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INFLUENCE OF WATER POTENTIAL ON SEEDLINGS OF SOME WHEAT (*Triticum aestivum* L.) HYBRIDS

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ABSTRACT

At germination time of some bread wheat genotypes, both dehydration caused by polyethylene glycol (PEG-6000) and salinity initiated by NaCl stresses have been applied at the age of the 7th day to investigate the seedling response of 4 F_1 hybrids contrary to their 7 parents. Double wetted sheets of filtering paper included in sterilized pettri dishes were the experimental medium of growing, while, weekly irrigation solutions differed conformably with treatments. Since, drought stress solution was performed with adding 200 g/l of PEG-6000 to distilled water to obtain -0.49 kPa of water potential, and saline solution was performed with solving NaCl in the distilled water to obtain 2000 ppm level. Hoagland solution was concerned for control treatment irrigation, regardless of the first irrigation for all treatments. Observations about stomata, growth and chemical analysis have been recorded around 2 months. Analysis of variance reflected the significance and some of the hybrid ability to stress tolerance.

Key words: Bread wheat, germination, drought, salinity, stomata, growth and chemical analysis.

INTRODUCTION

By the year of 2050, more than 50% increase in production of major cereal crops is required to meet the needs for the projected population (**Fahad *et al*., 2016**). Wheat ranks the second among these cereals after rice and ahead of maize with production of about 735 million ton annually (**USDA, 2015**).

Germination stage is one of the most critical periods in the life cycle of plants. Under water stress, low water potential is a determining factor inhibiting seed germination (**Shen *et al*., 1990**; **Wang *et al*., 2002**). Germination was still likely to occur after 30 days period according to the hydrotime model used by **Singh *et al*. (2013)** who ended their observations of wheat grains germination after only the first 30 days.

Low soil water potential limits or prevents germination and emergence of rainfed winter bread wheat (*Triticum aestivum* L.). Wide differences in seedling emergence among winter wheat cultivars have been reported, but few previous experiments have examined germination differences among cultivars as a function of water potential (**Singh *et al*., 2013**). Drought imposes one of commonest and most significant constraints to agricultural production, seriously affecting crop growth, gene expression, distribution, yield and quality (**Yang *et al*., 2004**; **Shi *et al*., 2008** and **2009**). In laboratory studies, seed germination as a function of water potential is often tested with soil adjusted to desired water potentials or by using polyethylene glycol (PEG) solutions (**Singh *et al*., 2013**), which effectively lowers the water potential of an aqueous solution (**Lagerwerff *et al*.,**

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1961; Williams and Shaykewich, 1969; Tingey and Stockwell, 1977). While, seeds are often placed on PEG-soaked filter papers (**Sharma, 1973; Redman, 1974; Wang *et al*., 2005; Singh *et al*., 2013**). PEG is an osmotic agent, which plays an important role in the regulation of mineral elements, hormones, protein metabolism and effects of signal transduction (**Ross and Harper, 1972; Verslues *et al*., 1998**).

The main function of PEG is to slow down the moisture rate of import and export seeds, which benefit to reduce membrane system injury in process of seed imbibition and repair impaired membrane system (**Ma and Liang, 2005; Jiao *et al*., 2009**). PEG and mannitol have been used by several investigators to impose water stress on plants, seeds and callus, by decreasing the osmotic potential of the growing medium (**Murungu, 2011; Singh *et al*., 2013; Battah, 2014; El-Sarag *et al*., 2015**). This technique has the advantage that the water potential of medium can be controlled independently of other physical conditions such as soil crusting or temperature. This can help one to understand how seeds may respond to physical conditions at planting (**Murungu, 2011**).

Salinization is the scourge of intensive agriculture (**Mer *et al*., 2000**; and **Rahman *et al*., 2008**). Water availability is one of the main environmental factors limiting photosynthesis and growth (**Khan *et al*., 1984**). Salinity affects seedling growth of plants (**Tezara *et al*., 2003**; **Rahman and Kayani, 1988**) by slow or less mobilization of reserve foods (**Kayani *et al*., 1990**), suspending the cell division, (**Meiri and Poljakoff-Mayber, 1970**) and injuring hypocotyls (**Assadian and Miyamoto, 1987**). In this regard, **Munns and Tester, 2008** found that the decreased rate of growth level after an increase of soil salinity is primarily due to the osmotic effect of the salt around the roots. **Datta *et al.,* 2009** reported the impact of salt stress under different salinity levels on five varieties of wheat.

Data showed that salinity affected the growth attributes significantly by reducing both of root and shoot growth. **Mandhania *et al.,* 2010** interested to study the effect of short term salt stress on seedlings of some salt-tolerant and salt-sensitive genotypes of wheat. They found that osmotic potential was decreased with salt stress.

Many important physiological and morphological processes such as leaf enlargement, stomatal opening and associated leaf photosynthesis can be directly affected by the reduction of leaf turgor potential, which accompanies the loss of water from leaf tissue (**Jones and Turner, 1978**). The morphology, anatomy and physiology as well as chemistry characteristics can being changed by the environmental factors, which can detain the growth of plant itself and reduce the speed of photosynthesis due to closure of stomata that controlled by water retention on leaves and the dehydration of cuticula (**Pennypacker *et al*., 1990**; **Watanabe *et al*., 1991**). Stomatal closure is one of the earliest responses of plants to water deficit that limits transpiration water loss and helps plants to retain water status under drought.

However, closure of stomata in turn, results in reduction of CO_2 availability for photosynthetic carbon metabolism, depresses net CO_2 assimilation rate and inhibits plant ability for dry matter accumulation (**Chaves *et al*., 2009**; **Hajiboland *et al*., 2014**). In this context, **Alam *et al*. (2011)** determined a negative effect of water stress on different stomatal characters in both adaxial and abaxial surfaces of flag leaf in different lines of bread wheat. While, **Liley and Ludlow (1996)** stated that the plasma membrane is generally protected from desiccation-induced damage by the presence of membrane-compatible solutes, such as" sugars and amino acids.

