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Research Article

Potassium Quantification for Wheat (*Triticum Aestivum* L.) under the Agroecological Conditions of District Swabi

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ABSTRACT

The present study was conducted at Agriculture Research Station Bamkhel, District Swabi, Khyber Pakhtunkhwa, Pakistan to observe the effect of different potassium (K_2O) levels on wheat productivity. Wheat variety Pirsabak-2004 was tested for different potassium (K_2O) levels of 0, 60, 70, 80, 90 and 100 kg ha^{-1}. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Statistical analysis of the data showed a significant ($P \leq 0.05$) effect of different potassium (K_2O) levels on emergence m^{-2}, tillers m^{-2}, 1000 grains weight (g) and grain yield (kg ha^{-1}) while a non-significant ($P>0.05$) effect on leaf area (cm^2), plant height (cm), spike length (cm) and grains $spike^{-1}$. The data revealed highest leaves $plant^{-1}$ (5.66) and plant height (86.66 cm) for potassium (K_2O) level of 60 kg ha^{-1}. The results further indicated highest leaf area (45.53 cm^2) for plots treated with potassium (K_2O) level of 70 kg ha^{-1}. Similarly, maximum tillers (192.44 m^{-2}), spike length (10.33 cm), 1000 grains weight (35.33g) and grain yield (5168 kg ha^{-1}) were recorded for plots applied with potassium (K_2O) at the rate of 80 kg ha^{-1}. The maximum emergence (48.66 m^{-2}) and grains $spike^{-1}$ (40.86) were noted for potassium (K_2O) level of 90 kg ha^{-1}. It was concluded that potassium (K_2O) level of 80 kg ha^{-1} resulted in maximum growth and yield components than all other treatments under study.

Keywords: Potassium, fertilizer, wheat, grain yield.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most widely used staple food grain in the world (Zaheer et al., 2024). In the food scenario of developing countries, 21 % of the total calories intake and 20% protein are from wheat (Manzoor et al., 2024). Its grain is rich in minerals, essential amino acids (except lysine) and vitamins (Kaleri et al., 2024). It is mainly intake in the form of baked products, chapatti, bran, malt, poultry and livestock feeds etc. Its demand may increase by 60 % of the present up to 2050 (Kubar et al., 2025) due to rapid expansion in world human population which may reach 8.3 billion up to 2025 (Umrani et al., 2024). Increasing food production through additional exploitation of limited natural resources and arable land has no longer been an effective option. Wheat is an internationally traded commodity (Naqeebullah et al., 2024). The annual average volume of wheat trade is about 106 tons during 1999 to 2003. By 2020 world demand for wheat is expected to be 40 percent higher than its level in the latter half of the 1990's. Like other developing countries, agriculture is the most important sector of Pakistan's economy and wheat is the most important agricultural commodity (Kaleri et al., 2024). It is grown by 80% of the farmers. It contributes 13.7% to the value added in agriculture and 3.0% to GDP

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(National Coordinated Wheat Program, NARC, and Islamabad). Pakistan falls in top ten wheat-producing countries of the world and ranks at No. 9 in terms area, at No. 5 in terms of yield per hectare and at No. 8 in terms of production (Kubar et al., 2025). Despite this top ten ranking in the production of wheat, the average grain yield is very much less than that of other countries of the world. The world average yield of wheat is 3210 kg ha^{-1} while in Pakistan it is 2750 kg ha^{-1} (Kaleri et al., 2023). Pakistan is the 7^{th} largest country with respect of total production of wheat (Gadahi et al., 2024). Wheat bears a key position in Pakistan's economy and is cultivated over an area of 8,463,000-hectare and 2.9% to GDP. According to recent statistics, the average grain yield of wheat in Pakistan 2379 kg ha^{-1} which is much lower than other wheat growing countries of the world (Ahmed et al., 2023).

Wheat contributes more calories and protein to the world's diet than any other food crop (Shahzad et al., 2022). In Khyber Pakhtunkhwa territory, wheat was planted on an area of about 0.7245 million hectares with an average yield of about 1434 kg ha^{-1}, which is lower than average yield of the country (Khalid et al., 2023). With recently increased support prices in the country, wheat has achieved much importance amongst the farming community. Farming community prefers to cultivate their fields with wheat instead of even cash crops like tobacco, and sugarcane. In such circumstances, it becomes more important to increase wheat production per acre. This could be possible by introducing new varieties with higher productivity and increasing crop stand in the field (Hussain et al., 2022). The recommended row to row distance is therefore to be adjusted with field requirements and fertilizer application. With increased wheat population in fields, there is danger of crop lodging which could be a great loss to the farmers. To counter such situations, it is necessary to increase crop resistance to lodging. Literature says that amongst other qualities, K nutrient increases crop resistance to lodging. Potassium is an essential nutrient for plant metabolism process. The physiological function of potash is activation of enzymes, maintaining tissue turgor pressure and opening and closing of stomata. Potassium is required by plants in much greater amounts than that of all the other soil supplied nutrients (Asif et al., 2024).

