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EFFECTS OF POTASSIUM APPLICATION RATE ON GRAIN YIELD OF WINTER WHEAT (*TRITICUM AESTIVUM* L.) ASSOCIATED WITH AGRONOMICAL AND PHYSIOLOGICAL CHARACTERISTICS

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ABSTRACT

The present study was conducted at the Research Farm, The University of Agriculture Peshawar, Pakistan to observe the effect of different potassium (K_2O) levels on wheat productivity. Wheat variety (Gulzar-2019) 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 the highest Emergence m^{-2} (42.99), leaves plant^{-1} (5.43) for potassium (K_2O) level of 80 kg ha^{-1}. The results further indicated highest leaf area (32.53 cm^2) for plots treated with potassium (K_2O) level of 70 kg ha^{-1}. Similarly maximum, spike length (10.24 cm), 1000 grains weight (35.36g), grains spike^{-1} (43.63) and grain yield (5168 kg ha^{-1}) were recorded for plots applied with potassium (K_2O) at the rate of 90 kg ha^{-1}. The maximum Tillers m^{-2} (186.55 m^{-2}) were noted for potassium (K_2O) level of 70 kg ha^{-1}. It was concluded that potassium (K_2O) level of 90 kg ha^{-1} resulted in maximum growth and yield components than all other treatments under study.

Key words: Potassium, fertilizer, wheat, grain yield.

INTRODUCTION

Wheat is the most significant crop in Pakistan, In the food scenario of developing countries, 21 % of the total calories intake and 20% protein are from wheat (Manzoor et al., 2024). It has a lot of protein, vitamins, and carbohydrates, providing essential nutrition to millions of people. In India, wheat cultivation covers a vast area

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of approximately 29.14 million hectares, making it the largest cultivation area globally, although it ranks second in terms of production (Kaleri et al., 2024).Wheat is a Rabi crop, started in October to December and obtained from March to May in Pakistan. The straw produced from wheat plants has various potential uses, such as biomass material for bioenergy or as organic fertilizer (Kubar et al., 2025). The quantity of wheat grain's proteins is influenced by factors such as genotype, soil and atmospheric circumstances and crop management techniques. While genetic factors play a significant role, external factors such as precipitation and cultivation practices also contribute to protein content variation (Umrani et al., 2024). Potassium is a nutrient that plants absolutely require and the third key component of commercial fertilizers. It plays a crucial part in improving crop yields, improving disease resistance, and strengthening the root system of plants (Naqeebullah et al., 2024). Including potassium in the fertilizer schedule has been shown to improve wheat outcomes, including taller plants, thicker grains, and higher grain weight (Rehmani et al., 2025). Potassium has a broad range of functions in plants, including enzyme stimulation, regulation of osmotic pressure, photosynthesis, stomatal movement, energy drive, and maintaining cation anion balance in the soil. It also helps plants withstand stress (Kaleri et al., 2024). Farmyard manure is a traditional soil amendment practice that positively affects soil properties and fertility. It enhances physical fitness of the soil, including its capability for retaining water, and provides both micro and macronutrients (Kubar et al., 2025). Farmyard manure also increases soil moisture storage, making it a valuable resource for sustainable land utilization. Organic materials, such as compost and decomposed crop residues, are important for enhancing soil fertility and nutrient status, especially considering the rising prices of synthetic fertilizers. The combination of farmyard manure with chemical fertilizers has been shown to increase yield and nutrient uptake, improving the efficiency of chemical fertilizers (Kaleri et al., 2023). Incorporating organic matter into salt-affected soils can improve soil infiltration and facilitate leaching of salts, leading to a decrease in electrical conductivity values of the soil (Gadahi et al., 2024). This highlights the potential of organic amendments in improving the quality of salt-affected soils (Ahmed et al., 2023). Overall, the mix of organic additives, such as farmyard manure, and chemical fertilizers can have significant benefits for wheat cultivation, including improved yield, nutrient uptake, and soil fertility (Hussain et al., 2022).

