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Effect of Potassium Chloride (KCl) on Biochemical and Morphological Parameters of *Triticum aestivum L.*

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Authors' contributions

This work was carried out in collaboration among all authors. Author DR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JNA and WS managed the analyses of the study. Authors MON and CUN managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The present study investigates how Potassium chloride (KCl) affects and alters the biochemical and morphological characters of *Triticum aestivum* L variety (Ghanimat). The experiment was arranged in Randomized Complete Block Design (RCBD) under the natural light condition. Potassium chloride (KCl) applied as foliar spray at the dose of (20, 40, 60, 80, and 100 ppm) on wheat plant. Morphological parameters including shoot length, root length, fresh and dry weight, relative water contents, leaf area, leaf no, root no were analyzed along with biochemical contents including Chlorophyll a b, protein, proline, sugar, carotenoid, phenol and amino acid contents. Results showed that the maximum concentration of morphological parameters observed at different applied potassium chloride but maximum morphological parameters are high in (control 20, 40, and

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60 ppm). Biochemical contents show that maximum concentration of Chlorophyll a b, protein, proline, sugar, carotenoid, phenol and amino acid contents observed in (control 100, and 40 ppm). The current study revealed that KCL deficiency as well as excess concentration affects plant growth and various morpho-physiological processes. The usage of optimum KCl we can improve the *T. aestivum* L quantitatively and qualitatively.

Keywords: Potassium chloride; Triticum aestivum L; morphological characters; randomized complete block design.

1. INTRODUCTION

Potassium chloride (KCl) is the most important potassium source, due to its wide use in fertilizers [1]. Production of potassium by electrolysis, like sodium and lithium is grossly inefficient due to back diffusion of potassium in the salt that causes short-circuiting in the cell and the formation of metal fog [2]. Salt mixtures with halides that are more stable than KCl have not been found, thus a low melting eutectic cannot be employed [3]. The most important salt substitute base is potassium chloride (KCl) despite its similar salty taste to NaCl, KCl is characterized by relatively offensive acrid, metallic, and bitter side tastes [4].

Wheat is the most widely grown crop in the world. In which has long slender leaves and stems that are hollow in most varieties. The inflorescences are composed of varying numbers of minute flowers, ranging from 20 to 100 [5]. The flowers are borne in groups of two to six in structures known as Spikelets, which later serve to house the subsequent two or three grains produced by the flowers. Though grown under a wide range of climates and soils, wheat is best adapted to temperate regions with rainfall between 30 and 90 cm (12 and 36 inches) [1]. Wheat is the major species of cereal grasses of the genus *Triticum* (family *Poaceae*) and their edible grains. Wheat is one of the oldest and most important of the cereal crops of the thousands of varieties known, the most important are common wheat (*Triticum aestivum*), used to make bread_Wheat (*Triticum aestivum.*) is one of the first domesticated food crops and has been the basic staple food of the major civilizations of Europe, West Asia and North Africa for last 8000 years. In Pakistan, wheat being the main staple food cultivated on the largest acreages. Pakistan falls in ten major wheat-producing countries of the world in terms of area under wheat cultivation, total production and yield per hectare. Wheat is the essential diet of population as it constitutes 60% of the daily diet of common man in Pakistan and average per capita consumption is about 125 kg and occupies a central position in agricultural policies of the government. The current studied aims to screen out different morphological parameters and biochemical parameters, of *T. aestivum* at different potassium chloride level. Our studies comprised on following objectives:

- To determine the effects of potassium chloride on morphological characters and biochemical contents of *T. aestivum.*
- To assess the effects of potassium chloride on the biochemistry of the test plant.
- The response of wheat to potassium chloride.

2. MATERIALS AND METHODS

2.1 Experimental Design

The experiment was conducted in botanical garden of Bacha Khan University, Charsadda having (latitude 34.1509' N, longitude 71.735' E, altitude 908 feet) during the wheat growing season (Winter) of 2019. The experiment was carried out in field using Randomized Complete Block Design (RCBD) during the month of November under natural light conditions, when the average temperature was 22^{c}. The seeds of *Triticum aestivum* L were sown at 2 cm depth in pots of 20 cm height and 25 cm diameter. The pots were filled with 3 kg of Clay loamy soil. The soils were analyzed having sand 27.15% silt 19.86% and clay 52.98%. No additional supplement was added to the experimental soil. The pots were treated with potassium chloride, at the doses of 0.0, 20, 40, 60, 80, and 100 ppm applied as foliar spray at vegetative stage. Each treatment was replicated three times in a Randomized Complete Block Design. Pots without the addition of

KCl (that is, 0.0 concentration) constituted the control.

