



A STUDY ON BOTANICAL, BIOLOGICAL YIELD AND AGRICULTURAL ASPECTS OF *TRITICUM AESTIVUM*

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ABSTRACT

Wheat (*Triticum aestivum* L.) is the most valuable cereal crop all around the world. Wheat crop needs proper nutrition for its stable growth and better yield. Potassium is one of the most important plant nutrient used for enhancing the wheat production and quality determination. This study was aimed to access the wheat growth and yield influenced by potassium and prevailing temperature under Randomized Complete Block Design (RCBD) with three replicates. The variety evaluated in this study was Punjab 2011 and eight treatments were applied as concentrations; T1= Control (No potash fertilizer application); T2= Potassium 60 kg/ha at sowing; T3= T2 + 2% KNO₃ spray at booting; T4= T2 + 2% KNO₃ spray at grain filling; T5= T2 + 2% KNO₃ spray at booting and grain filling; T6= 1/2T2 + 1/2 dose at booting; T7= 1/2T2 + 1/2 dose at grain filling and T8= 1/3 T2 + 1/3 dose at booting + 1/3 dose at grain filling were applied. Fertilizer 115,85 N.P Kg/ha was applied during seed bed preparation. Biochemical plant analyses were carried under the influence

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of potassium concentration. The recorded data was analyzed by analysis of one way ANOVA. The results revealed that potassium contents in plants had a significant effect on physiochemical attributes. Results shows that increase in plant height (cm), crop growth rate ($\text{gm}^{-2} \text{ day}^{-1}$), fertile tillers per plant, peduncle length (cm), spike length (cm), flag leaf area (cm^2), number of spikelets per spike, grains per spike, thousand grain weight (g), grain yield (kg ha^{-1}), biological yield (kg ha^{-1}), harvest index(%), chlorophyll content (mg/g), K concentration, potassium uptake (mg) and Potassium utilization efficiency ($\text{g mg}^{-1} \text{ K}$) in plant under prevailing temperature. This study will be helpful for improving the efficacy of crop minerals for growth and yields performance.

1. Introduction

Wheat (*Triticum aestivum* L.) is one of the important part of human diet around the world. Wheat is used to feed more than 35% of the world's population. Therefore, it plays a vital role in global food security and its stipulation common from developing countries especially (Ren et al., 2019). Primarily, it is used for making bread, chapati and biscuits. Wheat grain are rich source of starch(60-68%), cellulose (2-2.5%), fats (1.5-2%) and minerals (1.8%). Wheat is considered as a high calories diet because it contains starch(65- 75%) in white flour and starch(60-70%) in whole grain. Ingredients derived from wheat are used as raw assets for industrial food processings (Kumar et al., 2020).

Wheat provides large quantity of carbohydrates, energy and many other elements t like protein, vitamins (particularly B), fiber and chemical substances essential for health. Wheat fiber lowers the risk of heart disease, non-insulin-dependent diabetes and cancer particularly colon cancer (Shewry and Hey, 2022). Wheat has adequate amount of gluten protein that is used for bread making. Due to gluten, bread mixture binds together and becomes capable of absorbing gas. Purify flour of wheat contains less vitamins and causes constipation and malnourishment. The whole grain of wheat contains bran and wheat germ and protects from, heart problem,

weight gain and appendix (Kumar et al., 2020).

Wheat is cultivated in Pakistan from the last many centuries. Soil and weather conditions of Pakistan is most suitable for its cultivation. Mostly, it is grown in dry and semi-arid regions of Pakistan abundantly on a survival basis for daily consumption. Normally, families used 12.55% of their income in buying wheat and flour of wheat(Guo et al., 2019). During 2016-017, 25,482 million tons of wheat production was obtained from 9260 thousand hectare with 8.9% value in agriculture and 1.6% added to GDP of Pakistan. During period of 2018-19, 0.6% less area was used for wheat cultivation which was last year 8,797 thousand hectare and now 8,740 thousand hectares. Area of cultivation significantly decreased due to shifting of other crop cultivation and environmental changes. Although area of cultivation is decreased but production of wheat crop is slightly increased by 0.5% (which was last year 25.076 million tones and during 2021-2022 is 25.195 million tons) (Ahmed el., 2022).

Potassium is the most abundant macronutrient required for crop plants (Bagyalakshmi et al., 2012). Potassium (K) helps to uptake the essential nutrients from soil. It also shows a significant role in enzyme activation for protein and ATP synthesis. Potassium is also involved in the opening and closing of stomata. Potassium has a capability to

accumulate in high amount without displaying any toxicity, which makes it unique. It is also involved in photosynthesis, translocation of carbohydrates and water relation in plant physiology. It induces resistance in plants against several diseases (Brar and Tiwari, 2004). For regulating physiological process, potassium proves to be vital which helps the plant for survival under stress conditions (Çolpan et al., 2013). Adequate potassium supply results in optimal growth, development and higher condition of the entire plant because of better productivity of photosynthesis, energy transfer, translocation of photosynthates, grain filling, increased capability against diseases, and higher water use efficiency (Wang and Wu, 2013). The wheat growth and yield are considerably increased by the application of potassium. Potassium helps to stabilize the actions of various enzymes. It shows a significant role in preparation and translocation of food (Iqbal et al., 2020).

The objectives of this study was to determine the biochemical and physiological parameters, potassium efficiency under prevailing temperature and its effects on plant growth and grain yield of the wheat.

2. Materials and Methods

The experiment was designed to observe Potassium use efficiency as influenced by prevailing temperature and its effect on growth and yield components of wheat (*Triticum aestivum* L.)

Experiment site and conditions

The experiment was conducted on wheat variety (Punjab 2011) during Rabi season (2020-21) in Research Field of Plant Physiology Section, Ayub Agricultural Research Institute, Faisalabad.