Therefore, a link may exist between the capacity for osmotic adjustment and the degree of membrane protection from the effect of dehydration. **Tas and Tas (2007)** reported that there is a line between various physiological responses to drought and plant tolerance mechanisms such as high relative water content, water potential and membrane stability as well as pigment content stability. They found that membrane stability index (MSI) varied significantly between tetraploid and hexaploid wheat varieties under irrigated and water stress conditions while hexaploids were better than tetraploid.

In plants, in general, an appropriate growth strategy is key to fitness a competitive situation, so too in wheat seedlings, their growth strategy is critical to survival (**Du and Huang, 2008**). **Ihsan *et al.* (2016)** evaluated the potential for adaptability and tolerance of 4 wheat genotypes to an arid environment. They examined the influence of drought stress on growth indices and measured the development after 30, 45, 60 and 75 days from sowing.

Results indicated considerable reductions in crop growth rate (CGR) of all the tested genotypes due to drought stress, which also significantly diminished the leaf area duration (LAD) of all wheat genotypes. Furthermore, **Guendouz *et al.* (2016)** studied the effect of water stress and the supplementary irrigation on leaf characters. They reported that water stress reduced the specific leaf area (SLA) due to the reduction in cell division.

Several researches on physiological and biochemical changes that occur during leaf senescence (drought stress) focused on loss of photosynthetic pigments and re-absorption of mineral nutrients such as **Saeidi *et al.* (2010) and Hajiboland (2014)**. Chlorophyll and cartenoides are the main photosynthetic pigments of plants, so these are good indicators of the photosynthesis capability of a plant (**Guo *et al.*, 2013**).

Hereafter, **Keyvan (2010)**, **Moaveni (2011)** and **Abdoli *et al.* (2013)** reported that there was decrease in total chlorophyll content and photosynthesis rate with the increase in intensity of drought stress on wheat cultivars. Moreover, **Saeidi *et al.* (2015)** indicated that water stress during the vegetative growth stage significantly decreased each of chlorophyll a, b and total chlorophyll contents.

Furthermore, data obtained by **Guo *et al.* (2013)** concerning some drought treatments caused by using PEG-6000 at different concentrations on bread wheat seedlings, suggested that wheat seedlings may initially sense high drought environments, the harmful effects of water stress on the distribution and accumulation of carbohydrates, it also was reflecting specific detrimental effects of a drought environment. It implies that there was a closed relationship between the effects of water stress on chlorophyll fluorescence parameters of wheat seedlings.

Wheat genetic improvement through such these breeding programs concerning the counteractive environmental conditions, needs to understand well how genotypes response to stresses with the interaction between them. In addition, both of evaluation and screening are necessary to obtain good information about the parents and hybrids. Breeders regularly select for desirable expression of indirect selection criteria. Accordingly, this current investigation is hypothesizes that tolerance characteristics of the tested parents will result in their hybrids.The aim of this study was to investigate seedlings response of some bread wheat (*Triticum aestivum* L.) populations to drought and salinity treatments during the germination stage on some morphological, biochemical and physiological indicators.

MATERIALS AND METHODS

This study was achieved laboratorial in the academic year 2015/2016 at Faculty of Environmental Agricultural Science (FEAS), Al-Arish University (AU), North Sinai, Egypt.

Genetic Materials

The genetic materials used in this paper included seven bread wheat genotypes. These genotypes were chosen on the basis of their genetic diversity for several agronomic traits. The seven genotypes were used as crossed parents in a six population model. The name, pedigree and origin of these parental genotypes are presented in Table (1).Hence, four crosses have been derived from the mentioned before parents, whereas, only the two parents and their F_{1s} of each cross were included without their F_{2s} and the two backcrosses (Bc_{1s} & Bc_{2s}) of the six populations model. While, the 4 crosses have been designed as follows:

Cross 1 = Amna-2 X Damara-6

Cross 2 = Rama-2 X Sakha 95

Cross 3 = Alshoroq-3 X Sakha 95

Cross 4 = Salah-1 X Babaga-3

Methods

Sterilization

Enough quantity of bread wheat grains from each of parents and F_{1s} were sterilized by 0.1% $HgCl_2$ for 30 second then washed with potable water followed by distilled water.

Culturing conditions

Sowing

Sterilized grains were divided into three parts for each genotype; the first part of grains was devoted to untreated or the control treatment. In the same time, the other two parts were exposed to water potential throughout the mentioned before stress treatments. While, the experiment have been carried out with ten replications for each genotype using 20 grains sown in sterilized pettri dishes (14 cm in dimeter) containing double sheets of filtering paper, which were wetted with the irrigation solution.

Incubation

Pettri dishes were covered to save the moisture level and kept in full darkness in an incubator at 23°C for seven days, then exposed to the laboratory atmosphere and have been irrigated weekly with certain solutions.

Irrigation

Hoagland solution was used as the main source of the first irrigation for all treatments, which it was wetted the double filtering papers at the beginning of culturing. Hoagland solution was also used as the main source of the weekly irrigation only for the control treatment. Meantime, 2 certain solutions were caused the water potential in 2 stress treatments.

Stress treatments

The abovementioned water potential was observed in two treatments concerning both drought and salinity stresses, separately. Therefore, these two irrigation solutions of stress were irrigated the start germinated grains on the Pettri dishes by the end of the first week instead of Hoagland solution to cause stress. Drought stress solution was performed with adding 200 g/l of polyethylene glycol 6000 (PEG-6000) to distilled water to obtain -0.49 kPa water potential **(Michel and Kaufmanm, 1973)**. The saline solution was performed with solving sodium chloride (NaCl) in distilled water to obtain 2000 ppm level.

Table (1): Name, pedigree and origin of the parental genotypes.