Plants obtain K primarily from the soil in the form of K^+ which is also strongly absorbed soil components. Particularly by clay particles and is therefore not readily mobile in soils (Kalhoro et al., 2024). Although, potassium contents in Pakistani soils have traditionally been considered adequate for normal plant growth (Hafeez et al., 2024). However, awareness has been grown on the importance of K in crop production and need for potash have been realized in Pakistan (Syed et al., 2021). Under continuous cropping, fertilizers responsive varieties with improved management practices are further resulting in K mining. Wheat crops can remove more than 400 kg K_2O ha^{-1} per year. It is estimated that wheat crop with 6 t ha^{-1} grain in rice-wheat system will remove 187 kg N ha^{-1}, 55 kg P_2O_5 ha^{-1} and 252 kg K_2O ha^{-1} from soil. In the absence of K fertilizer or with low applied levels and intensive continuous cropping will result in the depletion of soil K reserves. Even soils which are initially well supplied with K will become deficient under such a management system. Total consumption of K from soil by wheat having 10 t ha^{-1} varies from 160-242 kg K ha^{-1} (Tahir et al., 2023). Keeping in view the role of potassium (K_2O) in growth and yield of wheat, the present experiment was conducted to determine optimum level of potassium (K_2O) for wheat under the agro-ecological conditions of district Swabi, Khyber Pakhtunkhwa, Pakistan using Pirsabak-2004 as a test variety.

MATERIAL AND METHODS

The present study was conducted at Agricultural Research Station Bamkhel, District Swabi, Khyber Pakhtunkhwa, Pakistan during winter 2023-24 using Randomized Complete Block Design (RCBD) with three replication. Wheat variety Pirsabak-2004 was tested for various levels of potassium (K_2O). i.e. Replication = 03
Net plot size: 3 m x 4 m, 12 m^2.
Variety = Pirsabak-2004
Treatments= 06
T_1 = untreated (control)
T_2 = 60 kg ha^{-1}
T_3 = 70 kg ha^{-1}
T_4 = 80 kg ha^{-1}
T_5 = 90 kg ha^{-1}
T_6 = 100 kg ha^{-1}

Recommended doses of nitrogen and phosphorus at the rate of 120 and 90 kg ha^{-1} respectively were applied as a basal dose to the whole experiment. All agronomic practices were carried out throughout the growing season.

Culture practices

To establish an optimal seedbed, the soil underwent careful preparation involving two comprehensive plowings, followed by leveling of the land. During the sowing process, we evenly distributed the recommended quantity of DAP fertilizer across all plots. Throughout the research, we provided potassium, zinc, and boron at different stages of wheat growth. Every five days during the first ten days after crop planting, we selected five plants from each plot to evaluate the plant characteristics.

Observations

Important indicators for evaluating crop performance include Emergence m^{-2}, Tillers m^{-2}, Plant height (cm), Leaves $plant^{-1}$, Leaf area (cm^2), Spike length (cm), Grains $spike^{-1}$, 1000 grains weight (g) and Grain yield (kg ha^{-1}).

Statistical Analysis

Statistix 8.1 was used to conduct statistical analysis on the data, and the Least Significant Difference (LSD) test was employed to compare the means of different treatments with a significance level of 5 %.

RESULTS AND DISCUSSION

Emergence m^{-2}

Emergence m^{-2} data of wheat variety Pirsbak-2004 is presented in Table 4.1. Statistical analysis of the data showed a significant (P≤0.05) effect of different potassium (K_2O) levels on emergence m^{-2} of wheat crop. Maximum emergence m^{-2} (48.66) was recorded in T5 (90 kg ha^{-1}) followed by T3 (70 kg ha^{-1}) with 39.55 emergence m^{-2} as compared to lowest emergence m^{-2} (36.77) from T_1 (control treatment). Our results are in contrast with the findings of Ali et al. (2024). They revealed a non-significant effect of different potassium (K_2O) fertilizers on emergence m^{-2} of wheat variety Pirsabak-2004.

