Optimization of Wheat (*Triticum aestivum* L.) Yield Relativities via Varying Levels of Potassium and Planting Geometry

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Abstract: Wheat (*Triticum aestivum* L.) is regarded as staple food in most of Asian countries regardless of their economic or social status including Pakistan. Being its utmost importance, wheat crop is grown in varied geographic zones of the world with different factors effecting yield of the crop comprising nutritional and planting geometry aspects. For this regard, a field experiment was conducted to investigate the effect of different nutritive element levels such as potassium with ranges of (0, 50, 100, 150 and 200 kg ha^{-1}) and planting geometry (broadcast and line sowings with 22.50 cm and 11.25 cm) with growth and yield associations of wheat. Different yield components like No. of fertile tillers (m^{-2}), Spike length (cm), Number of grains/spike and 1000-grain weight (g) were significantly increased by increasing potassium levels. Planting geometry did not influence on yield components. The crop fertilized with 100 kg Potassium ha^{-1} gave higher grain yield (5.48 t ha^{-1}) with reference to grain yield parameter of planting geometry.

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Introduction

Wheat is leading food grain of people of Pakistan and occupying largest area under this single crop. The future prosperity and economic stability of Pakistan mainly depends upon the quantum of material resources and their judicious exploitation and utilization. The population of Pakistan is increasing at an alarming rate while the rate of increase in food production is too low to meet its rapidly increasing demand. Therefore, there is a dire need for advanced planning and research to increase food production and improve quality in order to meet the needs of ever-increasing population. Wheat contributes in agriculture value added is 10.0 percent and 2.1 percent in Gross domestic product. Wheat is sown an area of 9180 thousand hectares and its annual production is 25.478 million tons (Govt. of Pakistan, 2015).

Despite higher yield potential, average grain yield of wheat is much less than most of the countries of the world. China, the world`s largest producer, is also the world largest wheat importer, averaging more than 10 million tons annually since 1980 (CIMMYT, 1996). There are many factors such as delay sowing, traditional methods of sowing and imbalanced fertilizer use that cause the reduction of wheat yield in Pakistan. Precise fertilizer use as per soil and cultivar's need is one of the great importance to increase fertilizer use efficiency. Use of low levels of K and intensive cultivation of high yielding varieties have enhanced crop and soil demand for K. As potash is released slowly from the soil minerals, so it did not meet requirement of high yielding crops (Iftikhar *et al.*, 2010; Baber *et al.*, 2011). The fixation process of potash with k with minerals is very fast, whereas the released of fixed K is very slow due to strong binding force present between K and clay minerals (Oborn *et al.,* 2005). Potassium decreases the attack of leaf rust on wheat varieties which are susceptible to leaf rust, so ultimately it increases yield and quality of wheat (Sweeney *et al.*, 2000). Plants internal resistance can be increased by increasing the supply of potash and its contents in plants (Huber and Graham, 1999). The present study was conducted to assess the role of different levels of potassium under varying planting geometry in wheat.

Materials and Methods

To assess the growth and yield of wheat to different levels of potassium under varying planting geometry, a field study was conducted at Students Farm, Department of Agronomy, University of Agriculture, Faisalabad during the year 2014-15. The experiment was comprised of five potassium levels 0, 50, 100, 150, 200 kg ha^{-1} with three plant spacing (broadcast, line sowing at 22.50 cm and line sowing at 11.25 cm spacing). Muriate of Potash (60% K_2O) was used as a potassium source. Nitrogen and phosphorous was applied @ 150 and 100 kg ha^{-1}, respectively, in all treatment. Replicated three times, the experiment was laid out in split plot design randomizing the planting geometry was in main plots and potassium levels in sub plots. The net plot size was maintained as 6 m × 2.25 m**.** The potassium was applied at different levels in the various treatments at the time of sowing. Whole the phosphorous and potassium (K) with half nitrogen was applied at sowing time while subsequent amount of N was given with first irrigation. First irrigation was applied after 23 days post sowing. Data on yield and yield components were recorded and analyzed statistically using Fisher analysis of variance techniques and differences among the treatment means were compared using Least Significant Difference (LSD) test at 5% probability level (Steel *et al*., 1997).

Results and Discussion

Number of fertile tillers (m^{-2})

Crop yield mainly depends upon many yield contributing components among them number of fertile tillers are very important because higher the number of fertile tillers m^{-2} higher will be the final yield of the crop (table 1).Data regarding number of fertile tillers (m^{-2}) show that different potassium levels have significant effect while planting geometry have non-significant effect on number of fertile tillers (m^{-2}). Among different levels of potassium, maximum number of fertile tillers (m^{-2}) (265.56 m^{-2}) was observed where potassium was applied at the rate of 50 kg ha $^{-1}$ followed by control, followed by 200 kg ha $^{-1}$ while minimum (228.33 m^{-2}) were observed in 150 kg ha^{-1}. Interaction of potassium levels with plant spacing was also non-significant. These results are in agreement with the work of (Hussain *et al*., 2002). They concluded that application of potash fertilizer significantly affected the total number of tillers of wheat. This might be due to proper nutrition availability which enhanced vegetative growth of the plants (Maqsood *et al*., 1999). These results are in line with (Malik *et al*., 1990); (Ali and Yasin., 1991); (Khaliq *et al*., 1999); (Tahir *et al*., 2008) and (Abbas *et al*., 2013) who reported that number of tillers was higher when crop is fertilized with potassium.

