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Impact Of Potassium On Wheat Crop Growth, Yield Component And Accumulation Of Macronutrients

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Abstract

Potassium fertilization can be used to maintain plant growth, nutrient uptake, and yield. To investigate the impact of wheat's accumulation of macro nutrients on varying potassium rates,a split plot design with four replicates experiment was carried out. The findings showed that there was a significant impact of varying potassium levels on wheat growth and grain yield. When compared to (control) plots that did not receive potassium application, the application of 100% potassium increased the majority of the wheat crop's growth, yield components, and nutrient accumulation from 20% to 50%. While potassium applications of 50% and 25% increased growth and yield components by 4–20%, potassium application at 75% also significantly increased growth and yield components from 8–40% when compared to control. However, there was a 4–20% increase in the growth and yield components when potassium was applied at 50% and 25%. The application of potassium increased the nitrogen content in grain by 3–6% and in straw by 2–11% when compared to plots that did not receive potassium. In contrast, the potassium application raised the potassium contents in grain by 50–154% and in straw by 70–140% when compared to control plots. However, potassium fertilization increased phosphorus contents by 2–10% in grain and 3–50% in wheat crop straw when compared to plots without potassium nutrition. Potassium levels of 25%, 50%, 75%, and 100% were all significant, suggesting that the optimal level for maximizing grain yields in wheat crops was 100%. The application of potassium nutrition improved all growth and yield components as well as the accumulation of potassium, phosphorus, and nitrogen in wheat crop grain and straw,according to the study's findings.

Key word- Macronutrients; Potassium; Wheat

Introduction-

Wheat is the primary source of energy for the global human diet and the food consumed by billions of people worldwide. Approximately 840 million tons of wheat, which currently provide 68% of the calories and protein in the world's diet, would be needed by 2050 at its present production level of 642 million tons India is the one of the top ten countries in the world for wheat production .Among the elements given to wheat, potassium is the most crucial component for plant growth. It is essential for the action of enzymes involved in photosynthesis, the synthesis of proteins and carbohydrates, and the ability to withstand pests and illnesses . The soils in our nation receive the greatest and comparatively big quantity of total K^+ as an insoluble mineral component. But only a tiny percentage is accessible to plants .A deficiency of potassium and a reduction in production might result from applying an insufficient amount of potassium fertilizer to silty and sandy loam soils for a number of years .Sustainable crop production is hampered by K^+ depletion, particularly for wheat crops. Therefore, knowledge of the K^+ requirements of wheat through balanced fertilization is crucial, and this knowledge

is based on the soil's K^+ state. Plants require potassium for a variety of reasons, including cell metabolism, enzyme activation, and improved crop quality and plant growth .

Materials and methods-

Two field experiments were carried out at the Experimental site with the help of agriculture research Centre Sriganganagar Rajasthan, during season 2021-2022 and 2022-2023. The experimental design was split plot with four replicates. Raj-3077 wheat seeds were planted in late October for the first and second seasons, respectively. At a rate of 60 kg/fed, seeds were dispersed evenly. As advised, the remaining cultural customs were followed. After harvesting, surface soil samples (0–20 cm layer) were taken from each plot and allowed to air dry in order to measure particle size distribution (as determined by the pipette method as described by Gee and Bauder, 1986), soil bulk density (Pa), and saturated hydraulic conductivity (Ks) in undisturbed samples (as described by Black, 1983). Chemical characteristics, such as soil pH, electrical conductivity (Ece), and available N, P, and K, were also assessed using the procedures outlined by Page et al. (1982).