No.	Name	Pedigree	Origin
1	Amna-2	CHIL-1//VEE'S'/SAKER'S' ICW99-0026-2AP-0AP-0AP-3AP-0AP	Syria
2	Damara-6	VEE/PJN//2*KAUZ/3/PLK70/LIRA'S'//CNO79*2/PRL ICW99-0427-8AP-0AP-0AP-3AP-0AP	Australia
3	Rama-2	BOOMA-2/BOCRO-4 ICW99-0351-1AP-0AP-0AP-5AP-0AP	South Africa
4	Sakha 95	SKAUZ*2_SRMA-CMBW91MO2694P-0T0PY-7M-010Y -010M-010Y-5	Egypt
5	Alshoroq-3	BOCRO-4/3/MAYON'S'//CROW'S'/VEE'S' ICW99-0368-18AP-0AP-0AP-22AP-0AP	Syria
6	Salah-1	LFN/II58.57//PRL/3/HAHN/4/KAUZ/5/KAUZ/6/TOWPE ICW99-0425-8AP-0AP-0AP-22AP-0AP	Syria
7	Babaga-3	CHEN/AE.SQ//2*OPATA/3/BABAX CMSS98Y00585S-040Y-0B-0MXI-0AP-0AP-8AP-0AP	Syria

Recorded data

Somehow mechanisms enable higher plants dealing stand against stress, principally dehydration, either they were such escaping, avoidance, tolerance or more than one of them, together, characterizations were distinguished in suitability such as that produced by **Singh (1993)** and **Khan *et al.* (2010)** as to variation and genetic control, as well as that which outlined by **Munns *et al.* (2011)** concerning saline stress characterization.

Usually, seedling germination parameters could be recorded since grains were considered germinating with the emergence of the radical (2-3 mm), which can be observed within few days until the end of the first ten days from the sowing date.

Worthwhile, these germination parameters didn't calculated in this study. Yet, characterizations at different ages of wheat seedlings were interested several main topics including determining of some physiological and chemical as well as growth analysis traits, with emphasize on some parental differences without their F_1 hybrids as an initial step under the stress conditions of PEG medium. Hereof, parental differences included some traits such as some stomatal characters, which have been recorded at the age of two months. Meanwhile, the other tested observations were previously recorded by the end of the 30th day.

Parental differences

In the hereinabove manner, once, the performance of the seven parents only was evaluated under only drought treatment in view of some biochemical mechanisms in addition to leaf stomata and membrane stability.

Stomatal characters

Adaxial and abaxial surface stomata characteristics have been estimated at 60 days old by using impression method outlined by **Mohammdy *et al.* (2006)**. Impressions were viewed with light microscope (40X objective). Observations were made on an average of 10 fields mm^{-2} for each leaf with a calibrated eyepiece micrometer to measure each of:

1. Stomatal frequency of adaxial leaf surface (SFAd).

2. Stomatal frequency of abaxial leaf surface (SFAb).
3. Mean stomatal area of adaxial leaf surface (SAAd) (µm stomata/mm^2 of leaf).
4. Mean stomatal area of abaxial leaf surface (SAAb) (µm stomata/mm^2 of leaf).

Membrane character

Membrane stability index (MSI) (%)

Leaf Membrane Stability Index (MSI) was determined at 60th day according to the method of **Premachandra *et al.* (1994)** as modified by **Sairam (1994)**. Leaf stripes (0.2 g) of uniform size were taken in test tubes containing 10 ml of double distilled water in two sets. Test tubes in one set were kept at 40°C in a water bath for 30 min and electrical conductivity of the water containing the sample was measured (C_1) using a conductivity bridge. Test tubes in the other set incubated at 100 C° in the boiling water bath for 15 min and the electrical conductivity was measured as above (C_2). MSI was calculated using the formula given below:

$MSI = (1 - C_1/C_2) X 100$

Biochemical mechanisms

Abscisic acid (ABA) accumulation (mg/g fresh weight)

The ABA content in the leaves was estimated at 60th day using HPLC. Weighed leaves were thoroughly extracted in acetone containing 0.1% butylhydroxytoluene (**Sharma *et al.*, 2002**). The extract was centrifuged at 5000 xg for 5 min at 4C°. The supernatant was filtered through a 30 µm syringe filter, and 10 µl of the filtrate were used for HPLC analysis.

The separation and quantitative estimation were carried out using a HPLC system (Perkin Elmer series 200 LC and UV/VIS detector 200 LC, USA) equipped with a 5 µm column (Spheri-5 RP-18, 220 x 4.6 mm, Brownlee). The solvent used was acetonitrile/water (26 : 74) run isocratically. The detector was set at 440 nm for the integration of peak areas after calibration with the external standard ABA.

Catalase (CAT) enzyme activity

Determination of antioxidant enzyme activity of catalase (units/mg of protein) in the leaves sample estimated by the method as described by **Beers and Sizer, 1952**. Catalase activity level was determined by following the decrease in absorbance at 240 nm for 3 min by using spectrophotometer.

Growth analysis

Henceforth, the experimental design will be consisted of the 7 bread wheat parents and their 4 F_1 hybrids. Measurements were recorded at 30-37 days old under the dehydration conditions as follows:

1. Crop growth rate (CGR) = NAR X LAI (g. dry matter/m^2 of land/day)

NAR: net assimilation rate (g dry matter/ dsm^2 LA/week) (on LA basis during one week)

$$- NAR = \frac{W2 - W1}{LA2 - LA1} X \frac{Loge\ LA2 - Loge\ LA1}{T2 - T1}$$

W_1: Leaf dry weight at week begging (T_1)

W_2: Leaf dry weight at the week end (T_2)

LA_1: Leaf area / plant at T_1

LA_{21}: Leaf area / plant at T_2

Loge: Nabarian log = 2.303 X Log_{10}

LAI: Leaf area index.

$$- LAI = \frac{Leaf\ area\ /\ plant\ for\ one\ surface}{Occupied\ soil\ \ area\ /\ plant}$$

Where:

LA=Maximize length X maximum widthX0.75

2. Leaf area duration (LAD)

Where:

$LAD = (LA_2 - LA_1) X (T_2 - T_1)$ (cm^2/week)

3. Specific leaf area (SLA) = LA/Lw (cm^2/ mg)

Where:

LA = Leaf area

Lw = Leaf weight

4. Fresh/dry weight (FWR) = Fw/W

Where:

Fw: Plant fresh weight

W: Plant dry weight

5. Root – weight ratio (RWR) = Rw/W

Where: Rw: Root dry weight / plant.

