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Effect of potassic fertilizer on yield and uptake of primary nutrients in wheat (*Triticum aestivum* L.)

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Abstract
A field experiment was carried out during the winter (Rabi) season of 2022-23, at the student's research farm, AKS University, Sherganj, Satna (M.P.) to ascertain the effect of different levels of potassium on growth, yield and nutrients uptake of wheat (*Triticum aestivum* L.).The experiment consisted of ten treatments i.e. 0, 10, 20, 30, 40, 50, 60, 70, 80 and 90 kg K_2O/ha. The experiment was laid out in randomized block design with three replications. Growth parameters like plant height and no. of tillers per running meter were noted highest with treatment T_{10} (90 kg K_2O/ha). Yield attributing characters such as spike length, no. of spikelets per spike, test weight and grain yield were found maximum in T_{10}- 90 kg K_2O/ha. Nutrient uptake in seed and straw was noted highest in T_{10}- 90 kg K_2O/ha and all parameters were increased with increasing level of potassium up to 90 kg K_2O/ha. Highest seed yield (4086 kg/ha) was obtained from application of 60 kg K_2O/ha (T_7). Increasing level of potassium up to 90 kg K_2O/ha increased N, P and K uptake in wheat over control. Seed yield, test weight, nutrient uptake were increased significantly with increasing levels of potassium up to 90 kg K_2O/ha.

Keywords: Wheat, potassium, growth, yield and nutrients uptake

Introduction
Wheat (*Triticum aestivum* L.) is the second most important food crop in India after rice (Oryza sativa L). It is often prioritized among grain due to its high nutritional value (70% carbohydrate, 12% protein, 1.7% fats, 2.7% minerals and 2% fiber). India's total production of wheat is 109.58 million tons which is 13.84% global production from 32.46 million hectares. Uttar Pradesh has the highest production at 35.59 million and 30.29% of all Indian production followed by Madhya Pradesh (20.09 million) and Punjab (18.71 million tons).
Potassium is one of the three essential nutrients required for crop growth. In fact, judging solely on the basis of crop removal, the amount of potassium taken up by the crop equals, or in many cases exceeds, the amount of nitrogen. Potassium is multifunctional in plants. It is essential for plant life processes and is found in high concentrations where vigorous growth occurs. It performs many functions in plants such as promoting growth and increasing 2 yield, assisting in the movement of plant matter, strengthening plant tissue and preventing lodging, and increasing plant disease resistance. Potassium plays an important role in maintaining cell membranes by stabilizing emulsions or highly colloidal particles and maintaining an adequate degree of protoplasmic hydration. It also plays a catalytic role, particularly in bacteria, by activating several enzymes that catalyze amino acid incorporation into protein peptide bond synthesis and phosphate group transfer. Potassium is extracellularly mobile in plants and helps to regulate the opening and closing of stomata in leaves and the uptake of water by root cells. The total K content of soils frequently exceeds 20,000 ppm (parts per million). While the supply of total K in soils is quite large, relatively small amounts are available for plant growth at any one time. That's because nearly all of this K is in the structural component of soil minerals and isn't available for plant growth. The amount of K supplied by soils varies due to large differences in soil parent materials and the effect weathering has on these materials. Application of potassium improved the content and uptake of nitrogen, phosphorus, potassium and manganese by wheat crop. Similarly the content and uptake of these nutrients increased with higher level of manganese application. Gupta *et al*. (2020) [1].

Materials and Methods
The current study's field experiment was carried out in the Research Farm at AKS University Sherganj, Satna, Madhya Pradesh, during Rabi, 2022–2023. Geographically, Sherganj is located 322 meters above mean sea level, in latitude 24º58' N and longitude 80º83' E, approximately 2 Kilometres from Satna district headquarters.

The district of Satna has hot, dry summers and cold, dry winters due to its semi-arid, subtropical climate. With a few showers in the winter, the monsoon season (which lasts only until September) accounts for over 80% of the total precipitation. About 950 mm of rain falls there each year. The warmest months, with a maximum temperature of 45 °C, are May and June. With an average low temperature of around 6 °C, January is the coldest month of the year.