2.2 Potassium Chloride Effect on Morphological Parameters of Wheat

Certain agronomic parameters were observed in field as shoot length by (Measurement scale), root length by (Measurement scale), fresh and dry weight through (Weight Machine), moisture contents, leaf area, leaf no, root no (Measurement scale) of each samples were determined.

2.3 Biochemical Analysis

- Chlorophyll content of leaves was determined by the method of [6].
- Protein content of leaves was measured by the method of [7] using BSA as standard.
- Proline content of leaves was measured by the method of [8].
- Sugar estimation of fresh leaves was done following the method of [9].
- Carotenoid content of leaves was measured by the method of [10].
- Phenol content was determined according to the Folin–Ciocalteau method as described by [11].
- Amino acid content was measured by the method of [12] using glycine as standard.

2.4 Statistical Analysis

All the data collected were analyzed by using Randomized Complete Block Design (RCBD) Results were submitted to an analysis of variance (ANOVA) using STATISTIX 8.1. When the ANOVA showed a statistical effect, means were separated by least significant differences (LSD) at $P < 0.05$.

3. RESULTS

3.1 Germination Percentage

Results showed that increase the concentration of potassium chloride cause significantly reduction in the germination percentage of *Triticum aestivum* cultivar Ghanimat (Fig. 1). The maximum seed germinations occurred at the control (93%) which is significantly similar to treatment 40 ppm (93%) also while minimum germination was related to 100 ppm (15%) at $P < 0.05$.

3.2 Shoot and Root Length

When we applied KCl stress plants showed reduction in shoot length and root length as compared to control in all sets (Fig. 1). Both morphological parameter showed maximum result in control shoot length (87.38) and root length (95.93) while minimum in 100 ppm shoot length (12.86) and root length (13.86) at $P < 0.05$.

3.3 Fresh Weight and Dry Weight

The Fresh and Dry weight of *Triticum aestivum* (Ghanimat) remained unchanged up to the level of 20 ppm of potassium chloride while highly significant reduction was obtained at the level of 80 ppm and 100 ppm of KCl salinity (Fig. 2). The maximum result showed in control of *Triticum aestivum* which was (1.40) fresh weight (0.303) dry weight while minimum data recorded on 100 ppm in both fresh weight (1.01) and dry weight (0.080) at $P < 0.05$.

3.4 Moisture Contents

In comparison to the control group the moisture contents were significantly reduced in very less quantity on 20 ppm concentration of potassium chloride but when apply 40, 60, 80 and 100 ppm concentration then it shows much reduction of moisture contents as compare to the first two concentration of salinity (Fig. 2). The maximum moisture was recorded on control (1.097) similarly to 20 ppm (1.024) while minimum result showed on 40 ppm (0.867) at $P < 0.05$.

3.5 Leaf Area, Root and Leaf No

The (Fig. 3) leaf area, leaf number and root number of *Triticum aestivum* show completely different result under salinity potassium chloride. Maximum result showed on non-saline (control) which was (34.98) leaf area, (27.33) leaf number (34.66) and root number while minimum result recorded in 100 ppm concentration of KCl which is (16.85) leaf area, (7.68) leaf number and (17.00) root number at $P < 0.05$.

3.6 Chlorophyll a and b Ratio

When applied Kcl stress *Triticum aestivum* showed reduction in (Total chlorophyll a and b ratio) as compared to control (Fig. 4). The result showed that maximum chlorophyll a/b ratio was found for treatment control (12.03, 8.083) while minimum chlorophyll a/b ratio was found for treatment 100 ppm (3.33, 4.00) at $P < 0.05$.

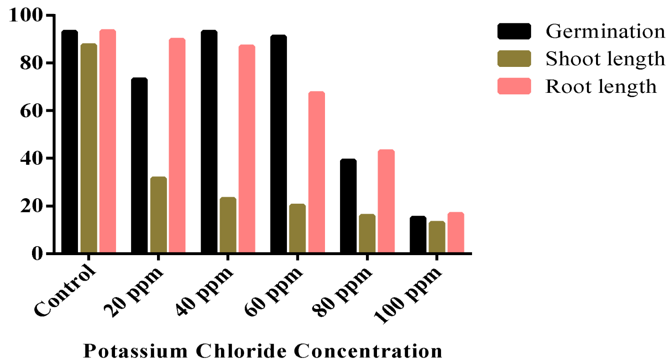

Fig. 1. Effect of different concentration of foliar applied Potassium chloride on germination (%), shoot and root length (cm) of *Triticum aestivum L.*

