# Effect of Salicylic Acid and Potassium Application on Proline Concentration in Leaves and Protein in Seeds of Wheat (Triticum aestivum L.) Irrigated with Different Saline Water

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***Abstract*—** Field experiment was conducted in Sharash township affiliated to Gurna district, north of Basra province on silty clay soil to study the effect of irrigation water salinity(1,3,and 6 dS.m$^{-1}$) ,foliar application of salicylic acid (0,150,300,and 450 mg.l$^{-1}$) ,and potassium fertilization (0,and 120 kgK.ha$^{-1}$) on leaves proline concentration and protein content in wheat seeds by using split- split plot design with complete randomized design. Results of study showed ,increasing of irrigation water salinity from 1 dS.m-1 to 3 and 6 dS.m-1 caused a significant increase in proline concentration in wheat leaves with an increase percent 56.06%, and 727.43% as compared with a control treatment respectively, and a significant decrease in protein concentration in seeds 3.37% and 14.3% as compared with control treatment respectively. Foliar application of salicylic acid caused a significant increase in proline concentration(19.15%,19.92, and 15.01%) and seeds protein(12.21%,20.53%,and 21.86%) as compared with control treatment respectively. While potassium application caused a significant decrease in proline concentration(11.63%) and a significant increase in seeds protein(8.14%) as compared with control treatment. The combined factors showed non-significant effect on proline concentration in leaves and protein concentration in seeds. The highest concentration of protein in seeds was with potassium fertilization, spraying with 300 mg.L$^{-1}$ salicylic acid and irrigation with 1 dS.m-1 water salinity to get protein concentration 15.1% as comparing with control treatment 9.97%.

***Keywords*—** salicylic acid, water salinity, potassium fertilization, leaves proline , wheat seeds protein

## I. Introduction

Wheat (Triticum aestivum L.) is one of the most important strategic crops, it is the world's number one place in terms of total area and global production(Kaydam et al.,2007).Soil and water salinity is one of the limiting factors of growth and productivity of plants in arid and semi-arid regions(Parida and Das,2005 ).Their effect on photosynthesis, chlorophyll, seed germination, seedling growth, vegetative growth, thus reducing yield and bad product quality(Daszowska-Gole,2011). Plants are exposed to salt stress in arid and semi-arid regions because of irrigation with saline water with no efficient drainage system(Panda and Khan,2009). Initial effects of salt stress are reducing water potential of plant cells, and disturbance of nutrition balance. The secondary effects are the projection of cells expansion, photosynthesis, inhibition of metabolism in cells, imbalance of hormones, and plant protein formation(Parido and Das,2005).

One of the strategies used to improve salt tolerance of plants are using of certain substances such as potassium fertilizers and salicylic acid which is one of plant phenols(Horvath et al.,2007). More studied had found that salicylic acid acts as a regulator, and control of nutrient uptake by roots,(Popova et al.,1997),resistance to carbon dioxide exchange(Raskin,1992),increased plant resistance to salt stress, quantity and quality of crops(Kaydan et al.,2007).

Potassium is contribute of a large number of enzymes activation in plants(more than 66 enzymes),enzymes of oxidation-reduction, synthesis of proteins, regulation of intracellular, oxygenation, and controlling of osmotic potential in cells(Mengel and Kirkby,1987). Several studies had indicated response of wheat production to potassium fertilization by the influence of salt stress, it is improve crop growth and productivity by improving the physiological processes of photosynthesis , water absorption, opening and closing of gaps, and absorption of nutrients(Egilla et al.,2001). Studies had shown crop resistance to saline is dependent on the absorption of both sodium and potassium . Application of potassium promotes of potassium absorption because of competition on the absorption sited of roots(El-Lethy et al.,2013).

According to the above factors, the present study aim is to increase salt tolerance of wheat crop by using salicylic acid and potassium fertilizer at different levels of water salinity and increasing the productivity of wheat within agricultural areas of northern Basra/Iraq.