MATERIALS AND METHODS

Experimental Layout and Treatments

The present study was conducted at the Research Farm, The University of Agriculture Peshawar, Pakistan during winter 2022-23 using Randomized Complete Block Design (RCBD) with three replication. Wheat variety (Gulzar-2019) 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 = (Gulzar-2019)
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}).

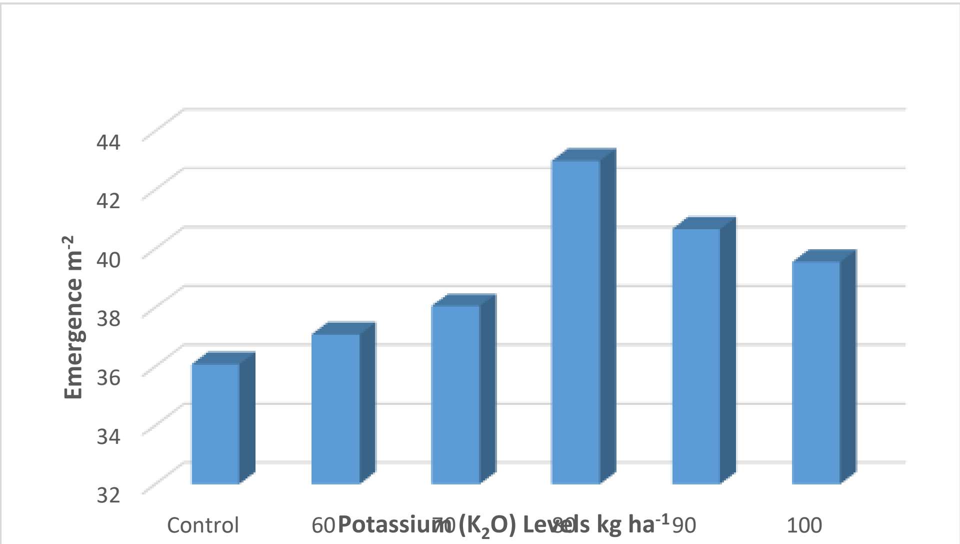
Statistical Analysis

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

Emergence m^{-2}

The study's findings showed a considerable difference ($p<0.05$) in the growth of wheat plants at various levels of potassium fertilizer. Increasing the amount of potassium rates or their combination resulted in an increase in emergence m^{-2}. Plants exhibited a greater emergence m^{-2} (42.66) when treated with 80 kg K_2O ha^{-1} . As the potassium fertilizer rate decreased to 70 kg K_2O ha^{-1} the emergence m^{-2} slightly decreased to (38.05). While the crops receiving T_5 =90 kg ha^{-1} and T_6 = 100 kg ha^{-1} resulted in mean emergence m^{-2} of (40.66) and (39.55). Further, the lowest mean emergence m^{-2} (36.07) was noted with T_1 = Control, no fertilizer, 00 kg ha^{-1}.



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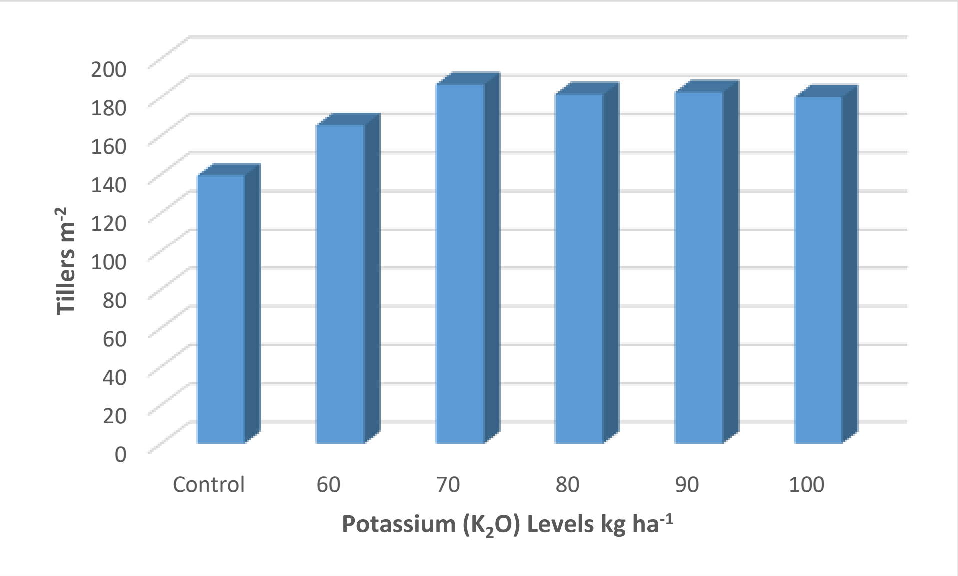
Tillers m^{-2}