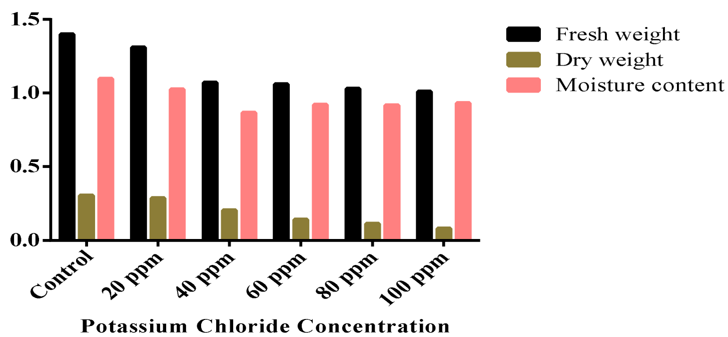

Fig. 2. Effect of different concentration of foliar applied potassium chloride on moisture contents (%), fresh and dry weight (gm) of *Triticum aestivum L.*

3.7 Estimation of Total Sugar Contents

The assessments of sugar content of *Triticum aestivum* verity Ghanimat (Fig. 5). The results demonstrate that maximum sugar contents were found for 100 ppm (84.33) while minimum in 20 ppm (67.68) at $P < 0.05$.

3.8 Estimation of Total Phenol Contents

Estimation of phenol contents of the selected plant *Triticum aestivum* was evaluated (Fig. 5). The result showed that maximum phenol contents were found for treatment 80ppm (52.396) was significantly similar to 100 ppm (52.138) while minimum phenol was found on non-saline (10.82) $P < 0.05$.

3.9 Estimation of Total Proline Contents

The proline of *Triticum aestivum* show completely different result under potassium chloride (Fig. 5). Maximum result showed on 40 ppm (28.334) while minimum proline contents were found on 60 ppm (27.033) was significantly similarly to non-saline (Control) (27.133) at $P < 0.05$.

3.10 Estimation of Total Protein Contents

The result of Protein contents in *Triticum aestivum* showed promotion on high concentration of potassium chloride (Fig. 6). Maximum promotion recorded in 100 ppm (5.9983) while minimum result found in control (1.8047) at $P < 0.05$.

3.11 Estimation of Total Carotenoid Contents

The result of carotenoid contents in *Triticum aestivum* showed reduction on high concentration of potassium chloride (Fig. 6). Maximum promotion recorded in control (6.4093) while minimum result found in 100 ppm (1.2630) at $P < 0.05$.

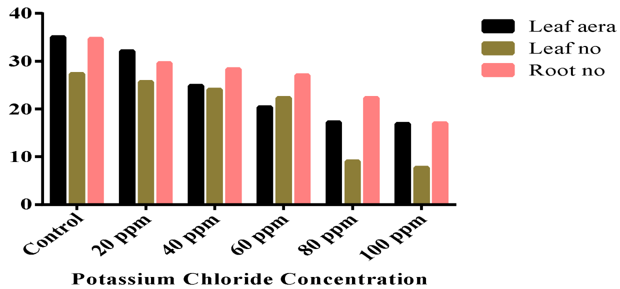

Fig. 3. Effect of different concentration of foliar applied potassium chloride on leaf area, $(cm)^2$ leaf number and root number of *Triticum aestivum L.*

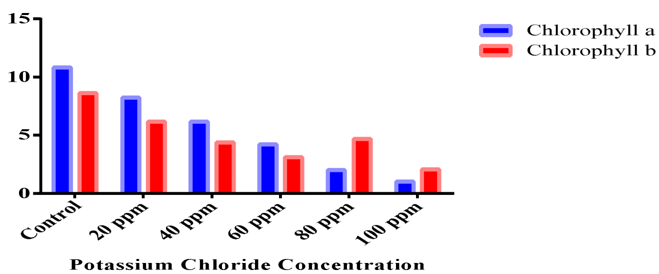

Fig. 4. Effect of different concentration of foliar applied potassium chloride on total chlorophyll a/b ratio (mg/g) of *Triticum aestivum L.*

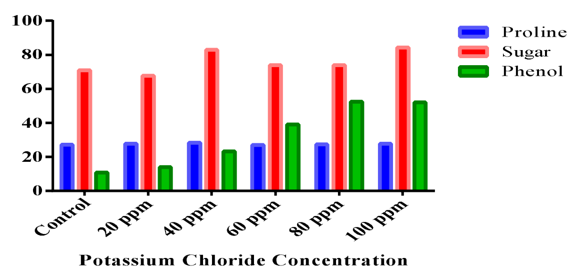

Fig. 5. Effect of different concentration of foliar applied potassium chloride on total proline (mg/g), sugar (mg/g) and phenol (mg/g) of *Triticum aestivum L.*