## II. Materials and Methods

A field experiment was carried out in one of the agricultural field of Sharsh district in Gurna district northern Basra province on silty clay soil to study the effect of irrigation water salinity levels(1,3,and 6 dS.m$^{-1}$),foliar application of salicylic acid(0,150,300, and 450 mg.l$^{-1}$) ,and potassium

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fertilization(0,and 120 kgK.ha$^{-1}$) on proline concentration in leaves and protein concentration in wheat seeds. The experiment was designed by using split-split plot design with complete randomized design with three replicates to be 72 experimental unit. Soil samples was taken from a surface(0-30 cm) and air dried and ground to pass a 2 mm screen . It was characterized for some properties in table 1 as the methods mentioned by Black(1965) and Page et al.(1982).

Field experiments land was prepared for tillage and divided into three blocks, the distance between them 2m ,and each block was divided into three main units according to levels of irrigation water salinity, the distance between them 1.5m. The main units were divided into secondary units with a number of potassium fertilization levels, the distance between them 0.5m. The secondary units were divided into smaller plots according to salicylic acid levels with area(2 x 2m$^2$) with distance 0.5m between them, Experimental plots were divided into lines (12 line /experiment unit),The distance between lines 15 cm with 5cm depth .

Field soil was fertilized with nitrogen at rate 200 kgN.ha$^{-1}$ as urea(46%N) with two doses ,one of them at planting (15$^{th}$,Nov.2015) and other after a month of planting. Phosphate was added as concentrated super phosphate (20.21% P) at rate 100kgP.ha$^{-1}$, and potassium as potassium sulphate with a rate 120kgK.ha$^{-1}$(40.43% K) one dose with planting. All mineral fertilizers were added as lines at 5cm depth. Wheat seeds(Bengal sp.) were planted with a quantity of 120 kg.ha$^{-1}$,( 3 gm for each line). Field plots were irrigated with water according to water quality (table 2) by mixing river water with drainage water to reach water studied salinity . After one month of planting salicylic acid was spread on plants ,numbers of spraying were 6 every 15 day till emergence of ears. Grain yield of wheat was harvested (5$^{th}$,April,2016) for each unit and dried at 65$^o$C. Proline concentration in leaves was determined according to the method mentioned in Troll and Linsley (1955), and seed protein according to the method of Cresser and Parsons(1979).Results analyzed by SPSS program ver.16.

## III. Results And Discussion

### *A. Proline Concentration in Leaves*

Results in table 3 showed the effect of irrigation water salinity ,salicylic acid, potassium fertilization, and their combinations on proline concentration in leaves of flag leaf in (ug.gm$^{-1}$ dry matter). Increases in water salinity from 1 dS.m$^{-1}$ to 3 and 6 dS.m$^{-1}$ caused a significant increase in proline concentration with a percentage increase 56.06% and 52.43% comparing with control treatment(1 dS.m$^{-1}$) respectively. These increase in proline concentration is due to physiological role of plant by exhaustive soluble substances to equilibrated external potential of soil solution resulting from increases of salt concentration and inhibition formation of proteins and accumulation of amino acids(Naqui et al.,2002; Parida and Das,2005;Fayez and Bazaid,2014).

Fig.1.b. Was showed a significant increase in proline concentration with increasing of salicylic concentration levels(15,300,and 450 mg.L$^{-1}$) with a percentage increase values 19.15%,19.92%, and 15.01% as comparing with control treatment respectively. This increase is due to salicylic acid role in stimulating amino acid proline(Deef,2007;Afran,2009).

Potash fertilization caused a significant decrease in proline concentration in leaves of wheat crop with a percentage value 11.63% comparing with control treatment(Fig.1.C), This decrease in proline concentration is due to potassium activation of protein synthesis enzymes, physiological role of potassium in an improving of plant growth, photosynthesis ,and production of cytokine in growth regulator, which delays protein degradation and reduction concentration of proline in leaves (Heidari and Jamshid,2011;Fayez and Bazaid,2014).