The high tillers m^{-2} of wheat increasing the amount of potassium rates or their combination resulted in an increase in tillers m^{-2}. Plants exhibited a greater tillers m^{-2} (186.55) when treated with 70 kg K_2O ha^{-1}. As the potassium fertilizer rate decreased to 60 kg K_2O ha^{-1} the tillers m^{-2} slightly decreased to (165.22). while the crops receiving T_5 = 90 kg ha^{-1} and T_6 = 100 kg ha^{-1} resulted in mean tillers m^{-2} (182.55) and (180.03) . Further, the lowest mean tillers m^{-2} (139.22) was noted with T_1 = Control, no fertilizer, 00 kg ha^{-1}.



Leaves plant^{-1}

Potassium concentrations have an impact on the length of the leaves plant^{-1}. The crops treated with T_6 = 100 kg ha^{-1} and T_5 = 90 kg ha^{-1} produced mean leaves plant^{-1} of (5.41) and (5.28), respectively, whereas the treatments T_4 = 80 kg ha^{-1} produced a maximum leaves plant^{-1} of (5.43). Similarly, we observed plant^{-1} of (5.34) and (5.20) when we administered crop treatments including T_3, T_2. Furthermore, we found that T_1 = control, which did not use any fertilizers, had the lowest mean leaves plant^{-1} (5.01).

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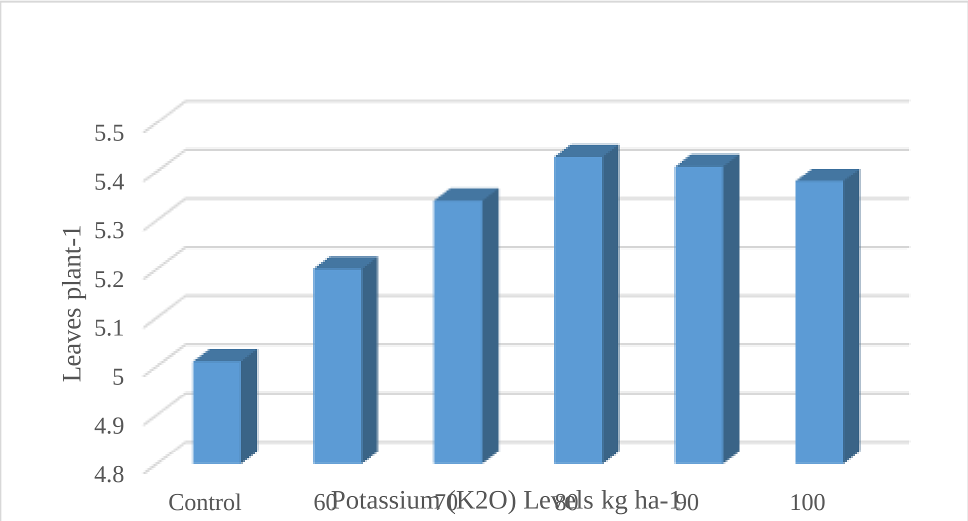
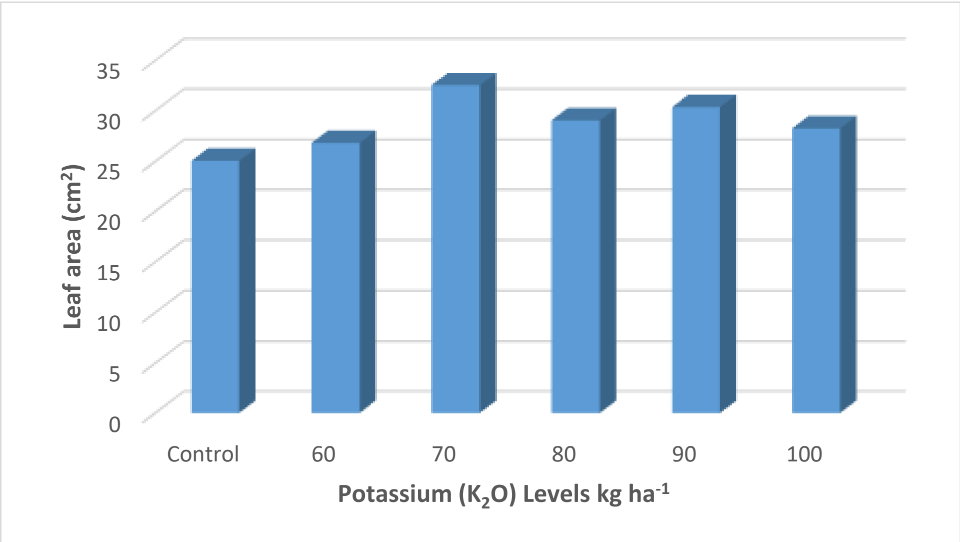