INITIAL PHYSICO-CHEMICAL PROPERTIES OF EXPERIMENTAL SOIL

S.N	Soil Characteristics	Values
1	Mechanical Composition	
	(i) Coarse sand (%)	24.40
	(ii) Fine sand (%)	56.60
	(iii) Silt (%)	9.40
	(iv) Clay (%)	7.40
	(v) Textural class	Loamy sand
2	Physical Properties	
	(i) Bulk density (Mg m^{-3})	1.49
3	Chemical Properties	
	(i) pH	8.50
	(ii) ECe (dS m^{-1}) at 25^0C	2.54
	(iii) CEC [c mol (p^+) kg^{-1}]	5.15
	(iv) Exchangeable Na [c mol (p^+) kg^{-1}]	1.08

	(v) $CaCO_3$ (g kg^{-1})	16.08
	(vi) O.C (g kg^{-1})	1.80
	(vii) A.N (kg ha^{-1})	133.60
	(viii)A.P (kg ha^{-1})	9.48
	(ix) A.K (kg ha^{-1})	159.15

Initial Properties of Experimental Soil
O.C=Organic Carbon A=Available

Treatments five T1 =Control, T2 = 25 kg K2O ha^{-1}, T3 = 50 kg K2O ha^{-1}, T4 = 75 kg K2O ha^{-1}, T5 =100 kg K2O ha^{-1}.

Fertilizer application-:

Sulphate of potash (SOP) was used to apply potassium in accordance with planned treatments. The required rates of phosphorus as single super phosphate (SSP) and nitrogen as urea were applied to each plot. At the time of seeding, a full dose of potassium and phosphorus was added, and nitrogen was applied in two equal portions.

Plant analysis: Grain and straw samples were used to analyze nitrogen content (%), phosphorus content (%), and potassium content (%).

Harvesting: Crop was harvested at maturity. All the growth and biomass parameters were recorded.

Statistical analysis: The soil and plant data were statistically analyzed using appropriate statistical procedures. Mean separations were done by CV, SE and LSD by using Statistics version of "**MSTATC**" computer software package.

Result-

Plant height (cm)-

Potassium levels' impact on wheat crop plant height was evaluated, and the findings are shown in Table 1. Split Plots that received 100% potassium fertilization had the tallest plants (98.57 cm), followed by those that received 75% potassium fertilization, which produced an average height of 93.22 cm.When 50 kg K_2O ha^{-1} and 25 kilogram K_2O ha^{-1} of potassium were applied, the plant height decreased to 90.84 cm and 85.5 cm, respectively. But in the control group, which did not receive fertilizer, the lowest plant height of 82.45 cm was recorded. Additionally, adding potassium has positive benefits on plant height. According to the LSD test, statistically speaking, the Significant ($P<0.05$) variations in plant height were observed between potassium levels of 25, 50, 75, and 100.

Spike length in centimeters -
Potassium levels' impact on the wheat crop's spike length was evaluated, and the findings are shown in Table 1.Plots fertilized with 100 kg K_2O ha-1potassium had the longest spike length (9.05 cm), followed by 25 kg K_2O ha-1potassium, which produced an average spike length of 8.35 cm. The spike length decreased to 8.05 cm and 7.72 cm when 50 kg K_2O ha-1 and 25 kilogram K_2O ha-1 of potassium were applied. However, the control group, which did not receive fertilizer, had the smallest spike length, measuring 7.45 cm. Additionally, spike length benefited from the potassium addition. According to the LSD test, the variations in spike length between potassium levels of 25, 50, 75, and 100 were statistically significant ($P<0.05$).

Plant Spikelet's spikeper -
The findings of an evaluation of the impact of potassium levels on the wheat crop's spikelet spikeper plant are shown in Table 1.In plots fertilized with 100 kg K_2O ha-1potassium, the spikelet's spikeper plant yielded the greatest results (11.97), followed by 75 kg K_2O ha-1potassium, which produced an average spikelet's spikeper plant of 10.95. The spikelet's spikeper plant decreased to 10.45 and 9.95 after 50 and 25 kg K_2O ha-1 of potassium were applied.

Without fertilizer, the control group's spikeper plant had the lowest spikelet, measuring 9.42. Potassium addition also has positive benefits on spikelet's spikeper plant. The LSD test indicated that there were statistically significant variations ($P<0.05$) between the potassium levels of 25, 50, 75, and 100 in spikelet's spikeper plants.

