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Potassium Fertilizer Influences Growth Traits and Yield of Wheat (*Triticum aestivum* L.) under Saline Regime

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ABSTRACT

Soil salinity is one of major deleterious abiotic stress limiting the yield of wheat crop. Plant growth & produce is severely affected by various biotic and environmental and metabolic processes. Application of Potash fertilizer can reduce the harmful effects of saline stress and increase crop yield. This research was carried out to evaluate detrimental effects of salinity stress on wheat produce and to suggest appropriate dose of potash fertilizer to achieve optimum production under saline conditions. There were four K doses as (ck, 50, 3/4th and 100 kilogram K_2O/ ha). The results depicted that potash fertilizer application increased wheat crop growth traits and produce substantially under saline regime, significantly. With potassium supplement, height of plant enhanced about 19.23 %, tillers per plant (36.24 %), length of spike (27.33 %) cm, wheat grains (23.5 %), and grain production increased (24.11 %) kg/ha. It was concluded that soil applied potassium fertilizer as K rate at 100 kg K_2O yielded in maximum crop growth development and wheat produce at rate of 50 and 75 kg K_2O ha^{-1}. Therefore, potash fertilizer at rate of 100 kg K_2O ha^{-1} may be adopted for optimum yield in wheat under saline environment.

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INTRODUCTION

Wheat occupies important position as staple food and nutrition through the world, including our country. As a major crop provides sole diet to humans as caloric energy (Sial *et al*., 2018; Kubar *et al*., 2019). The wheat is cultivated on an area of 9.0 m ha area with 25,750 m tones of yield (GoP, 2020-21). Comparatively, this wheat crop yield is much lower than developing countries of world. The main causes behind this low crop yield are the imbalanced chemical fertilization, poor crop management low organic matter and salinity and water logging issues. Worldwide it is noticed that Salinity stress as abiotic limiting factor restricts wheat crop production (Khaliq *et al.,* 2015; Cui *et al*., 2022). The salinity and water logging issue are throughout the world and it is widespread, and is influencing approximately 954 million ha of arable lands across the world (Hussain *et al.,* 2020). Soil salinity is a geochemical process that ensures many saline environments and it results due to increased salt concentration in the root zone. Abundance of salt can pose hazardous effects on plant growth development and yield (Khan and Aziz, 2013). Excessive saline salts can alter germination, crop growth and development of many crops however potassium can reduce the deleterious effect s of salinity (Shahid *et al*., 2020). Salinity stress has many adverse effects on vegetative biomass production by altering crop morphology and physiology (Hussain *et al.,* 2013; Chen *et al*., 2016). Due to saline stress quantum of species of reactive ready oxygen in plant biomass cells is elevated that ends in deterioration of cell membrane. Further, osmotic stress due to salts restricts roots ability of ions and water uptake and is countered by potash application (Tahir *et al*., 2021). It is well known that various species of crops vary in tolerance to bear salinity, which relies on the phonological aspects of crop growth traits.

Potassium is 3rd most important necessary for crop growth and development. Almost all photosynthetic activity metabolic activates as nutrients and water uptake of synthesis protein carbohydrate and, fruit formation, opening of stomata pores and boosting production (Patil *et al*., 2011; Ashraf *et al*., 2013). Potash assists in sugar translocation; root system strengthens, improves fruit and vegetable quality, and lessens the effects of crop lodging (Tahir *et al*., 2021). Balanced K application alleviates salinity stress in crops grown. Potassium resists diseases, counters drought and frost, soil salinity and quality improvement agricultural produce (Hussain *et al*., 2020; EL Sabagh *et al*., 2021). It is proven that with potassium supplementation crop growth improves and reduces salinity effects to great extent in wheat (Safaa *et al.,* 2013). Salinity is major soil related issue and we have lived with the saline environments. There is dire need to increase crop yields with saline conditions that can be obtained by potash application to soil (Kubar *et al*., 2019; Cui *et al*., 2022). Wheat crop is generally susceptible to salinity and alkalinity as abiotic stress conditions. It responses significantly to K application hence K fertilizer application with saline environment would be an appropriate strategy to counter salinity stress. Previously it was revealed in that potassium application has best effect on wheat production in prevailing saline conditions (Khan *et al.,* 2013; Rahman *et al*., 2014). Thus, this study on wheat and K research was carried out to observe the effects of different potassium rates on wheat crop production under saline conditions at Tandojam with following objectives a) to determine the effects of various potassium application rates on wheat yield b) to evaluate the effect of soil saline conditions on wheat yield.