Leaf area (cm^2)

Different levels of potassium affect wheat leaf area (cm^2). The treatments $T_3 = 70$ kg ha^{-1} produced a maximum leaf area (cm^2) of 32.53, while the crops receiving $T_5 = 90$ kg ha^{-1} and $T_6 = 100$ kg ha^{-1} resulted in mean leaf area (cm^2) of (30.36) and (28.26), respectively. Similarly, applying crop treatments with T_4 and T_2 resulted in the following mean leaf area (cm^2) 29.06 and 26.83 cm. Furthermore, we observed the lowest mean leaf area (cm^2) (25.07) when we applied T_1 = Control, no fertilizer, and 00 kg ha^{-1}.



Plant height (cm)

The study's findings showed a considerable difference ($p<0.05$) in the growth of wheat plants at various levels of potassium fertilizer. Increasing the amount of potassium rates or their combination resulted in an increase in plant height. Plants exhibited a greater height (89.11 cm) when treated with 90 kg K_2O ha^{-1} . As the potassium fertilizer rate decreased to 80 kg K_2O ha^{-1} the plant height slightly decreased to (87.21 cm), $T_3 = 70$ kg ha^{-1} produced (86.77 cm), while the crops receiving $T_2 = 60$ kg ha^{-1} and $T_6 = 100$ kg ha^{-1} resulted