Chemical analysis

Similarly and hitherto, seven parents and their four F_1 hybrids have been included. Determining was done by the age of 30 days per seedling. Nevertheless, observations were recorded since salinity stress was added beside the stress of drought contrary the control.

Plant pigments (mg g^{-1} FW)

Chlorophyll a, b, total chlorophyll and total carotenoids were determined according to the method reported by **Lochtenthaler (1987)**. Since, leaves sample (0.5 g) were extracted with 80% acetone and absorbance of supernatants measured spectrophotometrically.

1. Chlorophyll a was determined at wave length 663 µm.
2. Chlorophyll b was determined at wave length 645 µm.
3. Total chlorophyll was determined at wave length 652 µm.
4. Total carotenoids were determined at wave length 450 µm.

Total carbohydrates (mg g^{-1} FW)

Concentration of total carbohydrates was determined in the dried leaves, using the method described by **Herbert *et al.* (1971)**. Five ml of 67% sulphuric acid were added to a known weight of the matter (0.1 g) in a test tube. 6 hours later, the volume was completed to 100 ml with distilled water and the solution was filtered.

One ml of the filtrate was pipetted into a test tube and an aqueous phenol solution (1 ml 5%) was added to the solution and followed by concentrated H_2SO_4 (5 ml) from a fast delivering pipette. Measurements of the color intensity have been taken by using spectrophotometer at 490 µm and content was calculated by a standard curve of glucose.

Total phenolic content (TPC) (mg g^{-1} FW)

Determination was done by using the folin-ciocalteau method of **Singleton and Rossi, (1965)** which modified by **Gao *et al.* (2002)** as described previously by **Beta *et al.*, 2005**. Briefly, samples (200 mg) were extracted with acidified methanol (HCl/ methanol/water, 10:80: 10, *V/V*) (4 ml) at room temperature for 2h. The obtained extracts were oxidized with folin-ciocalteau reagents, and the reaction mixture was neutralized with sodium carbonate. The mixture was incubated at room temperature for 90 min, and its absorbance was measured at 725 nm. Acidified methanol was used as the blank. Ferulic acid was used as the standard, and results are expressed as ferulic acid equivalents per gram.

Nitrogen, phosphorus and potassium (NPK) content (mg/g FW)

The total nitrogen (N) concentration was determined by using the modified method of micro-Kjeldahel as described by **Peach and Tracy (1956)**.

Phosphorus (P), determination was done spectrophotometrically after digestion of plant material in sulphuric acid and hydrogen peroxide by Mo-blue method (**Jackson, 1973**).

Potassium (K) was determined using flame photometer according to **Chapman and Partt (1961)**. Consequently, records have been calculated from a standard curve of potassium dihydrogen phosphate.

Statistical Analysis

Records were subjected to analysis of variance *via* randomized complete design according to the method outlined by **Steel and Torrie (1980)**. Least significant difference (LSD) method at confidence intervals of 0.95 was used to compare means of each treatment, genotypes and their interaction. Computations were fulfilled conformably with the MSTAT computer program package.

RESULTS AND DISCUSSION

Parental Differences

According to data illustrated in Table 2, it is clear that analysis of variance indicated that stomatal traits, abscisic acid and catalase concerning the 7 parents of bread wheat, which have been evaluated in this study, were varied significantly or high significantly between and within treatments as well as their interaction. While, there was no significance in MSI.

Effect of water stress on stomatal traits and membrane stability index (MSI)

Stomatal characters such as stomatal frequency and area of each adaxil and abaxil surfaces: SFAd, SFAb, SAAd and SAAb were illustrated in Figs. 1, 2, 3 and 4. Water deficit stress treatment increased the range limits of these studied traits considerably from 35.00 – 70.67 under the control conditions, to 40.33 – 78.00 under the stressed conditions, which have been recorded by Babaga-3 and Sakha-95 parents, respectively; from 28.00 – 60.33 to 34.67 – 71.33, from 50960.22 – 68120.74 (µm stomata/mm^2 of leaf) to 53813.77 – 70006.23 (µm stomata/mm^2 of leaf), and from 49006.82 – 67053.07 (µm stomata/ mm^2 of leaf) to 52078.11 – 69130.26 (µm stomata/mm^2 of leaf) by the same parents under the same conditions, respectively.

It is of interest to note that each of stomatal frequency and stomatal area on the adaxial surface were greater than those on the abaxial surface. Meanwhile, membrane stability index (MSI) in Fig. 5 as a physiological character was varied significantly from 51.00% which recorded by Banaga-3 to 78.33% which recorded by Sakha-95under the control condition and from 57.33% to 92.00% under stress, respectively.

Stomatal conductance may be influenced under water deficit condition *via* changes in leaf-water potential and *via* metabolic changes in the leaf. There is evidence for non-hydraulic root-to-shoot communication on soil water status, which causes stomata to close without changes in water potential and turgor of leaf (**Gollan *et al*., 1992**).

Table (2): Analysis of variance for stomata, MSI, ABA and CAT of the tested drought-affected wheat parents.

SOV	d.f	Mean square						
		SFAD	SFAB	SAAD (µm stomata/ mm^2)	SAAB (µm stomata/mm^2)	MSI (%)	ABA (mg/g fresh weight)	CAT (g dry matter/m^2)
Treatments (T.)	1	564.67**	688.10**	7642622774.75**	58336569.51*	1710.10^{ns}	18946.93**	0.0001**
Genotypes (G.)	6	891.36**	915.33**	77754182528.54**	237035338.83**	743.00^{ns}	280.76**	0.0001**
T. X G.	6	13.50**	10.26**	71992814867.10**	20346869.57*	39.10^{ns}	234.52**	0.0001**
Error	28	1.83	1.21	3023571.43	7444736.55	0.67	0.057	0.0001
Total	41							
C.V (%)		2.5	2.34	1.72	4.72	1.19	0.88	0.36
Mean ± STDEV		54.14±12.14	47.10±12.37	101307.17±154208.70	54817.13±6646.26	68.33±12.52	27.35±23.19	0.004±0.0005

STDEV; standard deviation, *; significant at 0.05 level of probability, **; significant at 0.01 level of probability and ns; not significant.