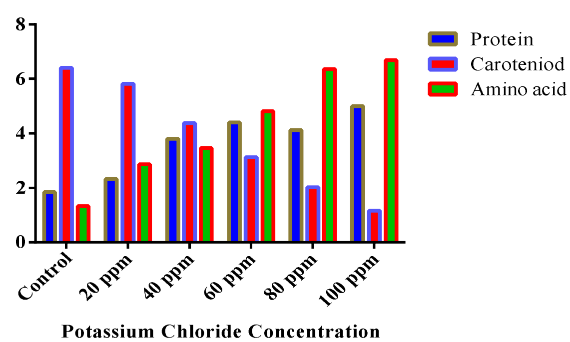

Fig. 6. Effect of different concentration of foliar applied potassium chloride on protein (mg/g), carotenoid (mg/g) and amino acid (%) of *Triticum aestivum L.*

3.12 Estimation of Total Amino Acid Contents

Result indicated that total amino acid contents in *Tritium aestivum* showed promotion on high concentration of potassium chloride (Fig. 6). Maximum ratio of amino acid contents was reported for 100 ppm (7.238) was significantly similarly to 80 ppm (7.00) while minimum data found in control (1.832) at $P < 0.05$.

4. DISCUSSION AND CONCLUSION

Potassium chloride (Kcl) is the most important potassium source, due to its wide use in fertilizers. Salt mixtures with halides that are more stable than KCl have not been found, thus a low melting eutectic cannot be employed [3]. The most important salt substitute base is potassium chloride (Kcl) despite its similar salty taste to NaCl, KCl is characterized by relatively offensive acrid, metallic, and bitter side tastes [4]. The results analysis of variance showed that salt stress had effect on the percentage of germination in the various treatments caused to significant differences. These results were observed by other researcher such as, [13] and [14]. The germination percent decreased with increasing the KCl concentration. In present result potassium chloride stress showed reduction in shoot length and root length as compared to control in all sets, both morphological parameters showed maximum result on control while minimum on 100ppm other researcher observed that plant shoot and root length is reduced may be increasing salt level, which lessens the available water to plant [15,16,17]. Our result showed that Fresh and Dry weight of *Triticum aestivum* (Ghanimat) remained unchanged up to the level of 20 ppm of potassium chloride while highly significant reduction was obtained at the level of 80 ppm and 100 ppm of Kcl stress, moisture contents comparison to the control group significantly reduced in very less quantity on 20 ppm concentration of potassium chloride but when apply 40, 60, 80 and 100ppm concentration showed highly reduction [18,16] reported the same result that Plant biomass decreased under saline soil conditions, because of toxic effects of Cl ions. Leaf area, leaf number and root number in present study of *Tritium aestivum* show completely different result under salinity potassium chloride. Maximum result on non-saline which was (34.98) leaf area, (27.33) leaf number and (34.66) root number while minimum result recorded on 100 ppm concentration of KCl which is (16.85) leaf area, (7.68) leaf number and (17.00) root number. The reason for this decrease is that the uptake of nutrient elements and water availability are limited under saline conditions [19,20]. Another interpretation for this result, destroy of ionic balance in plant with high salinity levels [21]; [16]. Sugar Content conclude that maximum sugar content was found to be 100 ppm while at least 20 ppm, the maximum phenol content for treatment was 80 ppm significantly similarly to 100 ppm. Was found while the least amount of phenol was found on non-saline. The maximum result was shown at 40 ppm while the least proline contents were found at 60 ppm as well as saline.

Upadhyay and Panda [21] observed that the significant decrease in reducing sugar in response to salinity also reduced the photosynthetic efficiency that led to hinder the biosynthesis of carbohydrates [18] Irrespective of the salts type Photosynthetic activity is greatly reduced due to salt stress [22]. Wright et al. [23] said that beside photosynthesis all other main processes such as protein synthesis and energy and lipid metabolism are also affected by salt stress. Some researchers, such as [24] showed that in alfalfa soluble sugars, proteins and total free amino acids including proline were gradually accumulated along with NaCl level. In our work total chlorophyll (a/b) and carotenoid pigments [25-29] content decreased with increasing of KCl concentrations, resulting in decreased photosynthetic rate. Wheat show more effect and decrease chlorophyll under potassium chloride stress. These results corroborate other studies, that indicate that plants subjected to increased salinity show decreased photosynthetic pigments These results also corroborate previous studies indicating that NaCl stress has more effects on chlorophyll b than chlorophyll a [30]. This implies in an increase in the chlorophyll a/ chlorophyll b ratio, since the first step of chlorophyll b degradation results in its conversion into chlorophyll a [31] and therefore, a decrease in total chlorophyll content [32]. This is also in accordance to other studies, such as those by [21] that observed the same regarding Salvinia molesta (Mitchell) and Pistia stratiotes (Linn) subjected to NaCl salinity. Total chlorophyll content was also higher in plants incubated with 50 mmol L-1 NaCl compared with the NaCl treatments, suggesting that this concentration can stimulate S. auriculata development and growth. This would suggest that this species would be able to broadly colonized coastal oligohaline wetlands, due to its adaptability to higher salinity conditions via physiological and biochemical changes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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