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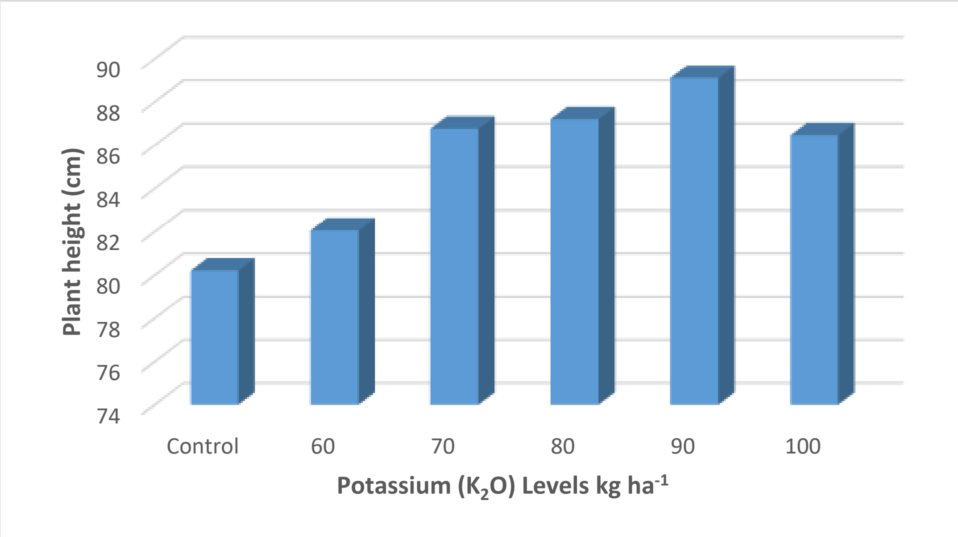
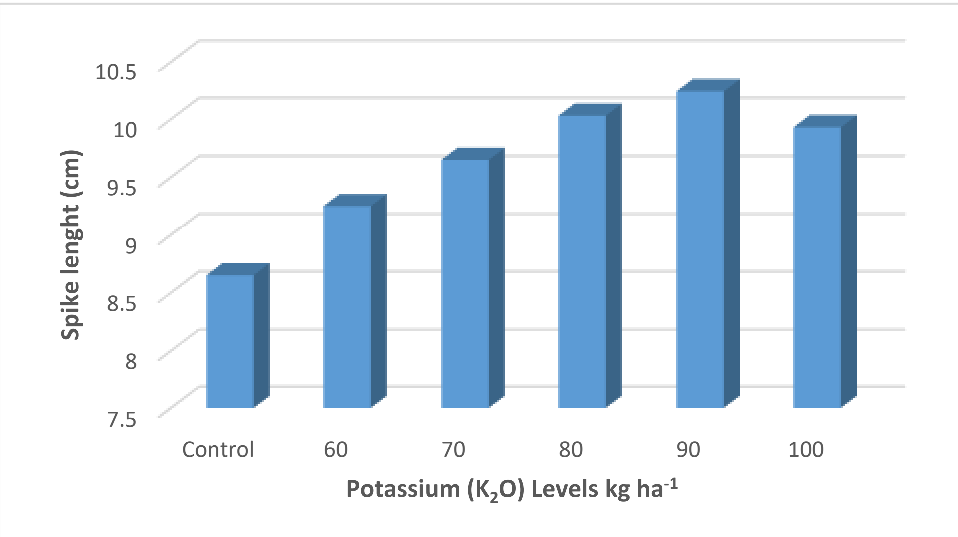
in mean plant heights of 82.06 cm and 86.47 cm. Further, the lowest mean plant height (80.21 cm) was noted with T_1 = Control, no fertilizer, 00 kg ha^{-1}.



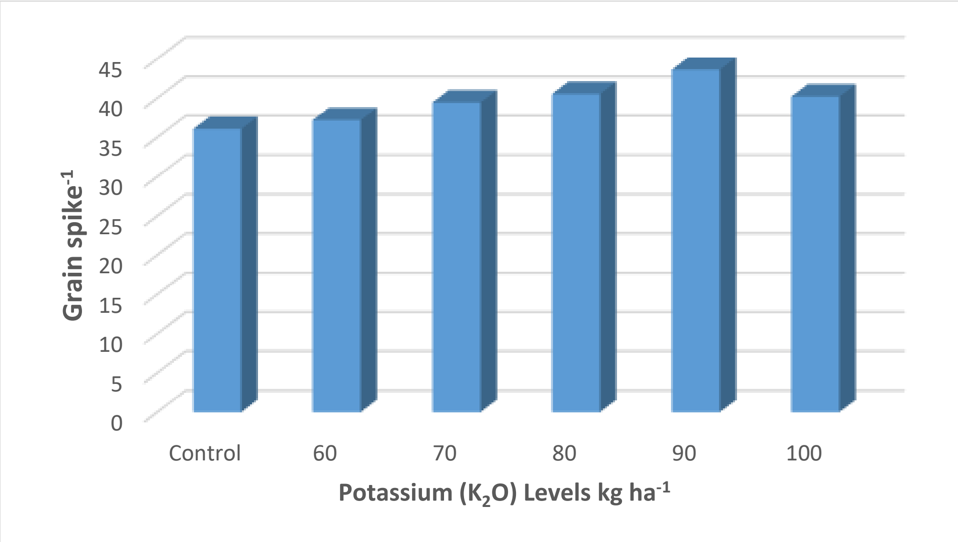
Spike length (cm)