Spike plant for grains -

The findings of an assessment of the impact of potassium levels on the wheat crop's grain spikeper plant are shown in Table 1. The plots fertilized with 100 kg K_2O ha^{-1}potassium produced the highest results in terms of grains per spike (67.72), followed by 75 kg K_2O ha^{-1}potassium, which produced an average of 62.65 grains per plant. Using 50 kg K_2O ha^{-1} and 25 kg K_2O ha^{-1} of potassium decreased the number of grains per spike to 58.75 and 54.65, respectively. However, the area without fertilizer had the lowest grain spikeha^{-1}, with 51.6. Additionally, the addition of potassium had positive impacts on each spike of grains. The LSD test indicated that there were statistically significant differences ($P<0.05$) in grains spike-1 between potassium levels of 25, 50, 75, and 100.

Seed Index(1000 grain weight in g)-

The impact of potassium levels on the wheat crop's seed index (1000 grain weight in grams) was evaluated, and the findings are shown in Table 1. The plots that were fertilized with 100 kilogram K_2Oha^{-1}potassium had the greatest seed index (45.20 g), followed by 75 kg K_2O ha^{-1}potassium, which produced an average seed index of 44.13 g. Using potassium at a 50% rate and 25 kg K_2O ha^{-1} caused the seed index to drop to 41.38 g and 40.02 g, respectively. But in the control group, which did not get fertilizer, the lowest seed index of 38.00 g was recorded. Additionally, the seed index improved with the addition of potassium. According to the LSD test, the variations in the seed index (1000 grain weight in grams) between potassium levels of 25, 50, 75, and 100 were significantly.

Grain yield/ plant (g)-

Table 1 shows the findings of an assessment of the impact of potassium levels on the wheat crop's grain yield $plant^{-1}$ (g). In plots fertilized with 100 kg K_2O ha^{-1}potassium, the highest grain yield per plant (12.25 g) was observed; in plots fertilized with 75 kg K_2O ha^{-1}potassium, the average grain yield per plant was 11.65 g. Using potassium at rates of 50 kg K_2O ha^{-1} and 25 kg K_2O ha^{-1} decreased the grain production per plant to 10.82 g and 10.25 g, respectively. But in control, without fertilizer, the lowest grain production per plant 9.55 g was noted. Additionally, the amount of grain produced per plant improved with the addition of potassium. According to the results of the LSD test, statistically, the variations in grain production per potassium levels of 25,50,75,100were significant ($P<0.05$).

Straw yield/ plant (g)-

The results of an evaluation of the impact of potassium levels on the wheat crop's straw production per plant (g) are shown in Table 1.Plots fertilized with 100 kg K_2O ha^{-1}potassium were found to have the highest straw yield per plant (13.40 g), followed by plots fertilized with 75 kg K_2O ha^{-1}potassium, which produced an average straw yield per plant of 12.38g. Potassium was applied at rates of 50 kg K_2O ha^{-1} and 25 kilogram K_2O per ha^{-}

which decreased the straw production per plant to 12.05 g and 11.42 g, respectively. However, the control group, which did not get any fertilizer, had the lowest straw production per plant, weighing 10.95 g. Additionally, the amount of straw produced per plant improved with the addition of potassium. According to the LSD test, statistically, the variations in straw output per plant between potassium levels of 25, 50, 75, 100 were significant ($P<0.05$).

Table 1. Effect of potassium levels on agro-traits of wheat crop during 2021-2022 and 2022-2023 seasons.

Treatments	Plant height(cm)	Spike length(cm)	Grain spike^{-1}	Seed Index (g)	Grain yield plant^{-1} (g)	Straw yield plant^{1} (g)
K0	82.45	8.4	51.6	24.00	9.55	10.95
K25	85.5	8.7	54.65	24.32	10.25	11.42
K50	90.84	9.4	58.75	25.80	10.82	12.05
K75	93.22	9.5	62.65	30.13	11.65	12.38
K100	98.57	10.5	67.72	33.20	12.25	13.40
CV	0.07	1.50	0.109	0.144	0.11	0.11
SE	0.2062	0.086	0.1238	0.1200	0.0303	0.0829
LSD (0.05)	0.4492	0.187	0.2698	0.2615	0.06	0.18