The experimental plot's soil had a clay loamy texture, a pH of 7.88, an EC of 0.20 dS/m, and an organic carbon content of 0.71%. The soil has low levels of accessible phosphorus (11.52 kg/ha), low levels of available nitrogen (158.30 kg/ha), and medium levels of potassium (271.50 kg/ha).Ten treatments (T_1 = control, T_2 = 10, T_3 = 20, T_4 = 30, T_5 = 40, T_6 = 50, T_7 = 60, T_8 = 70, T_9 = 80, T10 = 90 kg K_2O/ha) and three replications were used in the randomised block design experiment. Seeds were planted with a spacing of 22.5 cm between rows and 10 cm between plants. To create a beautiful tilth, the experimental field was first prepared by ploughing with a tractor-drawn plough, then harrowing and planking. At a depth of 3 cm, wheat (GW-322) was seeded at a rate of 120 kg/ha. Plant growth characteristics, including plant height and tiller count, were measured. At 30, 60, and 90 DAS, the height of the plants was measured from base to top, and at 30 and 60 DAS, the number of tillers was counted. For the ultimate plant height and tiller count, the average of five plants was taken into account. Specific yield characteristics were extracted from each plot following harvest, including spike length, number of spikelets per spike, 1000 grain weight, and yield. The lab examined the primary nutrients that wheat absorbed. The kjeldahl method (Subbiah and Asija, 1956) [16] was used to estimate nitrogen uptake, the spectrophotometer was used to estimate phosphorus uptake (Olsen *et al*., 1954) [7], and the flame photometric method (Jackson, 1973) [3] was used to estimate potassium uptake.

Results and Discussion

Table 1 presents the significant effects of varying potassium levels on growth parameters, including plant height and tiller count. The results indicate that greater potassium levels led to a considerable increase in plant height and tiller count. According to the research, the application of 90 kg K_2O/ha led to noticeably greater plant height and the largest number of tillers, followed by the application of 80 kg K_2O/ha. The increased nutrient availability caused by potassic fertiliser during the crop growth phases-where potassium was supplied at the start and later stages by a gradual and steady release of potassium-may be the cause of this rise in the height of the wheat plant. Potassium plays a crucial role in the meristematic growth through its effect on the synthesis of phytohormones, increasing the leaf area and chlorophyll contents of Wheat leaf and also contribute in nitrogen uptake in the plant. These findings are consistent with those of Kumar *et al*. (2017) [6], Chaturvedi (2006) [2] and Singh *et al*. (2012) [12].

A crop's final yield is mostly determined by its yield characteristics, which include spike length, the number of spikelets per spike, grain yield, and test weight (1000 seed weight), all of which were found to be significantly correlated with rising potassium levels (see table 2). Spike length, test weight, grain weight, and the number of spikes per plant were all much larger with the treatment of 90 kg K2O/ha than with the application of 80 kg K_2O/ha. Better nutrient availability during the crop's growth and reproductive phases may have contributed to the increase in yield characteristics of wheat. This increased the number of spikelets per spike, spike length, yield, and test weight, as well as the supply of additional photosynthates from sink to source.

The application of 90 kg K_2O/ha, followed by 80 kg K_2O/ha, resulted in a significantly higher nitrogen, phosphorus, and potassium absorption by grain and straw of wheat among the treatments. It was shown that the maximal nutrients uptake increased with rising potassium levels. Due to the availability of additional potassium in suitable proportions during the crop's development and reproductive stages, which was provided by chemical fertiliser, wheat's absorption of nitrogen, phosphorus, and potassium was improved under these treatments. These results align with the research conducted by Singh *et al*. (2016) [11], Vandana *et al*. (2008) [17], and Singh *et al*. (2015) [13].