Fig. 1. Effect of dehydration due to PEG-6000 on stomatal frequency of adaxil leaf surface (SFAd) of the tested 7 bread wheat parent seedlings

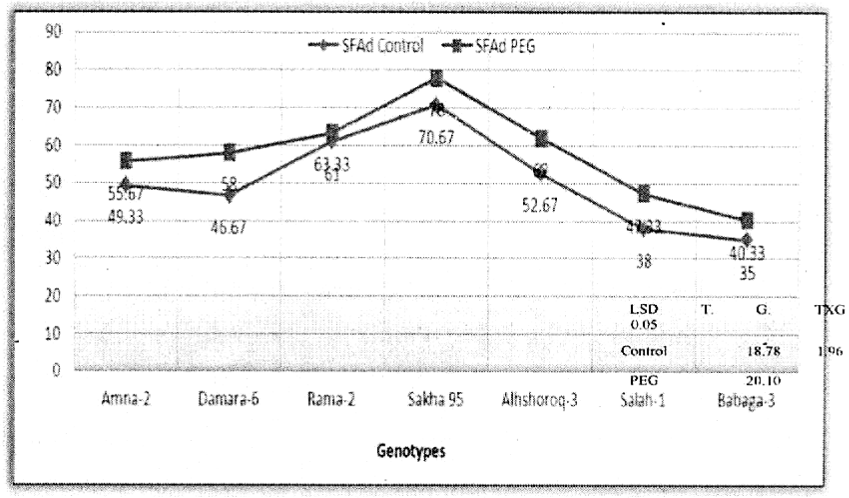


Fig. 2. Effect of dehydration due to PEG-6000 on stomatal frequency of abaxil leaf surface (SFAb) of the tested 7 bread wheat parent seedlings

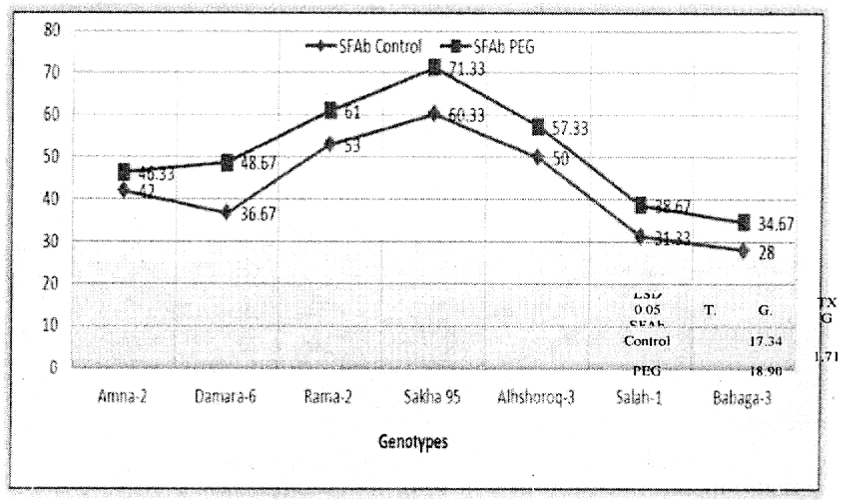


Fig. 3. Effect of dehydration due to PEG-6000 on mean stomatal area of adaxil leaf surface (SAAd)(µm/mm²of leaf)of the tested 7bread wheat parent seedlings

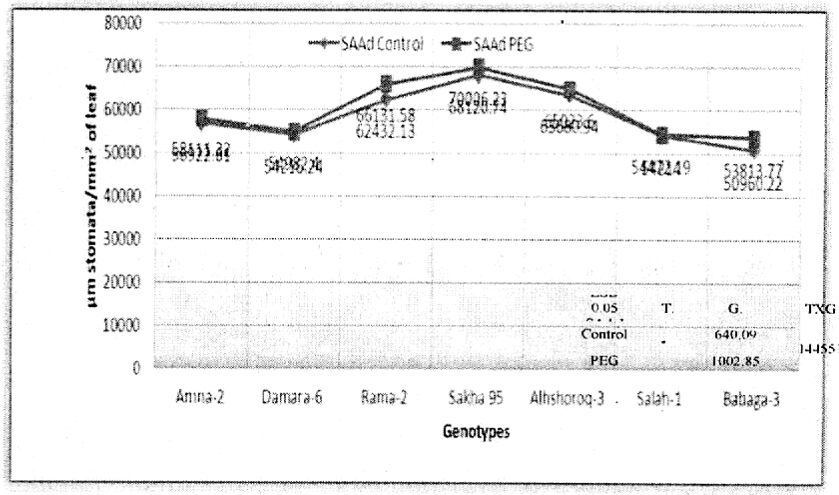
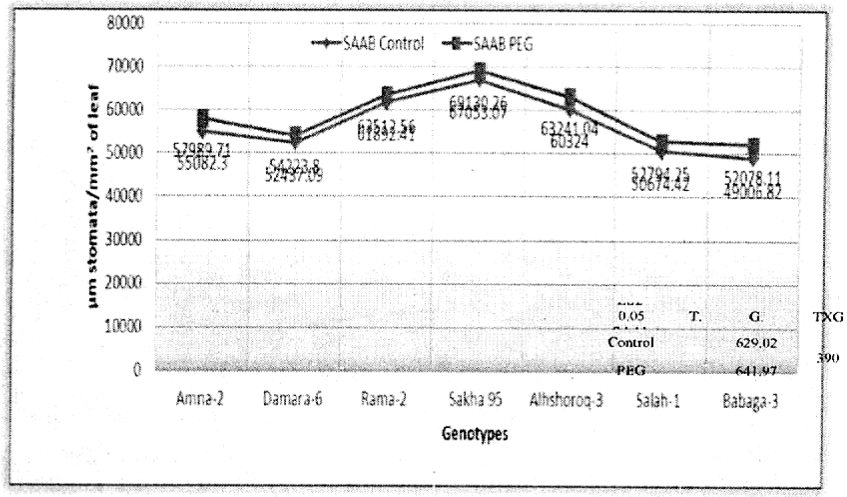