Tillers m^{-2}

Data concerning tillers m^{-2} are presented in Table 4.1. Statistical analysis of the data discovered that tillers m^{-2} were significantly (P≤0.05) affected by different potassium (K_2O) levels. Highest tillers m^{-2} (192.44) were noted for T_4 (80 kg ha^{-1}) followed by T_5 (90 kg ha^{-1}) with tillers m^{-2} of 183.55 as compared to lowest tillers m^{-2} (139.55) from T_2 (60 kg ha^{-1}). These results are in line with those reported by Yahya et al. (2023). They also revealed a significant effect of different levels of potassium (K_2O) fertilizers on tillers m^{-2} of wheat variety Pirsabak-2004.

Leaves $plant^{-1}$

The impact of different potassium (K_2O) levels on leaves $plant^{-1}$ of wheat variety Pirsabak- 2004 are shown in Table 4.1. Statistical analysis of the data revealed a non-significant (P>0.05) effect of potassium (K_2O) fertilizers on leaves $plant^{-1}$ of wheat crop. Maximum leaves $plant^{-1}$ (5.66) were noted for T_2 (60 kg ha^{-1}) followed by T_1 (control treatment) with 5.43 leaves $plant^{-1}$ as compared to lowest leaves $plant^{-1}$ (5.00) from T_6 (100 kg ha^{-1}). Similar results were also reported by Jamal et al. (2023). They also concluded a non-significant effect of different potassium (K_2O) levels on leaves $plant^{-1}$ in maize varieties.

Table 1. Emergence m^{-2}, tillers m^{-2} and leaves $plant^{-1}$ of wheat as affected by different potassium (K_2O) levels.

Potassium (K2O) levels (kg ha^{-1})	Emergence m^{-2}	Tillers m^{-2}	Leaves $plant^{-1}$
T_1 (control treatment)	36.77b	165.11	5.43
T_2 = 60 kg ha^{-1}	37.88ab	139.22	5.66
T_3 = 70 kg ha^{-1}	39.55ab	169.89	5.20
T_4 = 80 kg ha^{-1}	37.99ab	192.44	5.40
T_5 = 90 kg ha^{-1}	48.66a	183.55	5.42
T_6 = 100 kg ha^{-1}	38.44ab	181.33	5.00
LSD (P ≤ 0.05)	7.01	11.16	Non-Sign

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

Leaf area (cm^2)

Leaf area (cm^2) data of variety Pirsbak-2004 is indicated in Table 4.2. Statistical analysis of the data showed a non-significant (P>0.05) effect of different potassium (K_2O) levels on leaf area (cm^2) of wheat crop. Highest leaf area of

45.53 cm^2 was noted in T_3 (70 kg ha^{-1}) while lowest leaf area of 27.26 cm^2 was noted in T_6 (100 kg ha^{-1}). Our results are in contrast with the findings of Zareen et al. (2022). They revealed a significant effect of different potassium (K_2O) levels on leaf area of wheat variety Pirsabak-2004.

Plant height (cm)

The influence of different potassium (K_2O) levels on plant height (cm) of wheat variety Pirsbak-2004 are depicted in Table 4.2. Statistical analysis of the data revealed a non-significant (P>0.05) effect of different potassium (K_2O) levels on plant height of wheat crop. The highest plant height of 86.66 cm was noted in T_2 (60 kg ha^{-1}) followed by T_6 (100 kg ha^{-1}) with plant height of 85.77 cm as compared to lowest plant height of 82.11 cm from T5 (90 kg ha^{-1}). These results are in conformity with those reported by Khan et al. (2024). They also revealed a non-significant effect of different potassium (K_2O) levels on plant height (cm) of wheat variety Pirsabak-2004.

Spike length (cm)

Data relating spike length (cm) of variety as affected by different potassium (K_2O) levels are presented in Table 4.2. A non-significant (P>0.05) effect of different potassium (K_2O) levels on spike length of wheat crops was evident from statistical analysis of the data. Highest spike length of 10.23 cm was noted in T_4 (80 kg ha^{-1}) followed by T_5 (90 kg ha^{-1}) with spike length of 10.24 cm as compared to lowest spike length of 8.65 cm from T3 (70 kg ha^{-1}). The same results were reported by Ullah et al. (2024). They also revealed a non-significant effect of different potassium (K_2O) levels on spike length of wheat variety Pirsabak-2004.

Table 2. Leaf area (cm^2), plant height (cm) and spike length (cm) of wheat as affected by different potassium (K_2O) levels.