The percentage of nitrogen in grain -

Table 2 displays the results of an assessment of the nitrogen content of wheat crop grain.Grain fertilized with 100 kilogram K_2O ha^{-1} potassium had the highest nitrogen content (3.03%), followed by 75 kg K_2O ha^{-1}potassium, which had an average nitrogen content of 2.88%. Grain's nitrogen concentration decreased to 2.55% and 2..35%, respectively, when potassium was applied at rates of 50 kg K_2O ha^{-1} and 25 kilogram K_2O ha^{-1}. However, the grain with the lowest nitrogen level (2.08%) was the control, which did not receive any fertilizer.

The proportion of nitrogen in straw -

The findings of an evaluation of the nitrogen content of wheat crop straw are shown in Table 2.The maximum nitrogen content (0.79%) was found in straw fertilized with 100 kg K_2O ha^{-1}potassium, followed by 75 kg K_2O ha^{-1}potassium, which had an average nitrogen content of 0.76%. Applying potassium at rates of 50 kg K2O ha^{-1} and 25 kg K_2O ha^{-1} reduced the nitrogen content of grain to 0.75% and 0.72%, respectively. However, the control straw, which was not fertilized, had the lowest nitrogen content (0.70%).

Treatments	Nitrogen content in grain (%)	Nitrogen content in straw (%)	Potassium content in grain (%)	Potassium content in straw (%)	Phosphorus content in grain (%)	Phosphorus content in straw (%)
K0	2.08	0.70	0.25	1.15	0.50	0.02
K25	2.35	0.72	0.36	2.14	0.51	0.03
K50	2.55	0.75	0.40	2.65	0.52	0.03
K75	2.88	0.76	0.54	2.80	0.52	0.04
K100	3.03	0.79	0.60	2.95	0.54	0.05
CV	0.21	2.31	7.21	6.25	3.60	26.62
SE	0.0103	0.015	0.062	0.326	0.006	0.005
LSD (0.05)	0.0224	0.0201	0.0515	0.2139	0.0168	0.0119

Table 2. Effect of potassium levels on different ions concentration of wheat crop during 2021-2022 and 2022-2023 seasons.

Grain's potassium content (%)

The findings of an assessment of the potassium content of wheat crop grain are shown in Table 2.Plots fertilized with 100 kilogram K_2O ha^{-1} potassium had the greatest potassium content in grain (0.60%), followed by plots fertilized with 75 kg K_2O ha^{-1} potassium, which produced an average potassium content in grain of 0.54%.When potassium was applied at rates of 50 kg K_2O ha^{-1} and 25 kilogram K_2O ha^{-1}, the amount of potassium in grain decreased to 0.40% and 0.36%, respectively. However, the control, fertilizer-free grain had the lowest potassium amount (0.25%).

Potassium content in straw (%)

Table 2 displays the findings of an assessment of the potassium concentration in wheat crop straw.The greatest outcomes of 2.95% phosphorus content in straw was observed in plots fertilized with 100 kilogram K_2O ha^{-1} phosphorus, which was closely followed by 75 kg K_2O ha^{-1} phosphorus, yielding an average 2.80% phosphorus content in the straw.

Straw's phosphorus concentration decreased to 2.65% and 2.14%, respectively, when potassium was applied at rates of 50 and 25 kg K_2O ha^{-1}. However, the control group, which did not receive fertilizer, had the lowest phosphorus concentration in the straw (1.15%).

phosphorus content in grain (%)

Table 2 displays the results of an assessment of the phosphorus content of wheat crop grain.The greatest outcomes of Plots fertilized with 100 kilogram K_2O ha^{-1} phosphorus saw the highest phosphorus content in grain (0.54%), followed by plots fertilized with 75 kg K_2O ha^{-1} phosphorus, which produced an average phosphorus content in grain of 0.52%. Grain's phosphorus level dropped to 0.51 percent, and this decrease continued when potassium was applied at rates of 50 kg K_2O ha^{-1} and 25 kilogram K_2O ha^{-1}. However, the grain with the lowest phosphorus content (0.50%) was the control, which did not receive any fertilizer.

