomic factor affection the component of wheat. Pak. J. Agric. Res., 2: 1-5.
25. Khan, P., M. Imtiaz, M.Y. Memon and M. Aslam, 2009. Response of wheat genotype 'MSH-14' to different levels/ratios of nitrogen and phosphorus. Sarh. J. Agric., 25(1): 59-64.
26. Alam, S.M., S. Azam, S. Ali and M. Iqbal, 2003. Wheat yield and P fertilizer efficiency as influenced by rate and integrated use of chemical and organic fertilizers. Pak. J. Soil Sci., 22(2): 72-76.
27. Kaishtha, B.P. and B.C. Marwahs, 1977. Response of Sonalika wheat to graded doses of P in acid soils of different available P status at Palampur. Fert. Tech. Indi., 14: 235-239.
28. Bhatti, A., U.A. Bakhsh and A.H. Gurmani, 1985. Effect of nitrogen and phosphorus 01\1 the Brennan, R.F. 1992. Effect of super Phosphate and N on yield of wheat. Fert. Res. 31(1): 43-49 (Field Crop Absts, 46(3): 1991-1993 Soil and Fert. 56 (5):5188:1993).
29. Samad, A., 1984. Developing a co-efficient of cost benefit ratio for wheat on fertilizer receptive soils. M.Sc Thesis, Agron. Dept. Univ. of Agric. Faisalabad.
30. Brink, G.E., G.A. Peterson, K.R. Sistani and T.E. Fairbrother, 2001. Uptake of selected nutrients by temperate grasses and legumes. Agron. J., 93: 887-890.
31. Bateen, G.D., M.A. Khan and B.R. Cullis, 1984. Yield responses by modern wheat genotypes to phosphate fertilizer and their implications for breeding. Euphytica, 33: 81-89.
32. Gandapur, M.A.K. and A. Bhatti, 1983. Effect of nitrogen and phosphorus level on the yield of wheat cultivar Pak. J. Agric. Res., 4(3).