Table 1: Effect of different levels of Potassium on growth parameters such as plant height @30, 60 and 90 DAS and number of tillers per running meter @30 and 60 DAS

Treatments	Plant Height (cm)			Number of Tillers	
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS
Control	24.42	43.27	74.14	2.53	12.00
10 kg K_2O/ha	26.60	44.57	82.70	3.00	26.00
20 kg K_2O/ha	26.85	44.70	85.64	3.27	25.90
30 kg K_2O/ha	28.67	45.87	84.79	3.20	28.37
40 kg K_2O/ha	30.87	47.87	89.55	3.33	30.03
50 kg K_2O/ha	31.74	46.26	85.79	3.53	32.53
60 kg K_2O/ha	32.44	47.48	87.63	3.47	35.10
70 kg K_2O/ha	33.60	48.33	86.84	3.87	35.20
80 kg K_2O/ha	34.17	49.90	89.44	4.20	36.03
90 kg K_2O/ha	35.11	50.91	88.86	4.47	35.97
S. Em ±	0.85	0.64	1.20	0.24	1.69
CD (p=0.5)	2.56	1.92	3.60	0.70	5.07

Table 2: Effect of different levels of Potassium on yield characteristics such as spike length, number of spikelets per spike, grain yield and test weight

Treatments	Spike Length (cm)	Number of Spikelets per Spike	Grain Yield (kg)	Test Weight (g)
Control	5.49	21.33	1633.00	33.43
10 kg K_2O/ha	5.60	28.47	2286.00	36.49
20 kg K_2O/ha	5.90	29.53	2620.00	36.70
30 kg K_2O/ha	5.94	30.83	3180.00	38.87
40 kg K_2O/ha	5.92	34.47	3080.00	41.50
50 kg K_2O/ha	6.09	34.77	3820.00	43.20
60 kg K_2O/ha	6.61	35.50	4086.00	42.67
70 kg K_2O/ha	6.64	35.80	4753.00	44.35
80 kg K_2O/ha	6.56	36.67	3920.00	45.00
90 kg K_2O/ha	6.87	36.24	3910.00	45.47
S. Em ±	0.12	0.23	0.38	1.52
CD (p=0.5)	0.36	0.70	1.15	4.57

Table 3: Effect of different levels of Potassium on nutrients uptake in seed and straw i.e., nitrogen uptake, phosphorus uptake and potassium uptake in seed and straw

Treatments	Nitrogen Uptake (kg/ha)		Phosphorus Uptake (kg/ha)		Potassium Uptake (kg/ha)	
	Seed	Straw	Seed	Straw	Seed	Straw
Control	53.08	18.85	17.14	8.49	15.93	180.96
10 kg K_2O/ha	68.32	23.01	17.26	8.79	16.51	200.99
20 kg K_2O/ha	78.55	26.22	20.47	9.13	17.45	209.25
30 kg K_2O/ha	78.02	27.58	23.21	9.42	20.32	207.66
40 kg K_2O/ha	93.13	31.29	22.29	9.99	20.45	222.60
50 kg K_2O/ha	87.98	34.40	27.22	10.26	21.59	239.46
60 kg K_2O/ha	96.32	35.55	26.02	11.51	23.38	243.85
70 kg K_2O/ha	100.82	38.82	26.44	12.07	25.74	229.17
80 kg K_2O/ha	97.37	43.13	25.38	13.76	24.62	238.55
90 kg K_2O/ha	101.80	42.48	26.54	14.56	25.12	250.69
S.Em ±	2.66	1.71	0.82	0.87	0.88	2.41
CD (p=0.5)	7.98	5.12	2.46	2.61	2.65	7.21

Conclusions

One of the most crucial minerals for the growth and development of crops, potassium has a major impact on the yield, growth, and nutrient uptake by wheat plants. Higher potassium levels improved wheat yield characteristics (Spike length, number of spikelets per spike, grain yield (kg/ha), test weight (g), and growth characteristics (Plant height, cm) and number of tillers. They also improved wheat's ability to absorb nutrients (Nitrogen, phosphorus, and potassium). It was discovered that applying 90 kilogramme of K_2O /ha to wheat produced the best growth.

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