phosphorus content in straw (%)

Wheat crop straw's phosphorus content was measured; the findings are shown in Table 2.The top outcomes of Plots fertilized with 100 kilogram K_2O ha^{-1} phosphorus showed a phosphorus concentration of 0.05% in straw, similar to 75 kg K_2O ha^{-1} phosphorus, which produced an average phosphorus content of 0.04% in the straw. Applying potassium at a rate of 50 kg K_2O ha^{-1} and 25 kilogram K_2O ha^{-1} caused the phosphorus concentration in straw to drop to 0.03%. Without fertilizer, the control group's straw had the lowest phosphorus concentration (0.02%).

Discussion-

Essentially, one of the minerals needed for plant growth and wheat grain formation is potassium. depletion of potassium from soils and low potassium levels have adverse effect on crop yields.The results that effect of different potassium levels on the growth and grain yield of wheat was significant ($P<0.05$).Plant height of 98.57 cm and spike length of 10.5 cm were the outcomes of the maximum potassium of 100%.The highest potassium level of 100% resulted in 98.57 cm plant height, 10.5 cm spike length,67.72 is grains spikeper plant, 33.20 g seed index (1000 grain weight), 12.25 g grain yield per plant, 13.40 g straw yield per plant, 3.03% nitrogen content in grain, 0.79% nitrogen content in straw, 0.60% potassium content in grain, 2.95% potassium content in straw, 0.54% phosphorus content in grain and 0.05% phosphorus content in straw. The application of potassium at the rate of 75% resulted in 93.22 cm plant height, 9.5 cm spike length per plant ,62.65 grains spike per plant ,30.13 g seed index (1000 grain weight, g), 11.65 g grain yield plant per plant ,12.38 g straw yield plant per plant, 2.88% nitrogen content in grain, 0.76 % nitrogen content in straw, 0.54% potassium content in grain, 2.80% potassium content in straw, 0.52% phosphorus content in grain and 0.04% phosphorus content in straw.The application of potassium at the rate of 50% resulted in 90.84 cm plant height, 9.4 cm spike length per plant ,58.75 grains spike per plant ,25.80 g seed index (1000 grain weight, g), 10.82 g grain yield plant per plant ,12.05 g straw yield plant per plant, 2.55% nitrogen content in grain, 0.75 % nitrogen content in straw, 0.40% potassium content in grain, 2.65% potassium content in straw, 0.52% phosphorus content in grain and 0.03% phosphorus content in straw.The application of potassium at the rate of 25% resulted in 85.5 cm plant height, 8.7 cm spike length per plant,54.65 grains spike per plant ,24.32 g seed index (1000 grain weight, g), 10.25 g grain yield plant per plant ,11.42 g straw yield plant per plant, 2.35% nitrogen content in grain, 0.72 % nitrogen content in straw, 0.36% potassium content in grain, 2.14% potassium content in straw, 0.51% phosphorus content in grain and 0.03% phosphorus content in straw. The split plot having no potassium application (control) produced 82.45 cm plant height, 8.4 cm spike length per plant ,51.6 grains spike per plant ,24.00 g seed index (1000 grain weight, g), 9.55 g grain yield plant per plant ,10.95 g straw yield plant per plant, 2.08% nitrogen content in grain, 0.70 % nitrogen content in straw, 0.25% potassium content in grain, 1.15% potassium content in straw, 0.50% phosphorus content in grain and 0.02% phosphorus content in straw.

conclusion -

It is concluded that potassium fertilization has substantially enhanced wheat yield and yield contributing traits and grain protein content.When potassium was applied, the values for every wheat growth and grain yield component significantly rose. The highest potassium rate of 100 kg K_2O per ha^{-1} enhanced the amount of nitrogen, phosphorous, and potassium in wheat grain and straw and resulted in greater yields.

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