Fig. 4. Effect of dehydration due to PEG-6000 on mean stomatal area of abaxil leaf surface (SAAb)(µm/mm²of leaf)of the tested 7bread wheat parent seedlings



Furthermore, **Comic (2000)** concluded that the low rate of photosynthesis, as a result of water stress, was partially due to the stomatal closing, as the reduction of stomatal conductance is the most effective may be reduced water loss, bur acts as a burrier against the CO_2 diffusion to the photosynthetic cells, which results in the reduction of CO_2 concentration inside the leaves and therefore reduction photosynthesis rate. In addition, plant survival depends on maintaining a positive turgor, which is indispensable for expansion growth of cells and stomatal opening (**Zhu, 2003**). In this context, **Sari *et al.* (2015)** attributed the differences of stomata density and leaves thickness to the differences in ability to absorb the nutrients and to water evaporation as well as to sunlight intensity to the palisade cells.

Effect of water stress on abscisic acid (ABA) and catalase (CAT)

For the chemical analysis, from Figs. 6 and 7, it could be observed that each of abscisic acid (ABA) and catalase (CAT) increased significantly due to water deficit stress. Hereinafter, the mentioned before characters increased concerning the superior parent Babaga-3 from 7.99 (unit/mg protein) and 0.00477 (unit/mg protein) to 63.41 (unit/mg protein) and 0.00507 (unit/ mg protein), respectively.

Yoshiba *et al.* (1997) announced that one of the mechanisms that were found in plant at adaptation processes is the accumulation of some components such as abscisic acid for reducing the cell potential osmotic pressure without limiting the function of enzymes. Our results are in accordance with results of **Bakalova *et al.* (2004) and Csiszar *et al.* (2005)**, who were obtained a similar trend. The role of ABA in plant growth and development is multifunctional; it is involved in stomatal function, seed development and germination, and the plant's responses to water deficit, salinity and cold stresses (**Hong and Bary, 1992**). Synthesis of abscisic acid increases the activity of RN_{ase} **(Datta *et al.*, 2009).** Many studies confirmed a high amount of the plant stress hormone ABA as a result of increased water stress, where it plays an important role in the organization of plant responses to water stress (**Davies and Zhang, 1991**).

Under intense water stress, the concentration of ABA in plants increases, which triggers a number of processes starting from decrease in turgor pressure, decline in cellular expansion then stomatal closure to reduce water loss in leaves (**Thompson *et al.*, 1997**). The results in the present study did not differ from what has been reported before that water stress causes ABA accumulation in stressed plants (**Unyayar *et al.*, 2004**). All parents in this study showed an increase in ABA. Abscisic acid is a plant hormone that is also accumulated in plants under stresses conditions. It enables the plant to overcome abiotic stresses, such as water deficit, cold, salt and wounding (**Morgan, 1984; Finkeistein *et al.*, 2002**).

Priming seeds can increase free radical scanenging enzymes such as catalase (CAT) in seeds (**Chiu *et al.*, 1995; Chang and Sung, 1998; Afzal *et al.*, 2006**). Oxidative injury at the cellular level because of water stress is a major cause of crop damage. Genotypes respond differentially to such stresses because of variations in their antioxidant systems (**Balouchi, 2010**).

Effect of Water Stress on Growth Analysis

Table 3 obviously referred to highly significance between and within treatments in all characteristics of growth analysis for the 11 bread wheat genotypes (7 parents and their 4 F_1 hybrids), except leaf area duration which exhibited insignificant genotypic differences. Moreover, analysis of variance indicated that there were insignificant differences regarding to the interaction of treatments and genotypes.

Fig. 5. Effect of dehydration due to PEG-6000 on membrane stability index (MSI) (%) of the tested 7 bread wheat parent seedlings

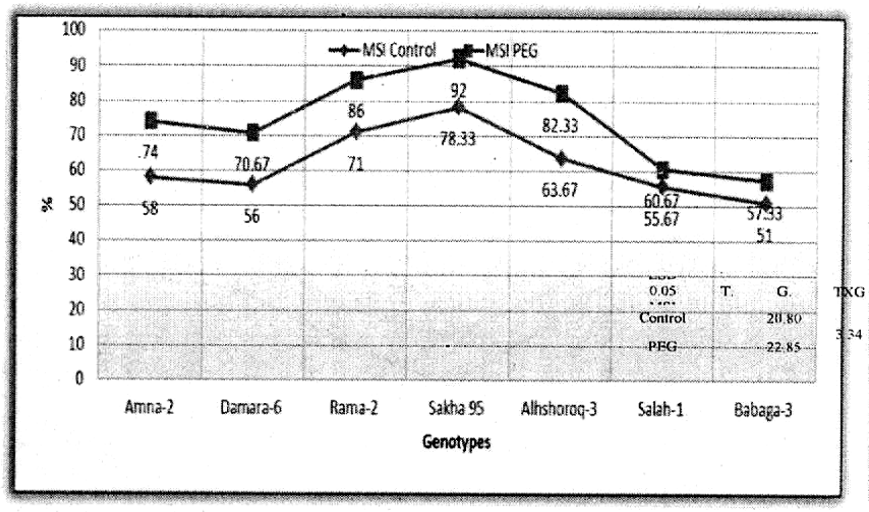


Fig. 6. Effect of dehydration due to PEG-6000 on abscisic acid (ABA) accumulation (mg/g fresh weight) of the tested 7 bread wheat parent seedlings

