Journal of Pharmaceutical, Chemical and Biological Sciences
ISSN: 2348-7658
Impact Factor (GIF): 0.615
Impact Factor (SJIF): 2.092
September-November 2015; 3(3):416-420

Original Research Article

Germination and Growth of Wheat Plants (*Triticum Aestivum* L.) Under Salt Stress

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Received: 18 September 2015 Revised: 17 October 2015 Accepted: 25 October 2015

ABSTRACT

Two experiments laboratory and pots were conducted to study the effect of NaCl concentrations (40,80,120 and 160 mMol/L) in addition to distilled water as a control treatment on germination and growth of wheat plants (cv Adanania) in factorial experiment with four replicates and complete random design according. The results of the study indicate that there was a gradual and significant decrease on germination parameters (percentage, speed and rate) and growth parameters (plant height, fresh and dry weights and concentration of chlorophyll, carbohydrate and protein) values as NaCl concentrations increased, but the high values were at the control treatment.

Keyword: Wheat; NaCl; germination

INTRODUCTION

Wheat (*Triticum aestivum* L.) is an important cereal crop used as staple food in many parts of the world and is a moderately salinity tolerance crop. Germination is the first and sensitive stage of the plant life cycle. This stage of growth is strictly influenced by environmental factors especially, temperature and humidity [1]. Salinity is a world–wide problem and it is particularly serious in arid and semi-arid regions. Salinity can affect germination and growth either by creating an osmotic pressure that prevents water uptake or by toxic effects of sodium and chloride ions [2]. High salt concentration in the soil or in the irrigation water can have a devastating effect on plant metabolism, disrupting cellular homeostasis and uncoupling major physiological and biochemical processes [3]. Germination of wheat seed decrease by increase NaCl concentrations (0–375mMol/L) [4]. Increasing concentrations of salinity (8.52and9.67ds/m) significantly reduced the germination parameters and reduced the length and dry weight of shoot of wheat [5]. NaCl concentrations (0, 4, and 8ds/m) decreased germination (percentage and rate) and seedling growth in wheat [6]. NaCl concentrations (0,2and4g/l) decreased chlorophyll content, carotenoides, total phenolic content and antioxidant enzyme activity in wheat [7]. Salinity stress (0,100, 200 and 300 mMol/L NaCl) decreased photosynthetic pigments content include, reducing sugars, protein contents, activity of antioxidant enzymes in wheat [8]. Similar results noticed in other crops such as barley [9], corn [10] and soybean [11].Therefore, the objective of this study is to examine the effect of salt stress (NaCl) on the germination and growth of wheat.

MATERIALS AND METHODS

The first part of the study was carried out in the laboratory by using the seeds of wheat (cv. Adanania) which had been obtained from the Public Authority for Agricultural Research /Ministry of Agriculture, Iraq. Seeds treated at salt concentrations (40, 80, 120 and 160 mMol/L) of sodium chloride in addition to distill water as a control treatment to examine the impact of these concentrations on the percentage, speed and the rate of seed germination. After being seeds sterilized in sodium-hypochlorite solution (5%) for 10 minutes then washed with sterile deionized water. Seeds were put in Petri dishes (20 seeds per Petri dish) containing filter paper (Whatman No.1) and were add 10ml of salt concentrations above and the dishes were wrapped with papers Para film to prevent pollution and evaporation, after that seeds were germinated in an incubator at 25 °C and relative humidity of 50%. Every day the germinated seeds were counted to calculate:

1. Germination percentage (GP): calculating by using the equation [12]:

$$GP = A^{\circ}/A \times 100$$

In which: A˚ = Number of germinated seeds. A = Total number seeds.

2. Germination speed (GS): calculating by using the equation [12]: $GS = A^{\circ}/D$

In which: D = Total number for days.

3. Germination rate (GR): calculating by using the equation [12]:

GR = X in 1st day/ d1+(X in 2nd day - X in 1st day)/ d2…..Xn–Xn-1)/dn

The second part of the study was carried out in the greenhouse by pots (capacity 4Kg). Ten seeds of wheat were planting in every pot and were irrigated with salt concentrations which mentioned above and according to the needs of plants during 40days and plant height (cm) and fresh and dry weights (g) of shoot were calculated. The dry weight was determined after drying at 65ºC for 48h. For biochemical study total chlorophyll [13], carbohydrate [14] and protein [15].

Experimental Design and Statistical Analysis

All experiments were carried out twice as a completely randomized design with four replications per treatment. The least significant difference (LSD) was used to compare between means at 0.05 probability levels [16].