Spike length (cm)

The length of spike also determines the productivity of wheat crop which ultimately contributes wheat yield. Data regarding number of spike length show that different potassium levels have significant effect while planting geometry have non-significant effect on spike length. Among the potassium levels, the maximum spike length. As regards levels of potassium, maximum spike length (994 cm) was observed where potassium was applied at the rate of 150 kg ha $^{-1}$ followed by 100 kg ha $^{-1}$, followed by 200 kg ha $^{-1}$ while minimum (8.95 cm) were observed in control. Interaction of potassium levels with plant spacing was also non-significant. These results can be line with of Wakeel *et al.,* (2002) and Abbas *et al.* (2013). They concluded that spike length is significantly increased by potassium application.

Number of grains per spike

Data regarding number of grains per spike showed that planting geometry of wheat have non-significant effect on number of grain per spike and potassium levels have significant effect in table 1. Among the potassium levels, the maximum number of grain per spike (56.48) was observed where potassium was applied at the rate of 150 kg ha $^{-1}$ followed by 100 kg ha $^{-1}$, followed by 200 kg ha $^{-1}$ while minimum (44.75) were observed in control. Interaction of potassium levels with plant spacing was also non-significant. All potash levels produced significantly higher number of grains over control. These results relates with finding which is reported by (Gwal *et al*., 1999); (Maqsood *et al*., 1999) and (Abbas *et al*., 2013).

1000-grain weight (g)

The weight of grains is an important yield contributing component and make a major contribution towards grain yield of wheat. Data regarding 1000-grain weight is affected by planting geometry and different levels of potassium are presented in table 1. Data regarding 1000-grain weight showed that planting geometry of wheat has non-significant effect on 1000-grain weight and potassium levels have significant effect. Among the potassium levels, the maximum 1000-grain weight (44.24 g) was observed where potassium was applied at the rate of 100 kg ha $^{-1}$ followed by 50 kg ha $^{-1}$, followed by 150 kg ha $^{-1}$ while minimum (40.66 g) were observed in control. These results are similar with the results which are reported by (Tahir *et al*., 2008) and (Abbas *et al*., 2013) that increasing K till 100 kg 1000-grain weight (g).

Grain yield (t ha^{-1})

The efficiency and effectiveness of a package of technology is ultimately reflected by the level of grain yield per hectare which is function of the cumulative behavior of the yield components, such as number of fertile tillers per unit area, number of grains per spike and 1000-grain weight. Data regarding grains yield (t ha^{-1}) is affected by planting geometry and different levels of potassium are presented in table 1. Data regarding grain yield showed that planting geometry of wheat have non-significant effect on grain yield and potassium levels have significant effect. Among the potassium levels, the maximum grain yield (5.54 t ha^{-1}) was observed where potassium was applied at the rate of 200 kg ha $^{-1}$ followed by 100 kg ha $^{-1}$, followed by 150 kg ha $^{-1}$ while minimum (4.35 t ha^{-1}) were observed in control. These findings are in line with results which is reported by (Tahir *et al*., 2008) and (Abbas *et al*., 2013) that increasing K level yield also boost. Interaction of potassium levels with plant spacing was also non-significant.

Table 1. Response of Wheat (*Triticum aestivum* L.) to Different Levels of Potassium and Planting Geometry

Treatments	No. of fertile tillers (m^{-2})	Spike length (cm)	Number of grains/spike	1000-grain weight (g)	Grain yield (t ha^{-1})
P_1 =Broadcast	243.07	9.31	51.622	42.503	5.126
P_2 = line 22.50 cm	249.53	9.58	50.823	43.15	5.206
P_3= line 11.25cm	233.60	9.80	52.56	42.90	5.22
Post hoc results	NS	NS	NS	NS	NS
K levels (kg/ha) K_0= 0	242.67 B	8.95 B	44.75 B	40.66 B	4.355 C
K_1= 50	265.56 A	9.38 AB	47.17 B	43.20 A	5.17 C
K_2 =100	233.89 B	9.81 A	54.97 A	44.24 A	5.48 AB
K_3 =150	228.33 B	9.94 A	56.48 A	43.11 A	5.355 AB
K_4 =200	239.89 B	9.75 A	54.95 A	43.05 A	5.54 A
Post hoc results	21.972	0.650	4.816	1.9454	0.3448
P × K	NS	NS	NS	NS	NS

*=Mean not sharing the same letters differ significantly from each other at 5% probability levels.
NS = Non-significant