Experimental Design

The experiment was accomplished in Randomized Complete Block Design (RCBD). Three replications were made to investigate the experiment and sowing was done in field with plot size of 216 m². The plot was further

divided into 8 small plots with size of 3m×9m. Each small plot was contained 10 rows with row-to-row distance of 23 cm. The fertilizer 115,85 N.P kg/ha was applied. Agronomic practices like drill sowing, irrigations (according to rainfall) and chemical weed control were performed uniformly. Following treatments were applied.

Treatments:

The treatments T1= Control (No potash fertilizer application); T2= Potassium 60 kg/ha at sowing; T3= T2 + 2% KNO₃ spray at booting; T4= T2 + 2% KNO₃ spray at grain filling; T5= T2 + 2% KNO₃ spray at booting and grain filling; T6= 1/2T2 + 1/2 dose at booting; T7= 1/2T2 + 1/2 dose at grain filling and T8= 1/3 T2 + 1/3 dose at booting + 1/3 dose

Sampling

To estimate the growth indices of wheat's varieties, the first sampling was performed thirty days from sowing. Subsequent samples were taken with time interval of seven days. The fresh weight of all samples was measured by weighing balance immediately after harvesting. At the end, these sun-dried samples were placed in an oven at 65± 2 for three days or till the constant weight obtained. By using these leaf area and its dry weight measurements, the subsequent growth traits were computed.

Leaf area (cm²)

Area meter (CI-203) instrument was used to measure the flag leaf area an instrument. 5 plants were taken randomly from each plot in order to performed leaf area analysis(Iqbal et al., 2020).

Plant height (cm)

Plant height of wheat was measured by using the measuring scale. Plants were selected randomly and then measured their height from base to main axis of the plant. For data analysis mean value of height of different plants were calculated from each treatment(Jan et al., 2017).

Biochemical Analysis

Chlorophyll contents

Chlorophyll a and b contents were measured in order to access the pigments rate. For this purpose, 1(g) of fresh leaves of wheat were grinded into pieces. Extract was made at temperature of 10°C for overnight by using 5 mL acetone solution (80%). Then extract was centrifuge at 14000 rpm for five minutes. Absorbance of supernatant were measured by spectrophotometer at 645 nm and 663 nm.

Chlorophyll a contents $[12.7 \text{ (OD 663)} - 2.69 \text{ (OD 645)}] \times V/1000 \times W$

Chlorophyll b contents $[22.9 \text{ (OD 645)} - 4.68 \text{ (OD 663)}] \times V/1000 \times W$

W represents the sample weight and volume of sample denoted by V.

Yield Parameters

Numbers of fertile tillers per plant

The numbers of fertile tillers were measured randomly from each plot of field(Iqbal et al., 2020).

Spike length (cm)

Maximum length of five plants was taken from each plot for substantial analysis(Ren et al., 2019).

Peduncle length (cm)

At maturity peduncle length of selected plants of main tiller was recorded from the upper node of tiller to the base of spike. Average value of peduncle length was calculated after the measurement was done using the meter rod.

Spikelets per spike

Spikelets per spike was taken from five plant of each replication after harvesting(Kumar et al., 2020).

Grains per spike

Numbers of total grains from a spike of mother shoot was recorded after manual threshing of selected plants(Wang et al., 2020).

Biological yield (Kg ha⁻¹)

Biological yield per plot was measured after harvesting. For this purpose, overall weight of

plants was taken from each plot using electrical balance(Ren et al., 2019).

Grain yield (Kg ha⁻¹)

A meter square area of wheat plot was harvested and sundried. Threshed wheat was used for recording the seed yield from each sub plot. The yield was later converted to Kg ha⁻¹(Kumar et al., 2020).

Harvest index (%)

Harvest index was measured after harvesting. It was calculated using the formula given below:

$$\text{Harvest index} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

1000 grain weight (g)

1000 grain weight was counted from each replication after harvesting and their weight was recorded using electrical balance.

Soil analysis

Before Sowing

Two soil samples were taken, one from the depth of 0-15 cm and second sample were taken from the depth of 15-30 cm. After taking soil samples I have checked the N, P, K, organic matter, boron and zinc contents.

After sowing

After sowing only, the K content were taken from all the samples by using automated spectrophotometer.

Plant analysis

Before treatment

Plant samples were taken from plots to check the effect of K concentration. Plant analyses were done by using digestion method.

After treatment

For the analysis of K concentration, samples were taken from plots after applying treatment. by digestion method. 0.1g of oven dried sample and put into the digestion flasks, add 3ml of sulphuric acid (H₂SO₄). Keep the reaction mixture for overnight. Place digestion flask on hot plate and heated at 250°C. Add hydrogen peroxide (H₂O₂) drop by drop with the help of glass pipette until unless the flask material was colorless.

K uptake (mg)

Potassium uptake efficiency is used for the determination of plant ability to absorb K nutrient present in soil.

$$KUE = \frac{\text{Shoot dry weight}}{K \text{ uptake}}$$

Statistical Analysis

Recorded data was subjected to analysis of variance by using Statistix 8.1 software. A suitable comparison test was used to determine the differences among treatments

under controlled and potassium used treatments.

3. Results and Discussions

3.1. Plant height (cm).

Fig 1 shows the different for all applied treatments and wheat showed maximum plant height (94.38 cm) under treatment (T3) and minimum plant height that is 85.96 cm was shown by plants under treatment (T8).