RESULTS AND DISCUSSION

Laboratory Experiment

Salt tolerance at germination stage is an important factor. However, table 1 showed a gradual and significant decrease in germination parameters (percentage, speed and rate) with increase NaCl concentrations and maximum decrease was recorded under highest NaCl concentration (160mMol/L). The germination percentage was reduced by (10.11, 22.54, 27.82 and 34.44%) under (40, 80,120 and 160 mMol/L) respectively compared to control, moreover the germination speed decreased by (7.14, 14.58, 32.74 and 38.10%) under (40, 80,120 and 160 mMol/L) respectively compared to control. The germination rate was decreased by (5.26, 13.94, 34.69 and 44.00%) under (40, 80,120 and 160 mMol/L) respectively compared to control.

Salinity effects germination in two ways:-

- Decrease the osmotic potential to such appoints which retard or prevent the uptake of water. Rahman [17] reported that germination was directly related to the amount of water absorbed and salinity delays that germination.
- May be toxic to the embryo. Wilson *et al*. [18] reported that salinity decreased the ratio K/Na and probably caused injury to embryo. While, Mass and Grieve [19] have the opinion that seed germination not only depends upon the salinity but also upon various other biological factors i.e. viability, age, coat permeability, dormancy and genetic makeup.

Table 1: Effects of NaCl concentrations on germination parameters of wheat plants

NaCl concentrations (mMol/L)	GP (%)	GS	GR
0	90.33	3.36	30.41
40	81.20	3.12	28.81
80	69.97	2.87	26.17
120	62.70	2.26	19.86
160	59.22	2.08	17.03
Mean	72.68	2.74	24.46
LSD(0.05)	2.51	0.30	1.08

Pot Experiment

The growth of wheat cultivar after 40days from plantation followed a pattern similar to the germination results. Table (2) showed highly significant decrease occurred in plant height and weight (fresh and dry) with NaCl concentrations increasing from (0 to 160 mMol/L) at rate of (33.91, 48.48 and 37.50%) respectively. Control treatment (no salt) has the highest plant height and weight (fresh and dry).

The reason for reduced plant height may be due to toxic effects of NaCl used as well as unbalanced nutrient uptake [20] or reduce cell division and DNA replication in interphase [21]. This reduction in weights with increasing salinity may be due to limited supply of metabolites to young growing tissues, because metabolic production is significantly perturbed at high salt stress, either due to the low water uptake or toxic effect of NaCl, also the reduction in dry matter production due to inhibition of metabolic processes such as photosynthesis and respiration [22]. Hussein et al. [23] reported that there are two ways that salinity could retard growth, by damaging growth cells so that they cannot perform their functions or by limiting their supply of essential metabolites.

Table 2: Effects of NaCl concentrations on growth parameters of wheat plants

NaCl concentrations (mMol/L)	Plant height (cm)	Fresh weight (g)	Dry weight(g)
0	40.02	2.31	0.64
40	37.17	1.99	0.59
80	35.44	1.75	0.56
120	34.46	1.55	0.47
160	26.45	1.19	0.40
Mean	34.71	1.76	0.53
LSD(0.05)	1.18	0.04	0.06

The increase in NaCl concentrations decreased the chemical contents (chlorophyll, carbohydrate and protein) concentration of wheat (Table 3). The maximum values of chlorophyll, carbohydrate and protein were from control treatment, but maximum decrease in chlorophyll, carbohydrate and protein at high concentration of NaCl (160 mMol/L) which is (69.64, 30.66 and 55.39%) respectively compared with control.

The reduced total chlorophyll concentration under NaCl salt concentrations which may be due to membrane deterioration of the cell membrane of the chloroplastid leading towards lesser accumulation of chlorophyll and lesser photosynthetic efficiency [24]. Salinity affects both water absorption and metabolic processes and a decline in the rate of Photosynthesis by negatively affecting CO_2 assimilation and leads to decrease nutrient uptake and finally carbohydrate concentration reduced [25].The reduced protein in the physiologically active leaves is due to reduced capacity to incorporate amino acids into proteins and an increase in proteolytic enzymes or due to contribution of polysomes to monosomes under stress condition or due to the synthesis of absiccic acid which increases the activity of RNase, thus indirectly inhibiting the protein synthesis [26].

Table 3: Effects of NaCl concentrations on chemical compounds of wheat plants

NaCl concentrations (mMol/L)	Chlorophyll (mg/g fw)	Carbohydrate (%)	Protein (%)
0	1.12	4.11	21.97
40	0.99	3.72	19.83
80	0.74	3.60	16.66
120	0.60	3.26	13.20
160	0.34	2.48	9.80
Mean	0.76	3.43	16.29
LSD(0.05)	0.09	0.13	0.41

CONCLUSION

It can be concluded from the foregoing results that increased NaCl concentrations leads to inhibited germination of wheat. Plant height, Dry and fresh weights and chemical compounds (chlorophyll, protein and carbohydrate) were decreased significantly with increased salt stress (NaCl).

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests.

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Cite this article as:
Hassan Abdul AL-Razak Ali AL-Saady. Germination and Growth of Wheat Plants (*Triticum Aestivum* L.) Under Salt Stress. J Pharm Chem Biol Sci 2015; 3(3): 416-420