Table 2. Economic Analysis with input and output returns

Treatments K levels(kg ha^{-1})	Fixed cost (Rs.)	Variable cost (Rs.)	Total cost (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Benefit-Cost Ratio
Control	95971	0	95971	178400	1.86
50 (K_1)	95971	4000	99971	181620	1.82
100 (K_2)	95971	8000	103971	215350	2.07
150 (K_3)	95971	12000	107971	207200	1.92
200 (K_4)	95971	16000	111971	212475	1.90

Grain rate = 1300 per 40 kg
Straw rate = 200 per 40 kg
Muriate of Potash (60% K_2O) = 4000 per bag

4. Conclusion

On the basis of economic analysis, benefit cost ratio was carried out (Table 2). The maximum net income of Rs. 111379 ha^{-1} was obtained when crop was fertilized with 100 kg K ha^{-1}, while minimum net income of Rs. 81649 ha^{-1} was obtained when crop was fertilized 50 kg K ha^{-1}. The maximum benefit-cost ratio of 2.07 was observed in case of 100 kg K ha^{-1}, while the minimum benefit-cost ratio of 1.82 was obtained when crop was fertilized with 50 kg K ha^{-1}.

References

1. Abbas, G., J. Z. K. Khattak, G. Abbas, M. Ishaque, M. Aslam, Z. Abbas, M. Amer and M. B. Khokhar. 2013. Profit maximizing level of potassium fertilizer in wheat production under arid environment. Pak. J. Bot., 45: 961-965.
2. Ali, R. and M. Yasin. 1991. Response of wheat to nitrogen and phosphorous fertilization. Pak. J. Agri. Res. 12: 130-133.
3. Babar, L. K., T. Iftikhar, H. N. Khan and M. A. Hameed. 2011. Agronomic trials on sugarcane crop under Faisalabad condition, Pakistan. Pak. J. Bot., 43: 929-935.
4. CIMMYT, 1996. World wheat facts and trends: understanding global trends in the use of wheat diversity and international flows of wheat genetic resource. Mexico, DF.
5. Govt. of Pakistan. 2015. Economic Survey of Pakistan, 2014-15. Ministry of Food, Agriculture and Livestock. Finance Division, Economic Advisors Wing, Islamabad, Pakistan, pp. 28.
6. Gwal, H.B., R.J. Tiwari, R.C. Jiaan and P. S. Prajapati, 1999. Effect of different levels of fertilizer on growth, yield and quality of late sown wheat. RACHIS Newslett., 18: 42-43.
7. Huber, D. M. and R. D. Graham. 1999. The role of nutrition in crop resistance and tolerance to disease. Rengel Z. (Ed.), Mineral nutrition of crops fundamental mechanisms and implications. Food Product Press, New York. 205-226.

8. Hussain, M. I., S. H. Shah, H. Sajjad and K. Iqbal. 2002. Growth, yield and quality response of three wheat *(Triticum aestivum* L.) varieties to different levels of N, P and K. Int. J. Agric. Biol., 3: 362-364.
9. Iftikhar, T., L. K. Babur, S. Zahoor and N. G. Khan. 2010. Impact of land pattern and hydrological properties of soil on cotton yield. Pak. J. Bot., 42: 3023-3028.
10. Khaliq, A., M. Iqbal, and S. M. A. Basra. 1999. Optimization of seeding density and nitrogen application in wheat cv. Inqlab-91 under Faisalabad conditions. Int. J. Agri. Biol., 4: 241-243.
11. Malik, M. A., S. H. Shah and A. Ali. 1990. Response of two wheat cultivars to different levels of potassium. Pak. J. Agri. Sci., 27: 183-186.
12. Maqsood, M., M. Akbar, N. Yousaf, M. T. Mehmood and S. Ahmad. 1999. Effect of different rates of N, P and K combinations on yield and components of yield of wheat. Int. J. Agric. Biol., 1: 359-361.
13. Oborn, Y., A. Rangel, M. Askekaard, C. A. Grant, C. A. Watson and A. C. Edwards. 2005. Critical aspects of potassium management in agriculture systems. Soil Use Manage., 21: 102-111.
14. Steel, R. D. G., J. H. Torrie and D.A. Dickey. 1997. Principles and procedure of statistics: Biometrical Approach, 3rd edition. McGraw Hill Book Co., New York.
15. Sweeney, D. W., G. V. Grande, M. G. Eversmeyer and D. A. whitney. 2000. Phosphorus, potassium, chloride and fungicide effects on wheat yield and leaf rust severity. J. Plant Nutr., 23: 1267-1281.
16. Tahir, M., A. Tanveer, A. Ali, M. Ashraf and A. Wasaya. 2008. growth and yield response of two wheat (*Triticum aestivum* L.) varieties to different potassium levels. Pak. J. Life Soc. Sci., 6: 92-95.
17. Wakeel, A., A. Hassan, T. Aziz and M. Iqbal. 2002. Effect of different potash levels and soil texture on growth and nutrient uptake of maize. Pak. J. Agri. Sci., 39: 99-103.

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