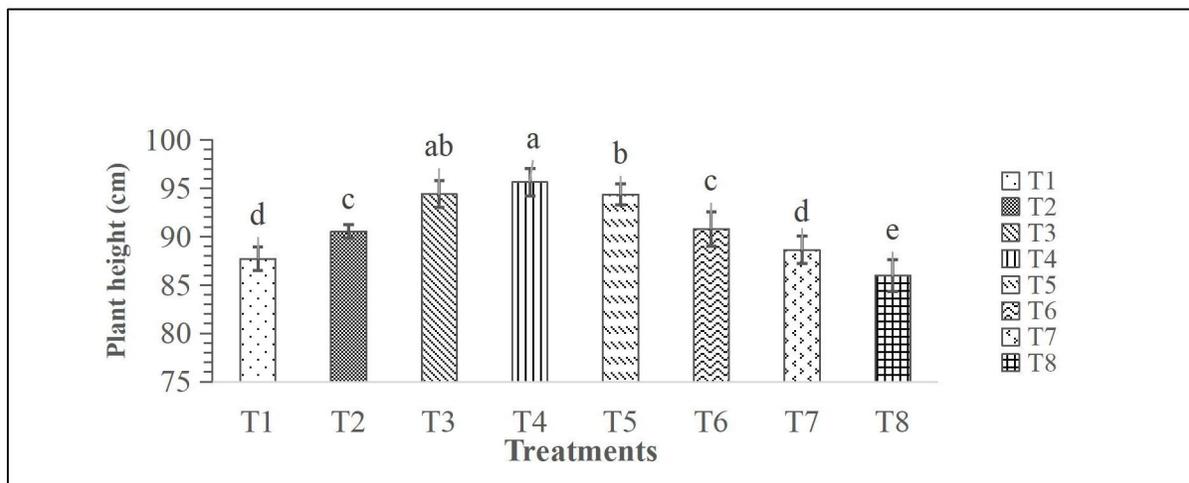


Figure 1: Graph presenting plant height of wheat under potassium (K) treatments

3.2. Chlorophyll a (mg/g)

Fig 2 shows the values for all applied treatments and wheat showed maximum chlorophyll a content of (0.3967) under

treatment (T4) and minimum chlorophyll a content that is 0.2967 was shown by plants under treatment (T8).

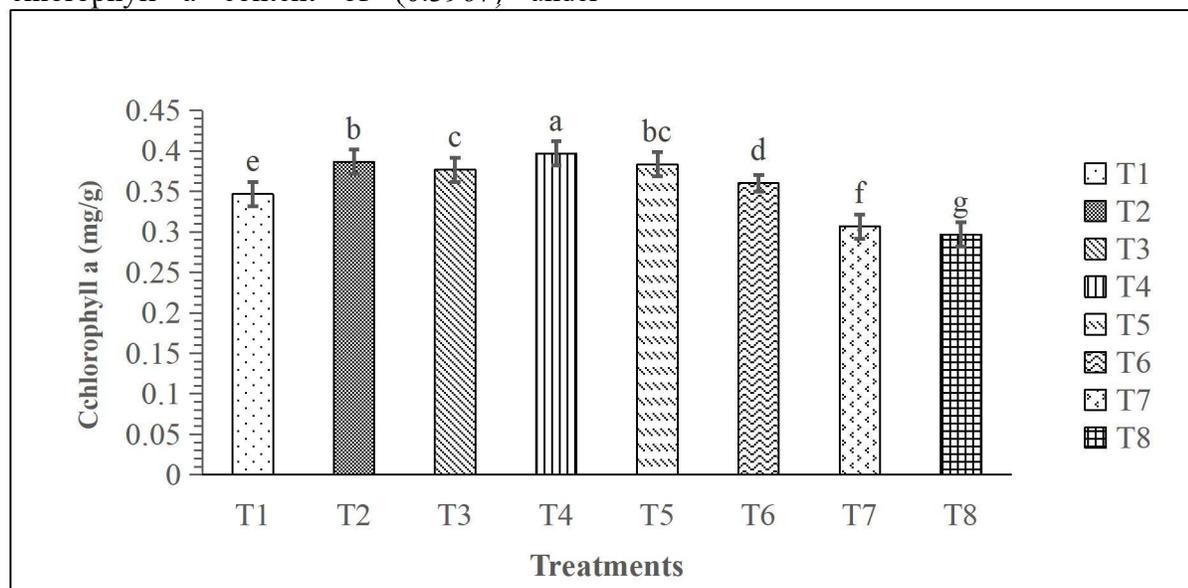


Figure 2: Graph presenting chlorophyll a of wheat under potassium (K) treatments.

3.3. Chlorophyll b (mg/g)

Fig 3 shows the values for all applied treatments and wheat showed maximum chlorophyll b content of (0.3667) under

treatment (T5) and minimum chlorophyll b content that is 0.2067 was shown by plants under treatment (T7).

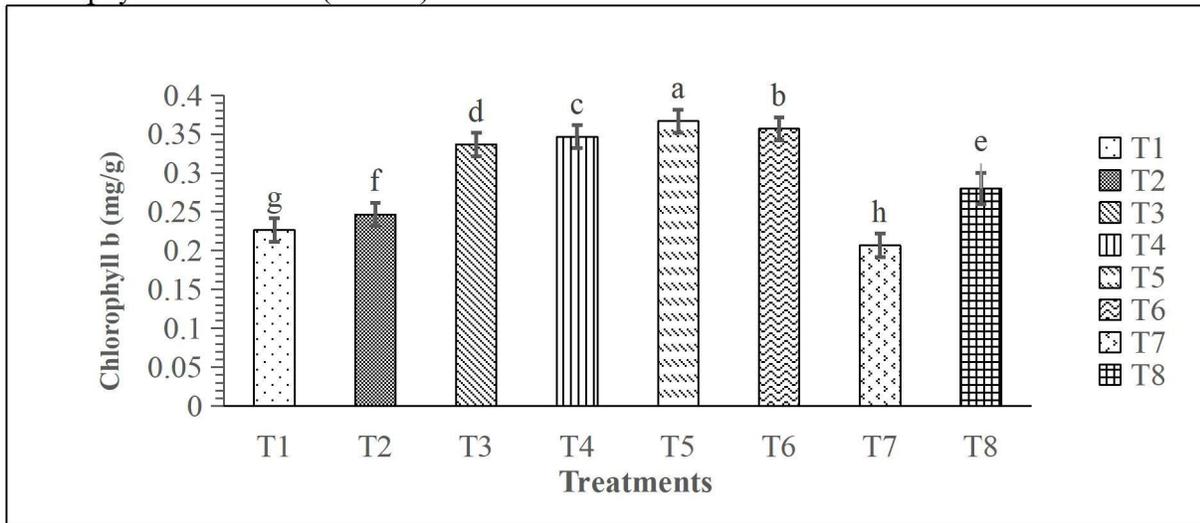


Figure 3: Graph presenting chlorophyll b of wheat under potassium (K) treatments.