MATERIALS AND METHODS

The current research study was under taken with potash fertilizer rates on yield of Wheat crop under soil saline conditions.

Experimental area

The research trail was under taken in plot field of Institute of, Salinity Control and Reclamation, Agriculture Research Sindh Tandojam 26 m during season of Kharif latitude 25o 25،40.21 "N, longitude 6831.40" E altitude.

Experimental details

The experiment was designed with four treatments viz., Control (00K), 50 kg, 75 kg and 100 kg K_2O ha^{-1}, respectively in experimental design Randomized Complete Block Design (RCBD) replicated four times. The field plots were 150m^2 area prepared in total there were 16 plots of 9m^2 (3×3). The rest of area was allocated for water channels and paths. Wheat crop variety Sindhu was chosen for this research trail and wheat seed was collected from the Chemistry Section, ARS Tandojam Hyderabad. All designed sub plots received nitrogen and phosphorous uniformly at rate of 168 kg N Urea & 82 kg $P_2 0_5$ DAP, respectively.

Soil Sampling and Processing

The experimental plot subdivided into 4 distinct blocks before sowing. The soil samples were collected (0-15 and 15-30 cm) soil depth with auger from each representative block. Around four samples from each depth were chosen and collected from the various depths were mixed to make one composite sample for every block. Soil samples were placed in plastic wrappers and shifted to the laboratory for further process and analysis methodology. The soil samples were then processed in the laboratory for detailed analysis. Soil samples were air dried crushed and sieved using 2mm dia sieve in lab. The sieved samples were kept in anaerobic conditions for subsequent lab analysis: Soil water extract 1: 10 ratio of EC (dS m^{-l}) and pH by EC and pH meter (Richards, 1954, Sultanpur and Shuwab, 1969), soil textural class by Boyouocos hydrometer method (Hesse, 1971), organic matter by Walkley-Black method (Walkley 1947), nitrogen by calculating from organic matter levels, available P by Olsen (Olsen *et al*., 1954) spectrophotometer, potassium (K) by NH_4AOC through flamephotometer.

Agronomic observations

At time of harvest 5 healthy plants were chosen from every replicate of each treatment sub plot. Agronomic observations included plant height; the height was measured from tip to bottom with scale and tillers were calculated manually. The spike length was also observed. Manual threshing was performed for threshing and separation of straw and grain. The grains in every plant were counted manually for all the representative plots.

Table 1. Characteristics of experimental soil used for experiment.

S. No.	Properties		Values
1.	Texture	Sand (%)	41.11
		Silt (%)	9.46
		Clay (%)	43.18
		Texture Class	Clay
2.	EC (dS m^{-1})		3.14
3.	pH (1:2.5)		8.5
4.	Percent Organic matter (%)		0.60
5.	Ca^{+2}(meq l^{-1})		6.1
6.	Mg^{+2} (meq l^{-1})		4.35
7.	Na^{+} (meq l^{-1})		51.54
8.	Cl^{-} (meq l^{-1})		25.28
9.	K^{+} (mg kg^{-1})		48.01

Data collection and analysis

Data analysis was subject means values under ANOVA for each representative treatment and every parameter comparison using (Statistix 8.1 software).

RESULTS

Effect of Potassium rates on Plant height

Potassium supplementation showed a positively significant influence on height of plants. There was increase in height of plants with increasing dose of K applied. The highest height of plant (59.32) was recorded in plants with treatment 4 at 100 kg K_2O ha^{-1}. However, minimum was observed in control level as given in figure 1.