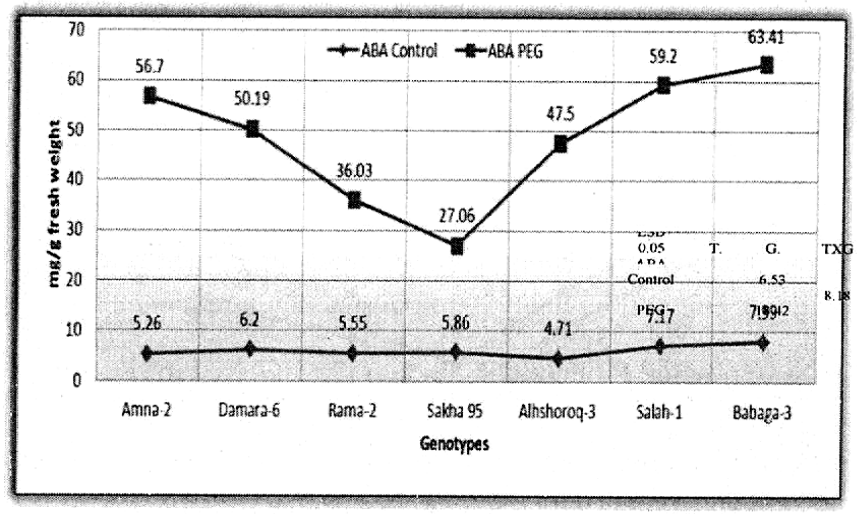


Fig. 7. Effect of dehydration due to PEG-6000 on catalase (CAT) enzyme activity (unit/mg protein) of the tested 7 bread wheat parent seedlings

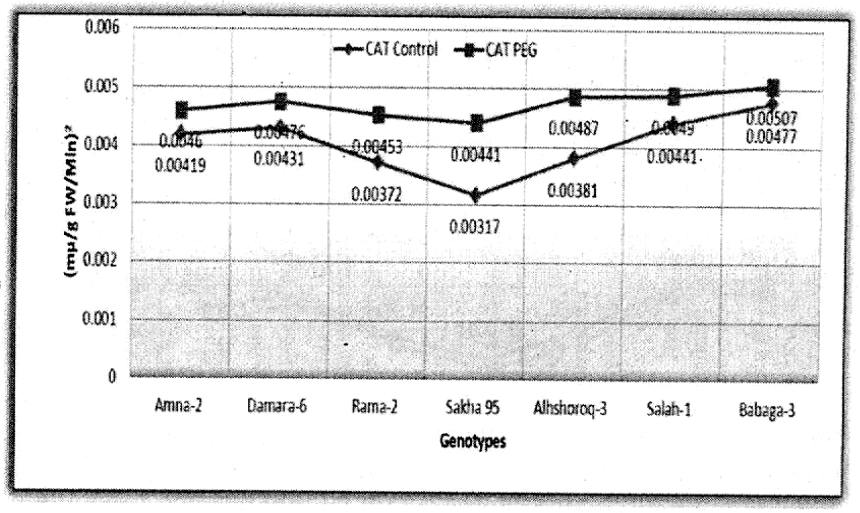


Fig. 8. Effect of dehydration due to PEG-6000 on crop growth rate (CGR) (g dry matter /m² of land/day) of the tested bread wheat population seedlings

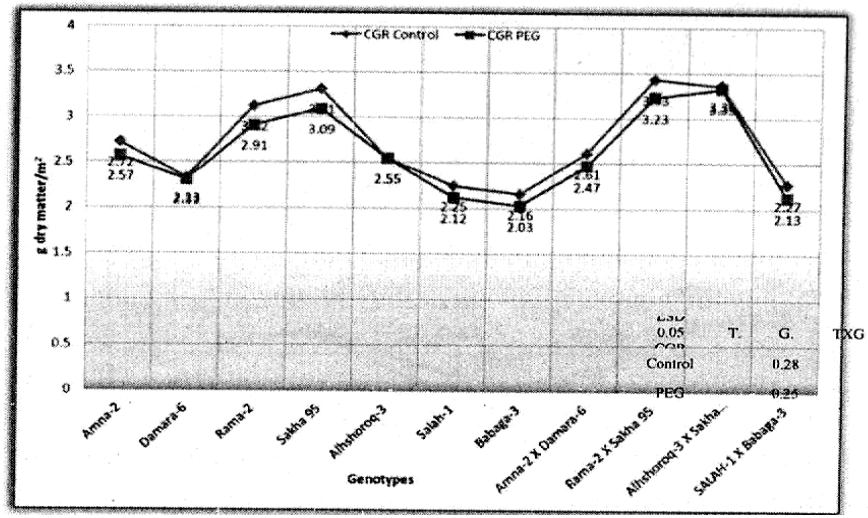


Table (3): Analysis of variance for growth analysis characters of the tested bread wheat parents and their F_{1s} influenced by dehydration

SOV	d.f	Mean square				
		CGR (x10^{-3}) (g dry matter/m^2 of land/day)	LAD (cm^2/week)	SLA (cm^2/mg)	FWR	RWR
Treatments (T.)	1	0.26**	336199.76**	141.15**	2.23**	0.0001**
Genotypes (G.)	10	1.34**	6404030.38ns	1071.25**	0.56**	0.0001**
T. X G.	10	0.009ns	14683.98ns	4.53ns	0.02 ns	0.0001ns
Error	44	0.024	17594.19	4.24	0.02	0.0001
Total	65					
C.V (%)		5.83	4.24	6.92	7.3	4.53
Mean ± STDEV		2.67±0.48	3129.49±1002.29	29.75±13.06	2.01±0.37	0.031±0.006

STDEV: standard deviation, *; significant at 0.05 level of probability, **; significant at 0.01 level of probability and ns; not significant.

Crop growth rate (CGR) (g dry matter/ m^2/day)

It is obvious from Fig. 8 that there were significant differences among the evaluated bread wheat population. It can be observed that water stress decreased the crop growth rate for all genotypes, except the two parents Damara-6 and Alshoroq-3 which did not affected. In this regard, the hybrid Rama-2 X Sakh-95 gave the highest crop growth rate 3.43 x 10^{-3} (g dry matter/m^2/ day) concerning the well-watered plants, while, the hybrid Alshoroq-3 X Sakha-95 recorded the highest value 3.33×10^{-3} (g dry matter/m^2/day) under the stressed conditions.

Meanwhile, water deficit treatment decreased the lowest limit of the crop growth rate which obtained by the parent Babaga-3 from 2.16 x10^{-3} (g dry matter/m^2 of land/day) under control treatment to 2.03x10^{-3} (g dry matter/m^2 of land/day).