3.4. Number of fertile tillers per plant

Fig 4 shows the values for all the treatments. Maximum number of tillers per plant was

observed under treatment T2, T3, T5 and T7 while minimum was marked with controlled treatment (T1).

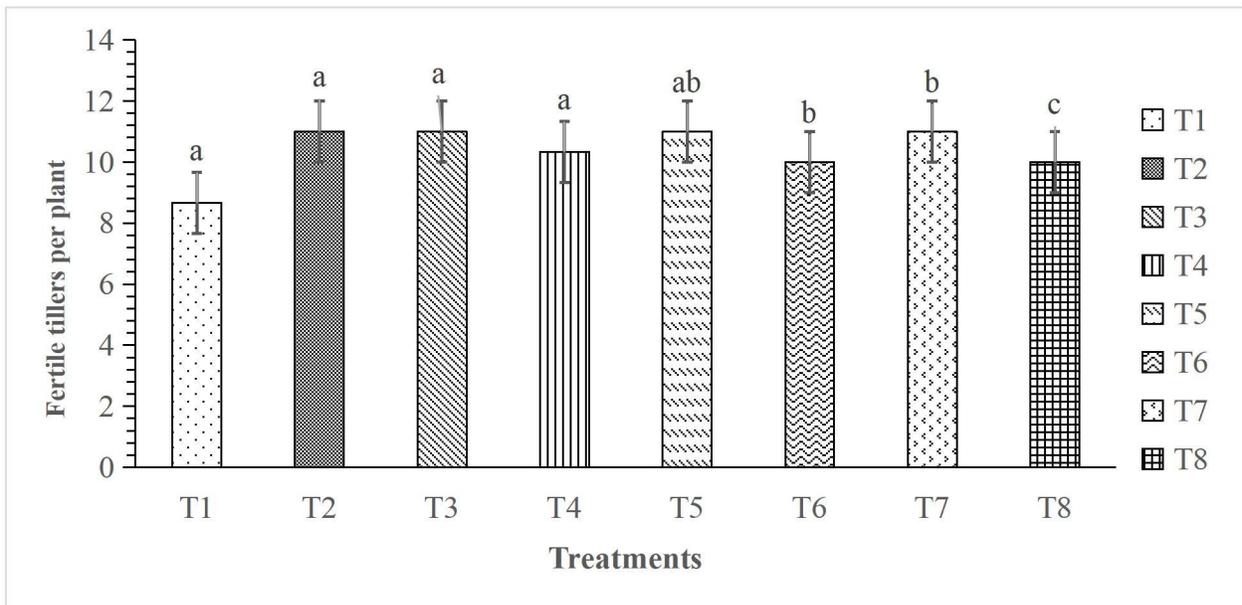


Figure 4: Graph presenting fertile tiller per plant of wheat under potassium (K) treatments.

3.5. Grains per spike

Fig 5 shows the values for all the treatments. Maximum number of grains per spike was

observed under treatment (T5) and minimum was marked with controlled treatment (T1).

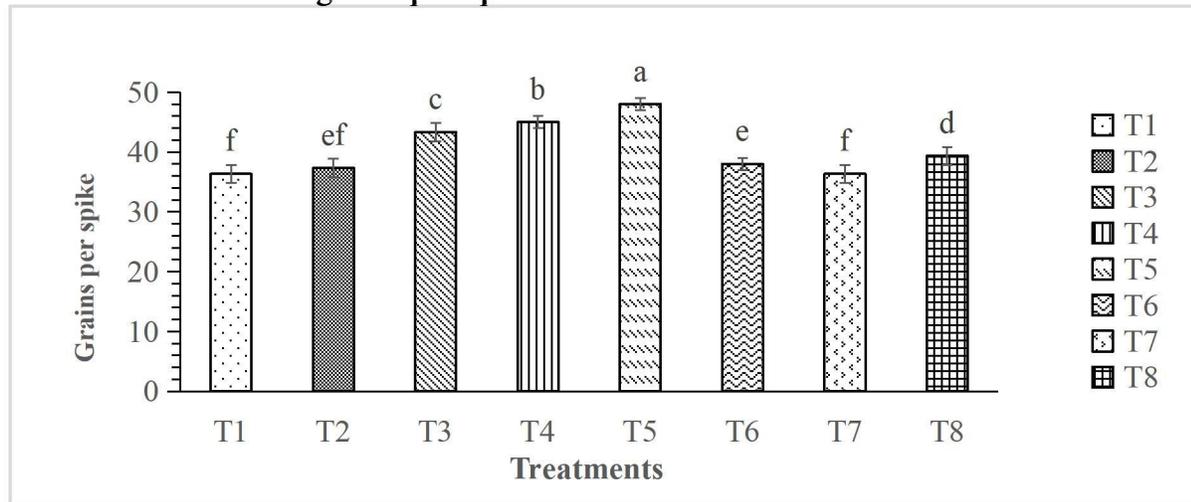


Figure 5: Graph presenting grains per spike of wheat under potassium (K) treatments.

3.6. Spike length (cm)

Fig 6 shows the values for all the treatments for spike length. Maximum spike length (12.3

cm) was observed under treatment T3 while minimum (9.3 cm) was marked with controlled treatment (T8).