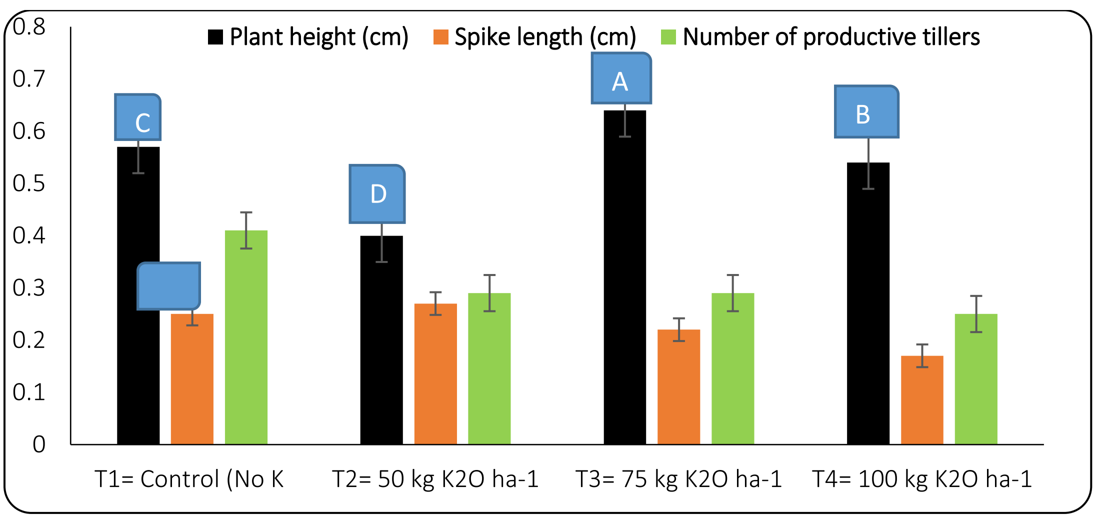

Figure 1. Mean performance of Plant Height, Spike Length and Productive tillers^{-1}with respect to Potassium fertilizer in all three treatments.

Effect of potassium rates on tillers Spike length

The soil application of potash had positive effect on productive tillers produced in wheat crop under saline conditions of stress. The crop plants with potash supplement yielded more maximum tillers than with plants with no K applied. However, K application at dose of 75 kg and 100 K_2O ha^{-1} produced maximum number (8.25 and 7.50) of tillers under saline conditions. The least no of tiller (5.0) was observed in the plots where no K was soil applied as presented in Figure 1.

Spike length was substantially affected through potash application on under saline environment. Soil K applied wheat crop plots depicted higher spike length than with no K supplied plots. The K^+ supplement at level 75 and 100 kilograms K_2O ha^{-1} was tantamount to each other statistical (7.88 and 8.50), afterwards 50 kg K_2O ha^{-1} that yielded 7.33 cm of spike length. The control plots had spike length of 6.25 cm of wheat crop.

Effect of K rates on number of grains plant^{-1}

Those wheat plants which were supplied with potassium fertilizer had produced maximum grains than the plots where no potash was soil applied. The K supplement at rate of 100 kg per ha gave elevated grains yield (221.6), thereafter 75 and 50 kg K_2O ha^{-1} that yielded 205.5 and 187 number of grains produced /plant of wheat crop. The plots with no K applied yielded minimum grains (168) of wheat per plant with respect to other plots Figure 2.

Effect of potassium rates on grain yield

Under the saline environment balanced and appropriate soil application of potash increased wheat grain production. Wheat plants which were supplied with potassium fertilizer produced maximum yield in comparison with no K soil application. The application of K at the dose 100 kg yielded in maximum yield (3727 kg), with respect to all treatments of research trial. The potash application at dose of 75 and 50 kg K_2O ha^{-1} producing 3446 and 3727 kg wheat grain ha-1 of produce. The plots with no potash applied treatment yielded lowest wheat grain production with a value of 2902 kg ha^{-1} Figure 2.

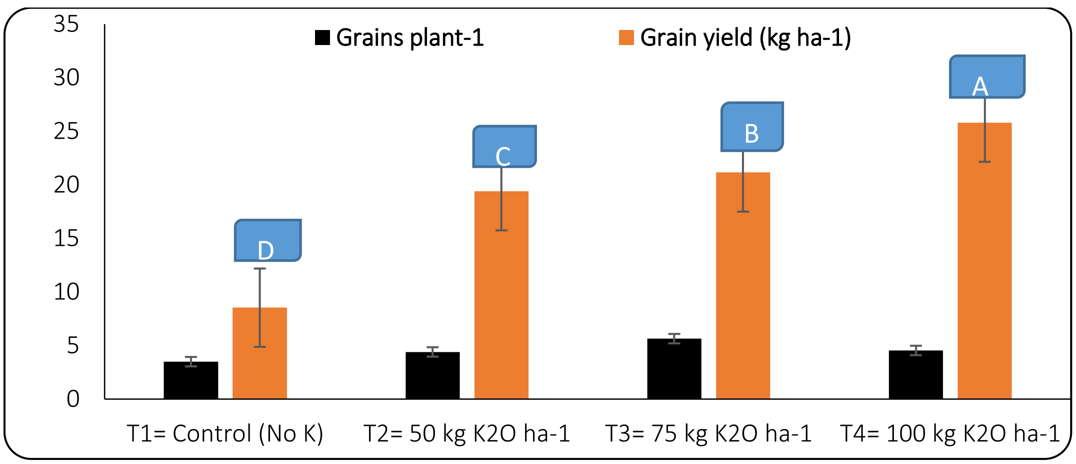

Figure 2. Mean performance of Grain per plant^{-1} and Grain yield by imposing K fertilizer in all three treatments.

