



P-ISSN: 2349-8528

E-ISSN: 2321-4902

www.chemijournal.com

IJCS 2020; 8(4): 2626-2629

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Received: 04-05-2020

Accepted: 06-06-2020

Vijay P Yadav

Department of Biological
Sciences Sam Higginbottom
University of Agriculture
Technology and Sciences
Prayagraj, Uttar Pradesh, India

Pranay P Pandey

Institute of Horticulture
Technology Greater Noida,
Uttar Pradesh, India

Neelam Yadav³

Department of Biological
Sciences Sam Higginbottom
University of Agriculture
Technology and Sciences
Prayagraj, Uttar Pradesh, India

Corresponding Author:**Pranay P Pandey**

Institute of Horticulture
Technology Greater Noida,
Uttar Pradesh, India

Assessment of effect of KCl salinity stress on growth and yield of wheat (*Triticum aestivum*) genotypes under Allahabad climatic condition

Vijay P Yadav, Pranay P Pandey and Neelam Yadav

DOI: <https://doi.org/10.22271/chemi.2020.v8.i4ae.10030>

Abstract

Salinity stress is one of the major physiological stresses especially in arid and semiarid regions that severely affected crop production in wheat plant. Germination percentage, number of leaves per plant, number of branches and total plant height were decreased when compared to controls with increasing salt concentrations. A pot experiment was carried out in a (CRD) completely randomized design with one wheat variety and three replicated. Chlorophyll, relative water content, protein, carbohydrate, and yield component were investigated. Asses' growth, yield, biochemical and antioxidant contributing characters under semi-controlled environmental condition in the Department of Biological sciences, Sam Higginbottom University of Agriculture Technology & Sciences, Allahabad, India. During November 2016 through March 2017 aiming to alleviate the salinity stress effects on wheat plant using different KCl concentration. The pot experiment was carried the results showed that had significantly differences in almost of measured characteristics. The assessment of revealed that the maximum RWC, chlorophyll, protein content, the highest seed yield per plant. This genotype was expected to provide higher yield and protein content after releasing.

Keywords: Wheat, salinity stress growth and yield

Introduction

Wheat (*Triticum aestivum* L.) is a major cereal crop of the world and it is commonly known as king of cereals. Wheat serves as staple food for 1/3rd population of the world and a major source of carbohydrates and nutrition to both humans and animals Anonymous (2010) [2]. It belongs to poaceae family and is the second most cultivated cereal crop after rice globally Gilles *et al.*, (2001) [5].

Wheat is more tolerant at germination stage but highly sensitive to salinity stress at later stage. The cultivation of wheat dates back to more than 5000 years during the era of Indus valley civilization where the original species was *Triticum sphaerococcum* popularly known as Indian wheat has now disappeared and replaced by present day species *Triticum aestivum* (Bread wheat), *Triticum durum* (macaroni wheat) and *Triticum dicoccum* (Emmer Wheat). Currently, the production of wheat in India is 94.90 million tonnes and area is 29.90 million hectares with a yield of about 3 tonnes per hectare Niaz *et al.* (2016) [8]. Next to rice, wheat is the most important food-grain of India and is the staple food of millions of Indians, particularly in the northern and the north-western part of the country. It is rich in carbohydrates, protein, and vitamins. India is the fourth largest producer of wheat in the world after Russia, USA and China and account for 8.7% of the world's total production of wheat. Nurul *et al.*, (2016) [9].

High levels of salt concentration in the germinating the high osmotic pressure of the solution which will prevent intake of water which is necessary for germination. Higher salt causes toxic effect on embryo. Higher salinity delayed and reduced germination percentage. Salinity decreased germination percent, root length, callus size, coleoptiles length and seedling growth, plant height, stem diameter, dry weight decreased with increasing levels of salinity.

Salinity reduced fertile ears, ear length, grain yield, straw yield, and harvest index and test weight. The response of plants exposed to salinity stress is a decrease in plant water potential, which reduces plant water use efficiency Hamam *et al.*, (2014) [6].

In Asia more than 80% of the developed fresh water resources are used for irrigation purposes about half of which is used for wheat production.