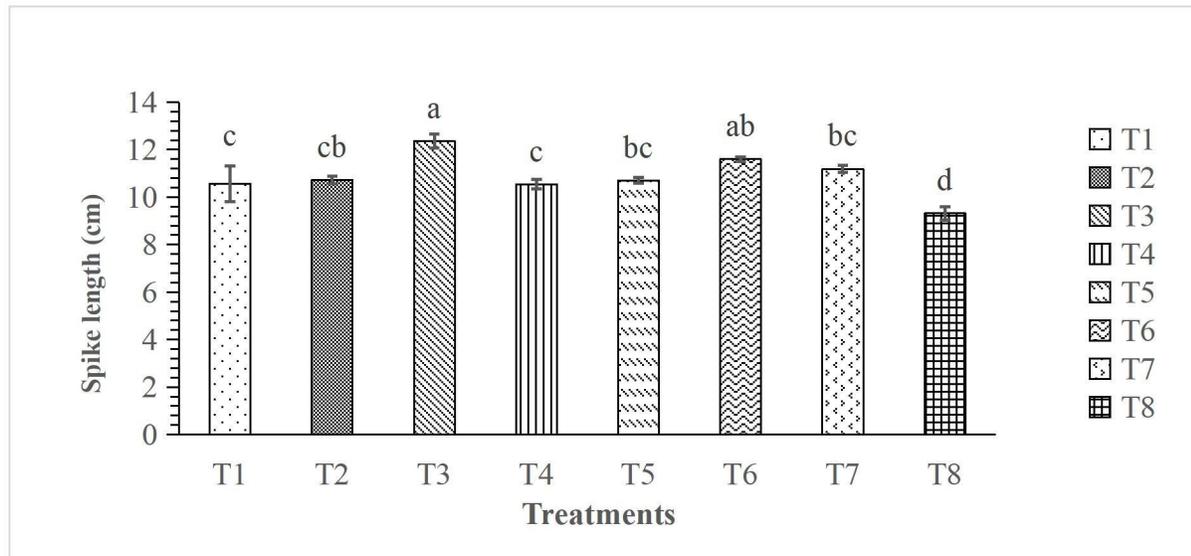


Figure 6: Graph presenting spike length of wheat under potassium (K) treatments.

3.7. Biological yield (Kg ha-1)

Fig 7 shows the values for all treatments. Maximum results for biological yield

observed under T5 with 12775 g as mean value. While minimum observations had been shown by T1 that is 9084 g.

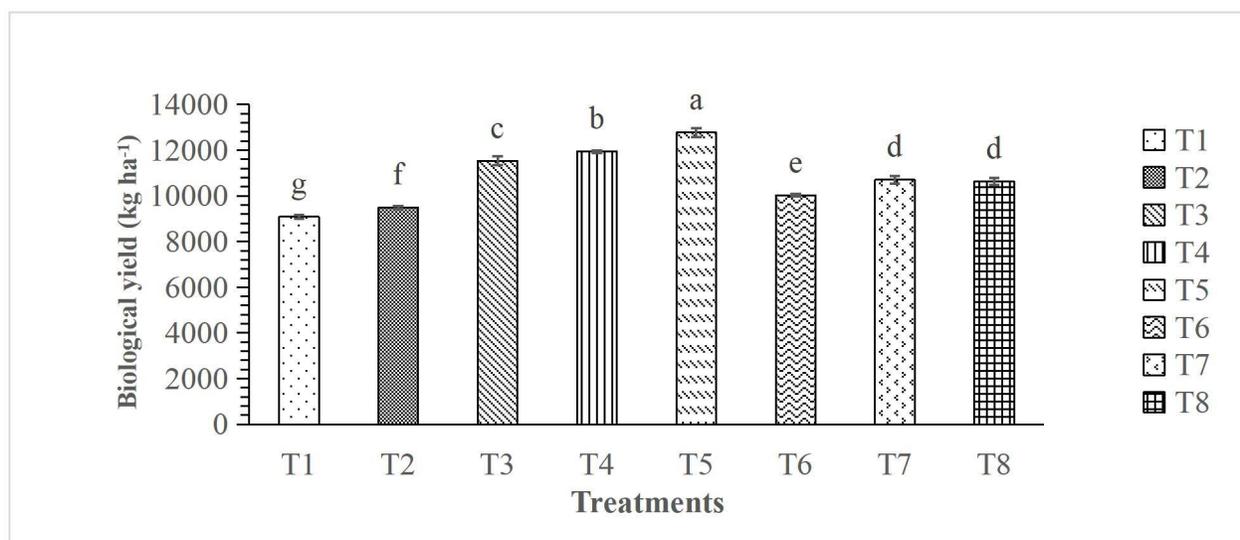


Figure 7: Graph presenting biological yield of wheat under potassium (K) treatments.

3.8. Grain yield (Kg ha⁻¹)

Fig 8 shows the values for all applied treatments and wheat showed maximum grain

yield of (4928.7) under treatment (T5) and minimum grain yield that is 3248.1 was shown by plants under treatment (T1).