Based on the use of K fertilizer, the wheat plants' spike length varied. The highest spike length (10.24 cm) was achieved when 90.00 kg K_2O ha^{-1} was applied, whereas the spike length slightly decreased to 10.03 cm when the potassium fertilizer rate was reduced to 80 kg K_2O ha^{-1} . while the crops receiving T_3 =70 kg ha^{-1} and T_2 = 60 kg ha^{-1} resulted in mean spike length of 9.65 cm and 9.25 cm. In contrast, the control group had the lowest spike length, measuring 8.65 cm. These results indicate the length of the wheat plants' spikes was significantly affected by the potassium fertilizer.



Grains spike^{-1}

The use of potassium in wheat crops positively and substantially impacted a number of physiological yields and yield related traits. Different levels of potassium affect wheat grain spike^{-1}. The treatments T_5 = 90 kg ha^{-1} produced a maximum spike^{-1} length of (43.63 cm), while the crops receiving T_4 = 80 kg ha^{-1} and T_6 = 100 kg ha^{-1} resulted in mean grain spike^{-1} of (40.53 cm) and (40.20 cm), respectively. Similarly, applying crop treatments with T_3 and T_2 resulted in the following mean grain spike^{-1} (39.46 cm), (37.20 cm). Furthermore, we observed the lowest mean grain spike^{-1} (36.06 cm) when we applied T_1 = Control, no fertilizer and 00 kg ha^{-1}.



1000 grains weight (g)

The seed index of wheat exhibited an increase, 1000 grains weight (35.36 g) when treated with 90 kg K_2O ha^{-1} . As the potassium fertilizer rate decreased to 80 kg K_2O ha^{-1}, the plant height slightly decreased to (33.31 cm). while the crops receiving T_3 =70 kg ha^{-1} and T_2 = 60 kg ha^{-1} resulted in mean seed index of wheat of (30.33 g) and (29.66 g). Further, the lowest mean 1000 grains weight (27.33 g) was noted with T_1 = Control, no fertilizer, 00 kg ha^{-1}.

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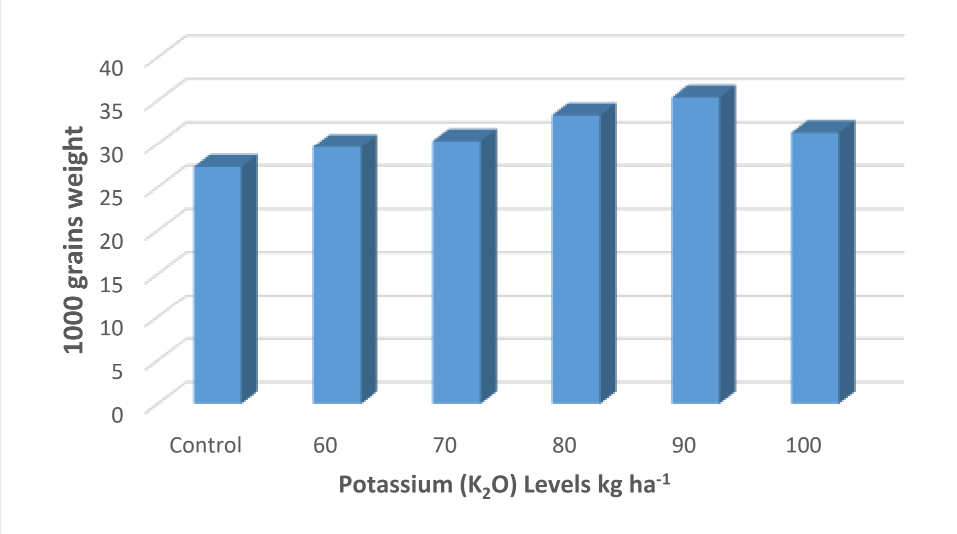
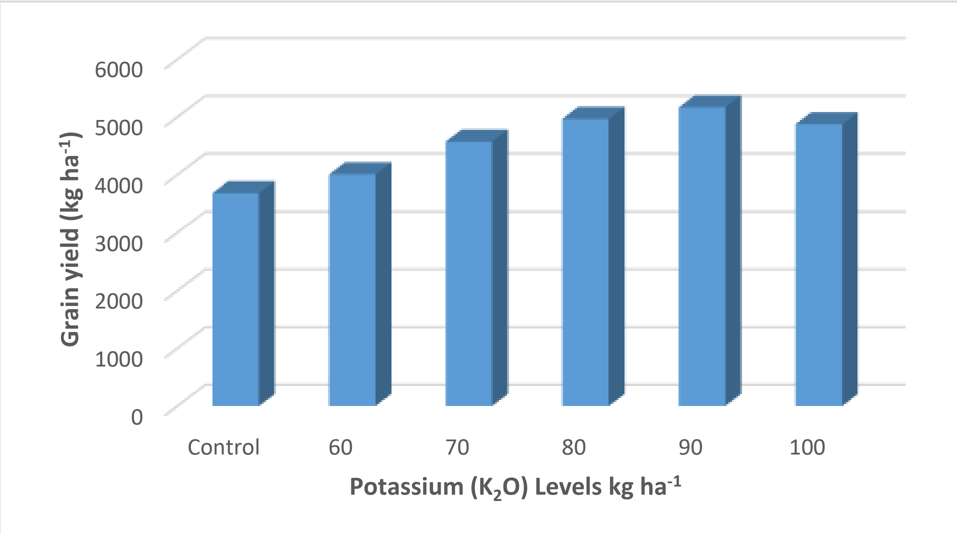