DISCUSSION

Effect of K rates on growth traits of wheat

Wheat crop is major cereal crop in world. Salinity stress is a major abiotic factor affecting wheat crop growth development and productivity to higher extent. Excessive salt accumulation in plant system corresponds to retarded crop nourishment (Tahir *et al.*, 2021). Potassium is on the key macro element which is needed by crop. It has many functions in plant to perform in plants, as enzyme activation (involved in the processes of metabolism, photosynthesis starch synthesis, reduction of nitrate, reduces loss of water, nutrients and water uptake, counters climate effect (Cui *et al.*, 2022). Potassium is deemed to improve the soil health, fruits and vegetables quality and environmental health (Brahane *et al.,* 2017). It also decreases the adverse effects of salinity conditions in many crops as well as Wheat yield and growth (Khan and Aziz, 2013; Rasool *et al.*, 2018). The present research trail was asserted to determine influence of potash application on overall wheat yield under salinity stress environments. The obtained results depicted that under saline environment potassium supplementation has resulted in maximum growth and wheat production. All study research parameters were significantly affected by K^+ soil applied rates. These findings clearly reveal that K application enhances tolerance in wheat crop under prevailing saline environments. The catalyzing influence of potassium application under saltish environment for crop especially wheat is endorsed by many researchers of agriculture science. Tahir *et al.*, (2021) revealed that K supplementation lowered the adverse influence of salinity and improves crop biomass and Wheat production. Further, Ashraf *et al.*, (2013) emphasized the K supplement to alleviate salinity stress and to enhance wheat production. However, in another research trail showed and increased salinity bearable to wheat crop and increased production under salinity induced environment.

Effect of various K rates on yield

Present research study, depicts about potassium rates of supplementation interpreted significantly different for various growth traits and development parameters. The appropriate dose of potash for reducing salinity stress of wheat crop, the analyzed different doses as ck, fifty, seventy five and hundred kilogram K_2O/ha. Generally, it was observed that K rates applied increase growth and produce also improved. The findings of our research trail could be coincided with the results obtained by (Hussain *et al*., 2020) while working the potassium rates on the growth and yield f the various wheat cultivars. For growth traits application rate of fifty and 75 kilogram K_2O/ ha were found tantamount, but the rate of hundred kilogram K_2O /ha chemical fertilizer was best for various all parameters tested. The very little characteristics of growth traits and production were recorded crop plants receiving no or less K amendment (EL Sabagh *et al*., 2021). It may be attributed to enhanced levels of potash fertilizer application. Appropriate potassium available in growing medium projects elevated catalyzing of enzymes and photosynthesis, by inducing biomass yield. However, with no K^+ supplementation oxidative stress deforms vegetative growth and biomass yield of wheat crop. These results found are in complete agreement with results of many other researcher workers in this field. Hussain *et al*., (2015) had reported that various doses (0 and 150 kg K_2O ha^{-1}), elevated K (150 kg K_2O ha-1) supplementation had increased yield of wheat growth and development. Further Rady and Muhamad (2015) proved that potassium fertilizer improved the growth traits and yield of wheat crop with salinity conditions, with further K supplied at 80 Kg ha^{-1} than 0, 20, 40 kg K $ha^{-1}$of the K application. In a similar research study, Maurya *et al*., (2014) told that an improved vegetative biomass of crop with the K supplied at 80 kg K_2O ha^{-1} whereas highest biomass yield characteristics were observed while applying 60 and 80 kg potash per hectare.

CONCLUSION

The application of potash fertilizer was effective to reduce the effect of saline environment on wheat crop growth traits nourishment and development. The potash has antagonistic affect K ions may have countered the Na ion by replacing and improving fertility and yield. It is suggested that under saline conditions growers may apply K as for enhanced growth parameters and wheat production under saline environments.

CONFLICT OF INTEREST

The authors declares that they have no conflict of interest.

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