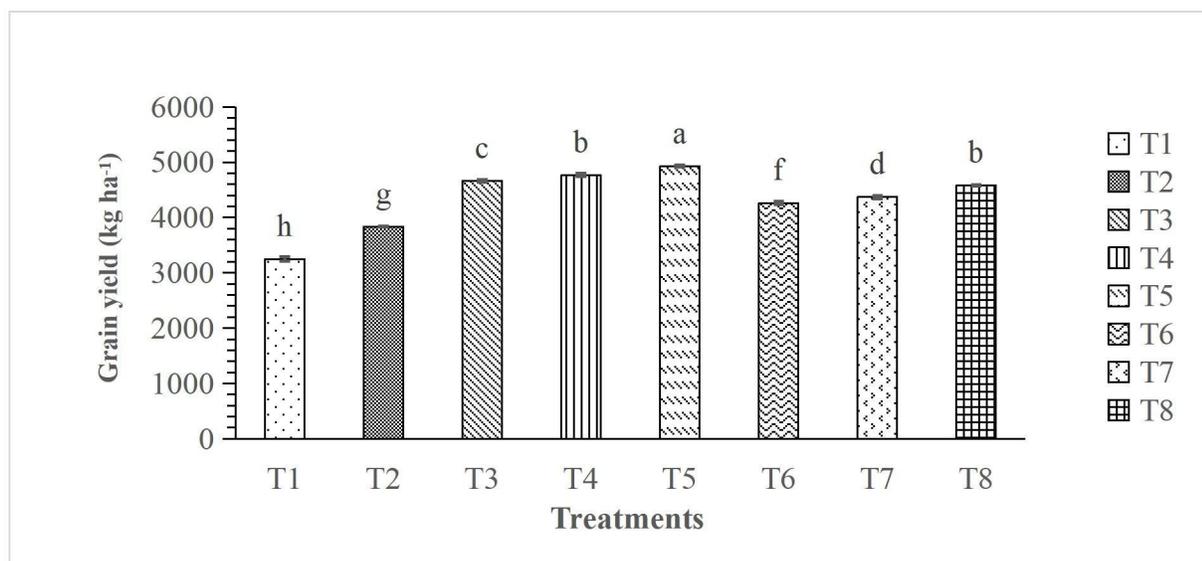


Figure 8: Graph presenting grain yield of wheat under potassium (K) treatments.

3.9. Harvest index (HI) (%)

Fig 9 shows the values for all applied treatments and wheat showed maximum

harvest index of (42.867) under treatment (T8) and harvest index that is 34.640 was shown by plants under treatment (T1).

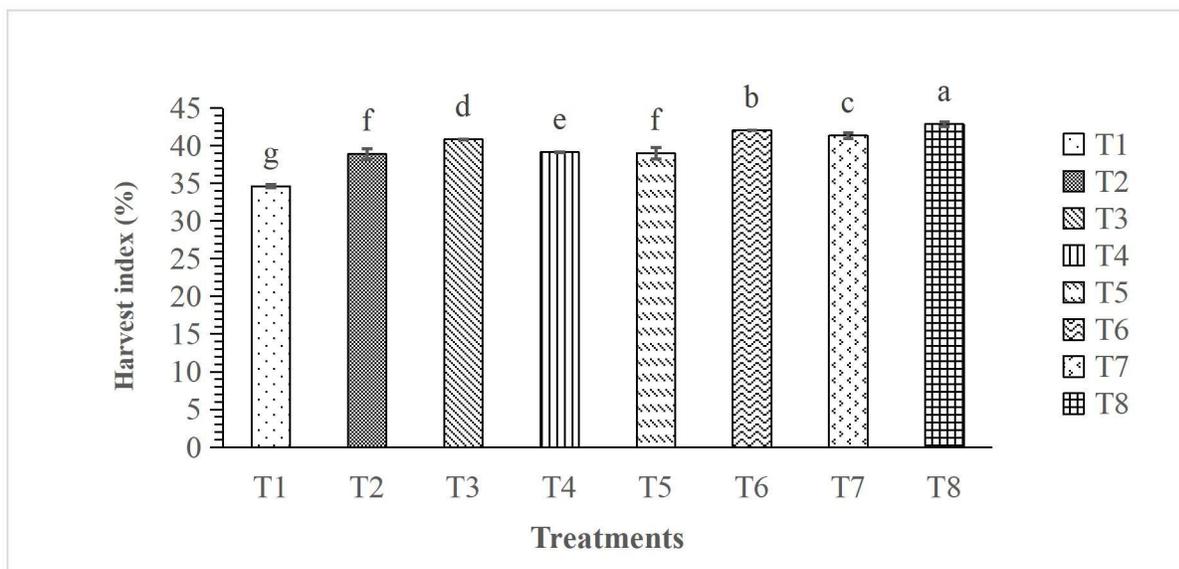


Figure 9: Graph presenting harvest index of wheat under potassium (K) treatments.

3.10. Plant analysis (%) before potassium application

Fig 10 shows the values for all plants before treatments of potassium and wheat showed

maximum values of (1.6000) for plants under treatment T6 but before potassium application, minimum values has been obtained for plants under T4 that is (1.5200).

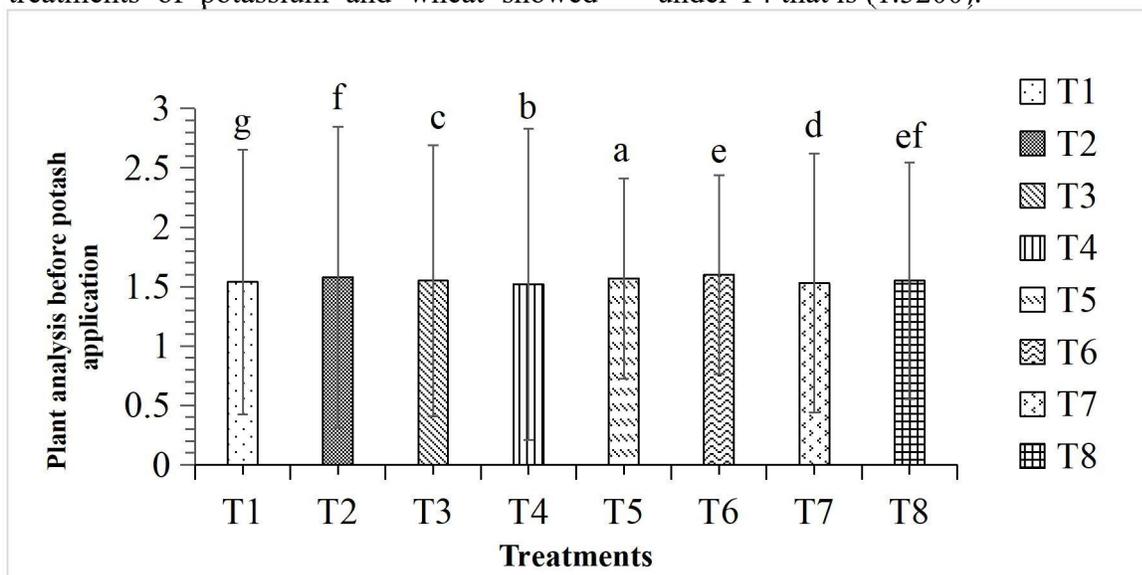


Figure 10: Graph presenting plant analysis before potassium application on wheat.