Among the entire environmental stresses drought is one of the most severe stresses for rice growth and productivity. Drought stress reduces both nutrient uptake by the roots and transport from roots to the shoot due to restricted transpiration rates and impaired active transport and membrane permeability. The challenge is to develop novel technologies and production systems that would allow wheat production to be maintained at the face of declining water availability. Rajeev *et al.*, (2012) [12]

The application of potassium, K can minimize the drought effects of wheat Potassium has substantial effect on enzyme activation, protein synthesis, photosynthesis, stomatal movement and water relations (turgor regulation and osmotic adjustment) in plants. Increased application of K has been shown to enhance photosynthetic rate, plant growth, yield, and drought resistance in different crops under water stress conditions Solang *et al.*, (2014) [14].

Salt stress causes inhibition of growth and development, reduction in photosynthesis, respiration, and protein synthesis metabolism. Decrease in uptake of KCL and there by decreases in growth at higher sodium concentration have also been reported. Accumulation of proline has been widely advocated for use as parameter of selection for salt stress tolerance. However, proline accumulation cannot be regarded as marker for salt tolerance, as it accumulates under various condition of stresses such as temperature, drought, and starvation where as in many salt stressed plants its levels decreases Yaşar *et al.*, (2012) [16].

Thus, the present study was conducted to elucidate the role of antioxidants, osmolytes concentrations and potassium, contents in relation to salinity stress tolerance in wheat crop. Raj *et al.*, (2002) [11].

Material and Methods

The experiment was laid out in CRD design with five treatments with three replications of wheat Variety AAI w13. The present field experiment consisted of five treatments including control the details are given as under.

T0: KCL (CONTROL) no treatment

T1: KCL (60mM) / 8.946g

T2: KCL (120mM) / 17.892g

T3: KCL (180mM) / 26.838g

T4: KCL (240mM) / 35.784g

Statistical Analysis

Data were analysed statistically adopting the technique of analysis of variance (ANOVA) using Complete Randomized Block Design. The level of significance of the treatment mean square at 5 percent probability was tested with „F” test value. The significant differences of the treatment means were further tested by using significance of critical difference at 5% level of respective degree of freedom of “t” values.

Result and Discussion

The present investigation was conducted during *Rabi crop* 2016-17 in pots condition at department biological science of SHUATS, to study “Assessment of effect of salinity stress of KCl wheat plant (*Triticum aestivum* L.)” on various growth, yield, biochemical, and antioxidant properties in Wheat.

Seed germination %

The maximum seed germination was recorded in control. The lowest seed germination T3 and T4 was recorded when KCl level increased respectively. The germination percentage of all concentration decreased with increased in treatment levels. Increasing salinity concentrations in germination often cause osmotic and or specific toxicity which may reduce or retard germination percentage Othman *et al.*, (2006) [10] Datta *et al.*, (2009) [4].

Plant height

The effect of KCl on total plant height 60 & 90, DAS of wheat

The maximum plant height was recorded in control. The plant height decreased with increasing rate of salt application. This decrease was higher in KCl. The minimum plant height was recorded in remaining of all the treatment showed of the plant height and different KCl concentration has a significantly over control.

Significant difference in plant height was observed with KCl applications of salt with comparison to control Taware *et al.*, (2009) [15].