Grain yield (kg ha^{-1})

The high grains yield of wheat Increasing the amount of potassium rates or their combination resulted in an increase in Grain yield (kg ha^{-1}). Plants exhibited a greater grain yield (5168 kg ha^{-1}) when treated with 90 kg K_2O ha^{-1} . As the potassium fertilizer rate decreased to 80 kg K_2O ha^{-1} the Grain yield slightly decreased to (4968 kg ha^{-1}). while the crops receiving T_3 = 70 kg ha^{-1} and T_6 = 100 kg ha^{-1} resulted in mean grain yield (4578 kg ha^{-1}) and (4876 kg ha^{-1}) . Further, the lowest mean Grain yield (3682 kg ha^{-1}) was noted with T_1 = Control no fertilizer 00 kg ha^{-1}.



DISCUSSION

The challenge of agriculture extends beyond just feeding large populations; it also involves ensuring that nutritious food reaches those in need. To address this, agricultural systems should be designed with a strong emphasis on improving public health and well-being (Khatri et al., 2024). Using various fertilizers, such as potassium can greatly enhance the growth and yield of wheat crops. Farmers and agricultural experts advise including these fertilizers in cropping plans to boost productivity and profitability (Boix et al., 2023). Our study's findings revealed significant variations in the growth and yield components of the wheat (Gulzar-