Potassium (K_2O) levels (kg ha^{-1})	Leaf area (cm^2)	Plant height (cm)	Spike length (cm)
T_1 (control treatment)	28.87	84.21	9.65
T_2 = 60 kg ha^{-1}	27.83	86.66	9.85
T_3 = 70 kg ha^{-1}	45.53	82.77	8.65
T_4 = 80 kg ha^{-1}	28.26	81.21	10.33
T_5 = 90 kg ha^{-1}	28.16	82.11	10.24
T_6 = 100 kg ha^{-1}	27.26	85.77	9.83
LSD (P ≤ 0.05)	Non-Sign	Non-Sign	Non-Sign

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

Grains spike^{-1}

Grains spike^{-1} data of variety Pirsbak-2004 as affected by different potassium (K_2O) levels are presented in Table 4.3. Statistical analysis of the data showed a non-significant (P>0.05) effect of potassium (K_2O) fertilizers on grains spike^{-1} of wheat crop. Highest spike^{-1} of 43.63 were noted in T_5 (90 kg ha^{-1}) followed by T_3 (70 kg ha^{-1}) with 40.86 grains spike^{-1} as compared to lowest spike^{-1} of 38.06 from T_1 (control treatment). These results are in contrast with those reported by Dawar et al. (2021). They revealed a significant effect of different potassium (K_2O) levels on grain spike^{-1} of wheat.

1000 grains weight (g)

Data relating 1000 grains weight are indicated in Table 4.3. Statistical analysis of the data showed a significant (P≤0.05) impact of potassium (K_2O) levels on 1000 grains weight of wheat crop. The highest 1000 grains weight of 35.33 g was noted in T_4 (80 kg ha^{-1}) followed by T_3 (70 kg ha^{-1}) with 1000 grains weight of 33.33 g as compared to lowest 1000 grains weight of 27.33 g from T_1 (control treatment). The above results are in line with the conclusions of (Ranazai et al., 2024). They also revealed a significant effect of different potassium (K_2O) levels on 1000 grains weight of wheat.

Grain yield (kg ha^{-1})

Table 4.3 indicates data responding grain yield (kg ha^{-1}) of wheat as affected by different levels of potassium (K_2O). Statistical analysis of the data revealed a significant (P≤0.05) effect of potassium (K_2O) levels on grain yield (kg ha^{-1}) of wheat crop. The highest grain yield of 5168 kg ha^{-1} was noted in T_4 (80 kg ha^{-1}) followed by T_5 (90 kg ha^{-1}) with grain yield of 4906 kg ha^{-1} as compared to lowest grain yield of 3682 kg ha^{-1} from T_1 (control treatment). The same results were reported by Zeb et al. (2022). They also revealed a significant effect of different potassium (K_2O) levels on grain yield (kg ha^{-1}) of wheat.

Table 3. Grains spike^{-1}, 1000 grains weight (g) and grain yield (kg ha^{-1}) of wheat as affected by different potassium (K_2O) levels.

Potassium (K2O) levels (kg ha^{-1})	Grains spike^{-1}	1000 grains weight (g)	Grain yield (kg ha^{-1})
T_1 (control treatment)	38.06	27.33 d	3682 d
T_2 = 60 kg ha^{-1}	40.20	30.66 c	4307 c
T_3 = 70 kg ha^{-1}	40.86	33.33 ab	4578 bc
T_4 = 80 kg ha^{-1}	40.33	35.33 a	5168 a
T_5 = 90 kg ha^{-1}	43.63	31.66 bc	4906 ab
T_6 = 100 kg ha^{-1}	40.20	31.33 bc	4876 ab
LSD ($P \leq 0.05$)	Non-Sign	2.50	391.87

CONCLUSIONS

Application of potassium improved the growth, yield and yield contributing parameters and potassium uptake as compared to solo application of each. Increasing the rate of potassium from 60 to 100 kg K_2O ha^{-1} produced and significant increase in wheat yield and potassium uptake. The seed yield increased linearly with increasing potassium levels. However, the plot fertilized with fertilizer of potassium 80 kg ha^{-1} produced maximum (5168 kg ha^{-1}). Among the tested Potassium (K2O) levels, T_4 (80 kg ha^{-1}) showed higher values for tillers m-2 , spike length (cm), 1000 grains weight (g) and grain yield (kg ha^{-1}). Potassium level of 80 kg ha^{-1} is recommended for general wheat cultivation in Distt: Swabi, Khyber Pakhtunkhwa, Pakistan.

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AUTHOR CONTRIBUTIONS

All authors contributed equally to this research.

COMPETING OF INTEREST

No conflicts of interest have been disclosed by the authors.

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