There were no significant differences between salinity of irrigation water and salicylic acid combinations on proline concentration in leaves(table 2).The treatment 6 dS.m$^{-1}$ water salinity and 300 mg.L$^{-1}$ salicylic acid gave highest concentration of proline (336.70 ug.gm$^{-1}$ dry matter) with a percentage value 1033.67% comparing with control treatment(29.70 ug.gm$^{-1}$ dry matter). These increases is due to physiological role of plant in an accumulation of free amino acids formation(Horvath et al.,2007).

Potash fertilization and water salinity combination had a significant differences in decreasing of proline concentration in leaves(table 2).Highest concentration of proline was 334.70 ug.gm$^{-1}$ dry matter for the treatment 6dS.m-1 water salinity and without potash fertilization with a percentage value 522.11% as compared with control treatment (53.80 ug.gm$^{-1}$ dry matter), while the lowest concentration of proline was with the treatment 1 dS.m$^{-1}$ water salinity and 120 kgK.ha$^{-1}$ (46.80 ug.gm$^{-1}$ dry matter). These results due to potassium role in activation of protein synthesis enzymes (Mengel and Kirkby, 1987).

### *B. Protein Concentration in seeds*

Results in table 3 and fig.2 showed effects of salinity water, salicylic acid concentration ,and potash fertilization on protein concentration in seeds of wheat crop. Increasing water salinity from 1 dS.m$^{-1}$ to 3 and 6 dS.m$^{-1}$ caused a significant decrease in protein concentration to reached to 14.04% and 12.45% with a parentage value 3.37% and 14.31% comparing with control treatment(14.53%) respectively (Fig.2.a). This decreases in protein concentration due to inhibition of protein synthesis by water salinity and high concentration of chloride which caused toxicity to plants(Para and Khan,2009). Parida and Das(2005) mentioned that salinity decrease photosynthesis and protein synthesis.

Foliar application of salicylic acid caused a significant increases in protein concentration in wheat seeds(Fig.2.b) ,with a percentage value 12.21%,20.53%,and 21.86% for 150,300,and 450 mg.L$^{-1}$ salicylic acid concentration comparing with control treatment respectively. This increase in protein is due to salicylic acid role in an increasing of nitrogen, potassium, and proline in seeds ,and inhibition of sodium accumulation in seeds(Hadi et al.,2014).

Potash fertilization caused a significant increases in protein concentration to reach its mean 13.14% and 14.21% with a percentage value 8.14% as comparing with control treatment(Fig.2.C). This increases in protein concentration is due to potassium role in increases of nitrogen uptake by roots

and its role in an activation of protein synthesis enzymes (Mengel and Kirkby,1987).

Combination treatment between irrigation water salinity and salicylic acid concentration(table 3) showed a significant effect in protein concentration in seeds. The highest protein was with the treatment 3 $dS.m^{-1}$ water salinity and 450 $mg.l^{-1}$ salicylic acid which reached to 14.74% which did not differ significantly with the treatment 3 $dS.m^{-1}$ and 300 $mg.L^{-1}$ salicylic acid, with an increase percentage 2.86% with control treatment, while the lowest concentration of protein was with the treatment 6 $dS.m^{-1}$ water salinity and without spraying with salicylic acid (8.27%). The results were agree with the results of Afran,2009;Joshi et al.,2013.

Triple combination treatment between studied factors showed a significant effect on protein concentration in seeds (Table 3). The highest concentration of protein was with potash fertilization and spraying with 300 $mg.L^{-1}$ salicylic acid and irrigated with 1 $dS.m^{-1}$ water salinity(15.10%) with an increase percentage 9.9% with control treatment(13.37%).

## IV. Conclusions

Results of the study showed that increasing of irrigation water salinity caused a significant increase in protein concentration in leaves and decrease in protein concentration in wheat crop seeds, while potash fertilization had a significant effect in decreasing proline concentration in leaves and increasing in protein concentration in seeds.

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