3.11. Plant analysis (%) after potassium application

Fig 11 shows the values for all plants after treatments of potassium and wheat showed maximum values of (2.6400) for plants under

treatment (T5) after potassium application and minimum values has been obtained for plants under T6 that is 1.8200 with applied potassium.

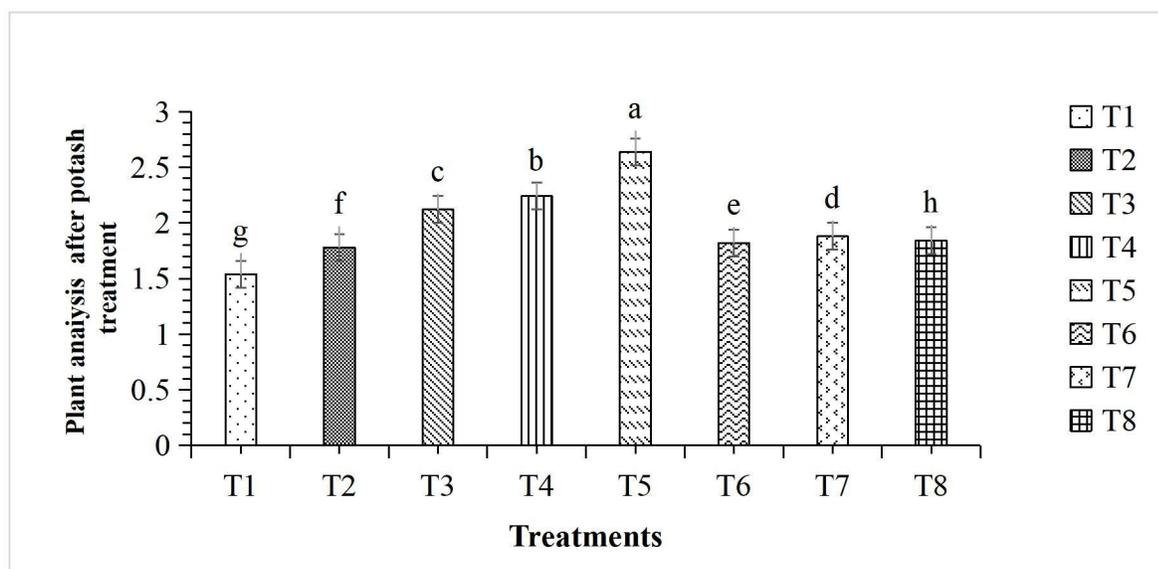


Figure 11: Graph presenting plat analysis after potassium application of wheat.

3.12. Potassium use efficiency ($g\ mg^{-1}\ K$)

Fig 12 shows the values for all plants for efficiency of potassium in selected wheat plants and showed maximum values of

(0.3800) for plants under treatment (T5) with efficiency of potassium application and minimum values has been obtained for plants under T1 that is 0.200.

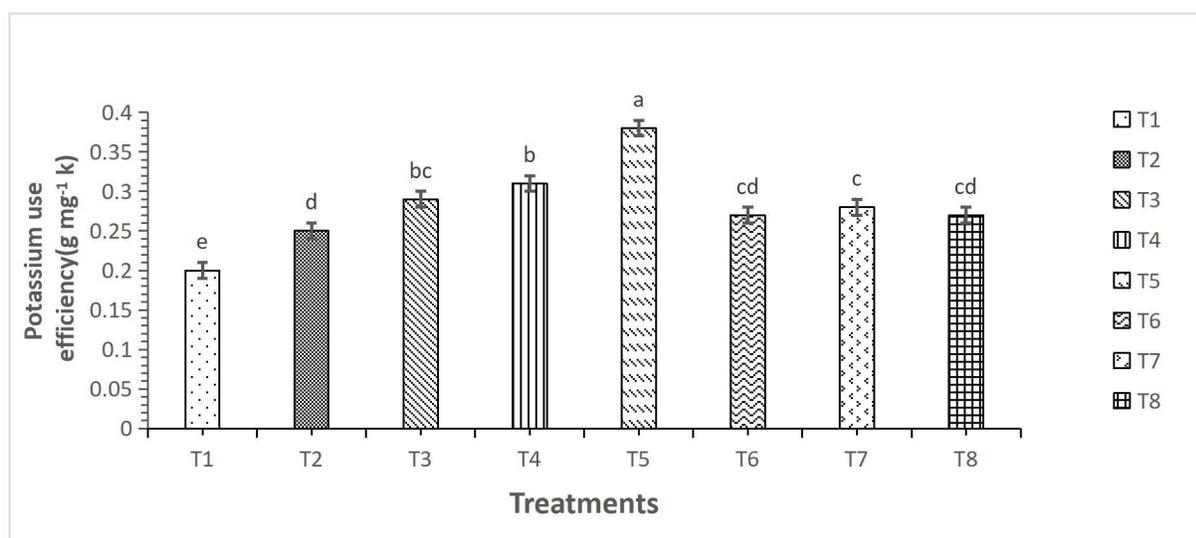


Figure 12: Graph presenting plant analysis for potassium use efficiency on wheat.

3.1

3. Potassium uptake (mg)

Fig 13 shows the values for all plants for potassium uptake and wheat showed

maximum values of (124.42) for plants under treatment (T5) with potassium uptake by selected plants and minimum values has been obtained for plants under T1 that is (72.37).