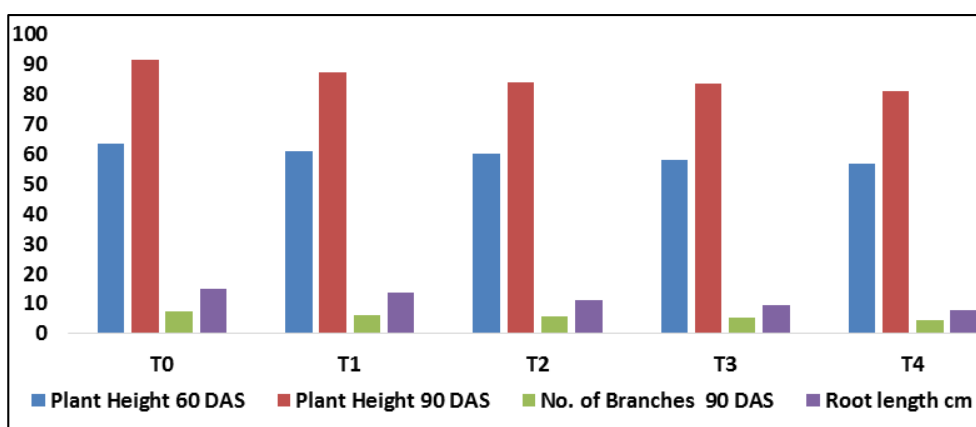


Fig 1: Effect of KCl salinity stress on growth parameter, Plant Height, Number of Branches and root length of wheat

Number of branches

The effect of KCl on the number of branches per plant 30, 60, 90, DAS of wheat.

The maximum No. of branches was recorded in control. The average number of branches per plant decreased. The lowest number of branches per plant T3 and T4 was recorded when KCl level increased respectively. The number of branches per

plant of all concentration decreased with increased in treatment levels Afzal *et al.* (2008) [1], Taware *et al.*, (2009) [15].

Root fresh weight

The results show that maximum root fresh weight was recorded in control T0 followed by KCl, respectively. The

lowest number of branches per plant T3 and T4 was recorded when KCl level increased respectively. The root fresh weight of all concentration decreased with increased in treatment levels Yaşar *et al.* (2012) [16] and Shamaila *et al.*, (2006) [13].

Root dry weight

It was observed from the data that root dry weight was decreased progressively with increased KCl levels. The maximum root dry weight was recorded in control T0 followed by KCl, respectively. The lowest root dry weight T3 and T4 was recorded when KCl level increased respectively. The root dry weight of all concentration decreased with increased in treatment levels Yaşar *et al.* (2012) [16] and Argente *et al.*, (2006) [3].

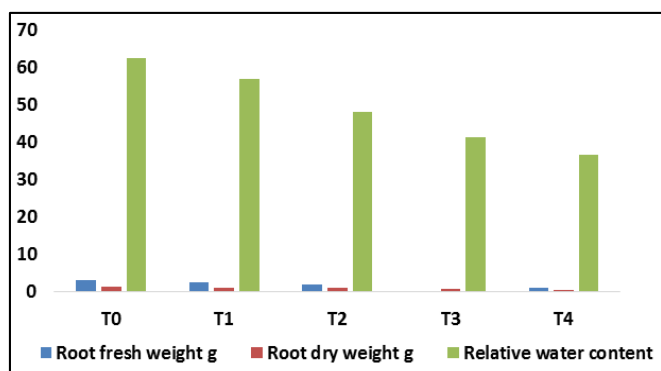


Fig 2: Effect of KCl salinity stress on fresh and dry weight of roots and relative water content of Wheat.

Root length (cm)

Root length decreased significantly with increased KCl levels. The maximum shoot length was recorded in control T0 followed by KCl, respectively. The lowest root length T3 and T4 was recorded when KCl level increased respectively. The root length of all concentration decreased with increased in treatment levels Afzal *et al.*, (2005) [1] and Gilles *et al.*, (2001) [5].

Relative water content %

Relative water content % decreased with increase in salinity levels of salt concentration. Control treatment showed highest relative water content. The maximum relative water content was recorded in control, followed by T1 and T2 in 60mM and 120mM KCl respectively. The lowest RWC T3 and T4 was recorded when KCl level increased to 180mM and 240mM respectively. The relative water content of all concentration decreased with increased in treatment levels Raj *et al.*, (2002) [11].