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2019). Under treatment T_5 = 90 kg ha^{-1} we observed extreme values, such as a maximum, Spike length (10.24 cm), grains $spike^{-1}$ of 43.63, seed index (1000 grain weight) of 35.36 g, a grain yield of 5168 kg ha^{-1}. The data revealed the highest leaves $plant^{-1}$ (5.43) for potassium (K_2O) level of 80 kg ha^{-1}. The results further indicated highest leaf area (32.53 cm^2), Tillers m^{-2} (186.55 m^{-2}) for plots treated with potassium (K_2O) level of 70 kg ha^{-1}. The maximum emergence m^{-2} (42.99) were noted for potassium (K_2O) level of 80 kg ha^{-1}. In soils deficient in potassium, crop yields improved with the proper application of these nutrients (Yahaya et al., 2023). Potassium fertilizers were administered at a rate of 2000 g ha^{-1}. Subsequently, various plant parameters were assessed, including plant height, tillers per square meter, spike length, grains per spike, grain weight per spike, seed index, grain yield, and harvest index. Using potassium improved plant growth in a number of ways, such as plant height, number of tillers m^{-2}, spike length cm, grain per spike, grain weight per spike, seed index 1000 grain weight g, grain yield kg ha^{-1}, and harvest index kg ha^{-1}. This observation was confirmed with findings previously reported by (Toor et al., 2021). Ali et al. (2021) conducted research that is consistent with the findings of this study. Potassium (K) is an essential fertilizer that controls many physiological processes in mature plants, such as water uptake, nutrient mobilization, protein production, enzyme activation, photosynthesis, starch and sugar movement (Nosheen et al., 2021). Hafeez et al. (2024) also reported that plant growth increased with increased potassium (K) supply. A similar observation was made by Salim et al. (2020), who found that plant height, the number of tillers per square meter, and dry matter accumulation were enhanced when potassium was applied in two equal split doses at sowing and tillering stages rather than in a single basal application (Singh et al., 2020). The application of fertilizer-K was observed to regulate N metabolism, leading to increased N absorption by the plant (Patel et al., 2025). Therefore, when fertilizer K is applied together, they promote vegetative growth and result in an increased number of fertile tillers per unit area. The soil analysis report revealed that organic carbon (OC) and total nitrogen levels were found to be low. Additionally, it indicated the possibility of potassium (K) deficiency induced by magnesium (Mg), which can be attributed to inadequate soil fertility management practices. Therefore, it is advisable to use fertilizers containing nitrogen and potassium (K) to meet the requirements of the wheat crop effectively (Toppo et al., 2024). The number of days it took for the plants to reach physiological maturity was significantly influenced by the interaction between nitrogen (N) and potassium (K) fertilizers. However, the 69 kg N ha^{-1} treatment was statistically similar to the 30 and 60 kg K ha^{-1} treatments. On the contrary, plots that were not fertilized were followed by the application of K fertilizer without N fertilizer resulted in a shortened time to reach physiological maturity (Lu et al., 2017).The height of wheat plants was significantly affected by the combined effects of nitrogen (N) and potassium (K) rates. The tallest plant height, measuring 90.57 cm, was achieved with 30 kg of K ha^{-1} . Close behind was a plant height of 84.18 cm, obtained when the same N rate was paired with 60 kg of K ha^{-1}. On the other hand, the shortest plant height of 45.71 cm was observed in unfertilized plots. These findings further illustrate that increasing N rates in combination with K, up to 30 kg ha^{-1}, positively enhanced the height of wheat plants (Sharma et al., 2023). The number of tillers per unit area was greatly influenced by the combined effects of potassium (K) rates. The highest count of total tillers (595.00) was observed when 60 kg K ha^{-1} were applied, closely followed by the combination of 46 kg N ha^{-1} and the same K rate (548.33). Conversely, the lowest count of total tillers (205.33) was recorded in plots where no fertilization was applied (Qiu et al., 2022). The findings indicate that the grain yield was significantly influenced by the interplay potassium (K) fertilizers. The impact of different rates of K on grain yield ranged from 1041 to 4392 kg ha^{-1}. It was observed that all plots that received fertilization had higher grain yield compared to unfertilized plots. Additionally, the grain yield showed a tendency to increase with higher K rates up to 70 kg ha^{-1} (Can et al., 2021). After conducting research, it was established that the most efficient approach to boosting wheat growth and augmenting grain yield with 90.00 kg K_2O ha^{-1} (3194 kg ha^{-1}) was observed in the unfertilized treatment (Yuan et al., 2021).

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 90 kg ha^{-1} produced maximum spike length (10.24 cm), 1000 grains weight (35.36g), grains $spike^{-1}$ (43.63) and grain yield (5168 kg ha^{-1}) were recorded for plots applied with potassium (K_2O) at the rate of 90 kg ha^{-1}. Among the tested Potassium (K_2O) levels, T_4 (80 kg ha^{-1}) showed higher value for emergence m^{-2} (42.99), and leaves $plant^{-1}$ (5.43). The results further indicated the highest leaf area (32.53 cm^2) for plots treated with potassium (K_2O) level of 70 kg ha^{-1}. A potassium level of 90 kg ha^{-1} is recommended for general wheat cultivation in Peshawar, Khyber Pakhtunkhwa, Pakistan.

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