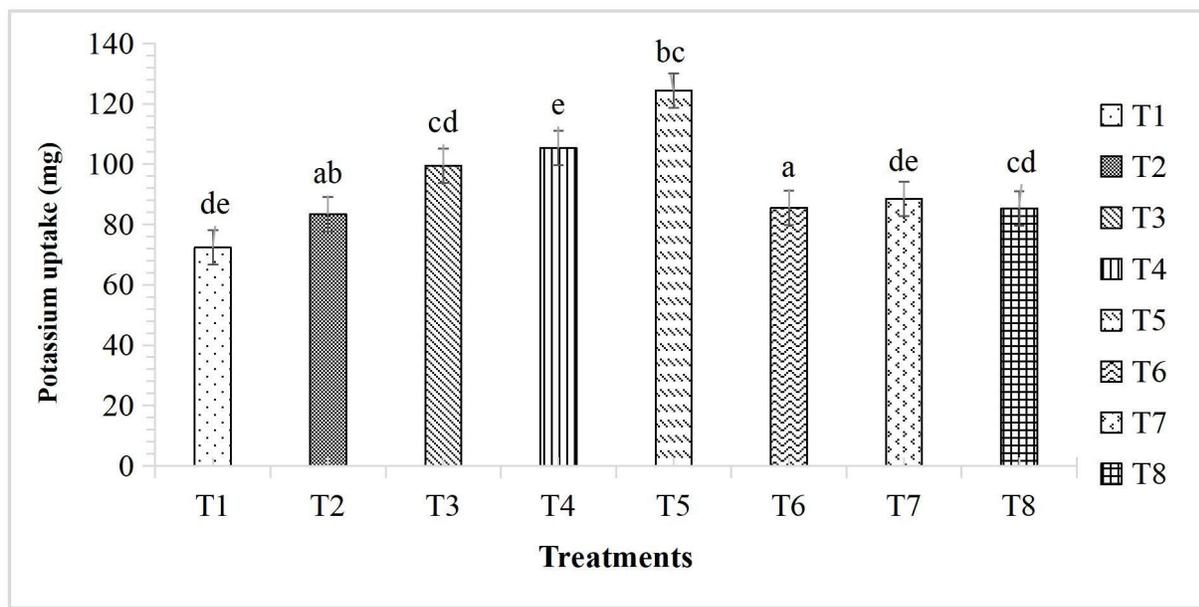


Figure 13: Graph presenting plant analysis for potassium uptake of wheat.

Our findings are agreed with the previous studies. Wang et al. (2020) reported significance differences in plant height of wheat crop. Present study observations are also in accordance with results of Zhan et al. Raghvendra et al. (2018) for plant height and various other traits. Presence of variations in various treatments of potassium for plant height in wheat were highly significant. The analysis of variance showed highly significant results for chlorophyll a and chlorophyll b content. All the treatments of potassium showed significant difference values. Under T4 (K during preparation of seed bed + foliar application of K at grain filling stage) the chlorophyll a showed higher value and under T5 (K during preparation of seed bed + foliar application of K at booting and grain filling stages) chlorophyll b showed higher content. The results of present study are in accordance with the findings of Wang et al. (2020). Guo et al. (2021) also reported significant results of chlorophyll a and chlorophyll b content in wheat crop. These consequences about treatments of potassium for chlorophyll a and chlorophyll b content fall in range found in literature review.

The number of tillers per plant is also a yielding parameter in wheat crop. Maximum number of tillers per plant was observed under treatment T2, T3, T5 and T7 while minimum was marked with controlled treatment (T1). The results for tillers per plant are in accordance with the findings of Raghvendra et al. (2018). Ahanger and Agarwal (2017) also reported significant results of number of fertile tillers per plant in wheat crop. These consequences about treatments of potassium for fertile tillers per plant fall with the range in literature. These recommended doses of potassium could be useful for obtaining better number of tillers per plant due to more variations.

The grains per spike is the yielding parameter of wheat crop. Present study observations are also in accordance with results of Raghvendra et al. (2018) for plant height and various other traits. Presence of variations in various treatments of potassium for grains per spike in wheat were highly significant. The number of spikelets per spike is also yield parameter. Iqbal et al. (2020) reported significance differences in number of spikelets of wheat crop. Present study observations are also in accordance with results of Zhang et al. (2016)

for spikelets and various other traits. Presence of variations in various treatments of potassium for number of spikelets in wheat were highly significant.

The peduncles length played a vital role wheat growth. The recommended potassium treatments effects peduncle length variously. It was also reported significant results with peduncle length in wheat crop. Lv et al. (2017) also contributed to describing significant valuable results for peduncle length. Raghvendra et al. (2018) and Ahanger and Agarwal, (2017) also reported homogenous results. Biological yield of wheat that is influenced by the application of potassium. The results for biological yield of wheat in of this study are in accordance with the findings of (Ren et al., 2019). Ahanger and Agarwal, (2017) also reported significant results of biological yield in wheat crop. These consequences about treatments of potassium for biological yield fall with the range in literature. These recommended doses of potassium could be useful for obtaining better biological yield due to more variations. The results for potassium use efficiency of wheat agreed with the findings of Krishnasamy et al. (2014). They found the significant difference for potassium use efficiency in wheat.

4. CONCLUSION

Wheat is a staple food and nutritious crop and serves as a food of animals. It is used in the production of many food products. Potassium nitrate used as a source of potassium for foliar spray. By using standard methods different kinds of parameters were calculated such as physiological, agronomic and biochemical parameters. It is determined from this research experiment that split dose of potassium plays a noteworthy job in enhancement of overall developmental growth of wheat. This study will be helpful for improving the efficacy of crop minerals for growth and yields performance. It is recommended that the farmers should use

split dose of potassium fertilizer for better growth and yield of wheat and it may also be helpful in future prospects.

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