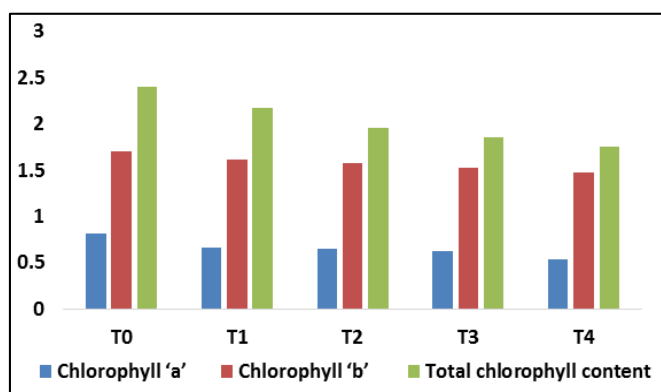


Fig 3: Effect of KCl salinity stress on photosynthetic pigments, chlorophyll a & b and total chlorophyll content in wheat

Total chlorophyll

Leaf total chlorophyll content decreased with increase in salinity levels of salt concentration comparison to control. Control treatment showed highest total chlorophyll content. The maximum total chlorophyll content was recorded in salt concentration control (7.10), followed by (6.41) and (6.10) in T1 and T2 KCl respectively. The lowest (5.44) and (4.43) was recorded when increased to T3 and T4 respectively. The chlorophyll 'a' content of all concentration decreased with increased in treatment levels Taware *et al.*, (2009) [15].

Proline content (µg/g)

Leaf proline content decreased with increase in salinity levels of salt concentration comparison to control. T4 treatment showed highest leaf proline content.

The maximum proline content was recorded in salt concentration T4 (7.10 µg/g), followed by (6.41 µg/g) and (6.10 µg/g) in T3 and T2 KCl respectively. The lowest (5.44 µg/g) and (4.43 µg/g) were recorded when increased to T1 and T0 respectively. The chlorophyll 'a' content of all concentration decreased with increased in treatment levels.

Accumulation of proline, GB and soluble sugars under stress protect the cell by balancing the osmotic strength of cytosol with that of vacuole and external environment Raj *et al.*, (2002) [11].

Protein content %

They observed an increase in protein content when increasing salt concentration T4 treatment showed highest protein content when control treatment showed lowest protein content.

The maximum protein content was recorded in salt concentration T4 (19.51%), followed by (17.16%) and (15.42%) in T3 and T2 KCl respectively. The lowest (12.62%) and (10.22%) was recorded when increased to T1 and T0 respectively. The protein content in the present study indicated that AAI W₁₃ wheat variety responded significantly better having maximum protein content respectively, levels.

Results indicate a positive effect for potassium chloride using various concentrations on total protein of wheat plant there appeared to be an inverse relationship between salt concentrations and protein content, although protein content was still higher than the controls Kapoor and Srivastava., (2010) [7].

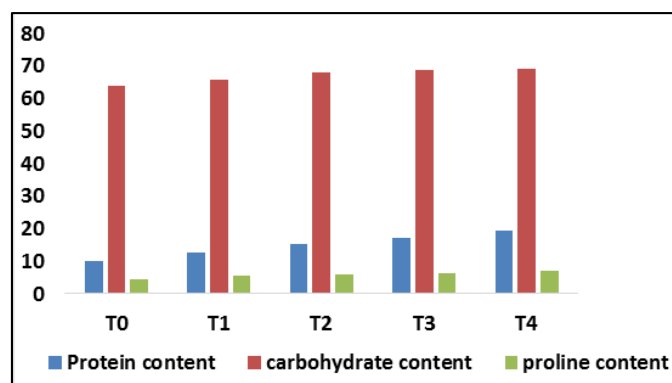


Fig 4: Effect of KCl salinity stress on biochemical parameter, protein content, carbohydrate and proline content in wheat.

Carbohydrate content %

Seed carbohydrate compositions were differently altered by salinity stress T4 treatment showed highest protein content when control treatment showed lowest carbohydrate content.

The maximum carbohydrate content was recorded in salt concentration T4 (69.27%), followed by (68.9%) and (68.09%) in T3 and T2 KCl respectively. The lowest (65.67%) and (63.95%) was recorded when increased to T1 and T0 respectively. The carbohydrate content in the present study indicated that AAI W₁₃ wheat variety responded significantly better having maximum carbohydrate content respectively, levels.

They observed for sugar concentration, salinity stress increased starch accumulation in while starch concentration in were decreased with increasing salinity Yaşar and Esra (2012) [16].

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