The mechanisms by which the water stress affects the photosynthesis process is not clearly understood yet, but the stomatal closing is one of the most important reasons for the low rates of photosynthesis in plants suffering from water stress (**De Souza *et al.*, 2005**).

It is well established fact that Na is a toxic element whose higher concentration disturbs the different metabolic activities. The varieties which are successful in retaining the Na in root are tolerant.

It is well established fact that the plant infrastructure is decided by the growth parameters such as, leaf area duration (LAD), crop growth rate (CGR), net assimilation rate (NAR) and specific leaf area (SLA). This concept not only involves the final crop yield and its components, but also probes into the physiological events that have occurred early in the growth stages causing variation in yield potential **(Akram, 2011)**.

Leaf area duration (LAD) (cm^2/week)

From the results illustrated in Table 3 and Fig. 9, it is remarked that water deficit stress decreased leaf area duration significantly, and there were insignificant differences among the studied bread wheat genotypes. Ranges of 2.094-4.982 and 2.016-4.420 (cm^2/week) were estimated under each of watered and water deficit cultivation conditions, respectively.

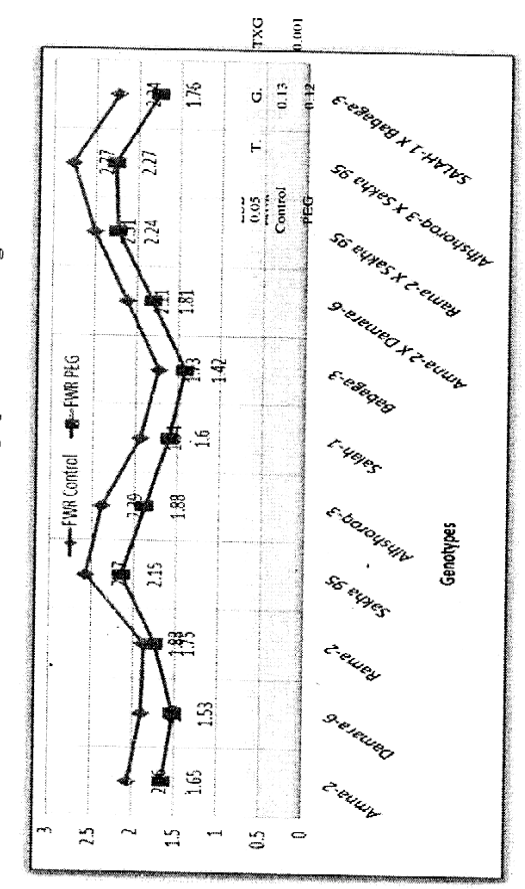


Fig. 11. Effect of dehydration due to PEG-6000 on fresh–dry weight (FWR) of the tested bread wheat population seedlings

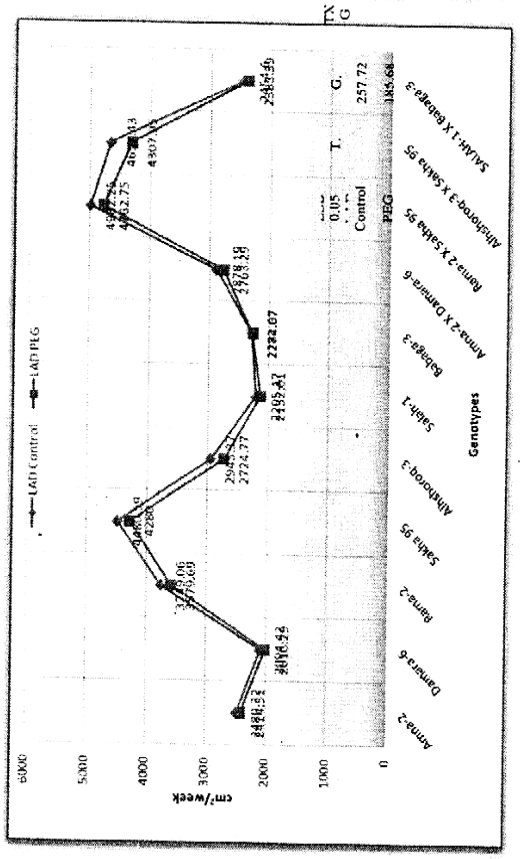


Fig. 9. Effect of dehydration due to PEG-6000 on leaf area duration (LAD) (cm^2/week) of the tested bread wheat population seedlings

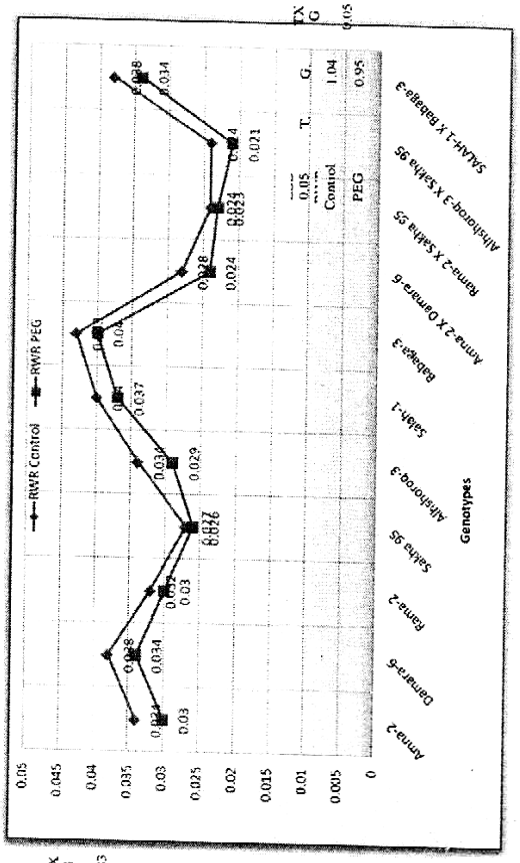


Fig. 12. Effect of dehydration due to PEG-6000 on root–weight ratio (RWR) of the tested bread wheat population seedlings

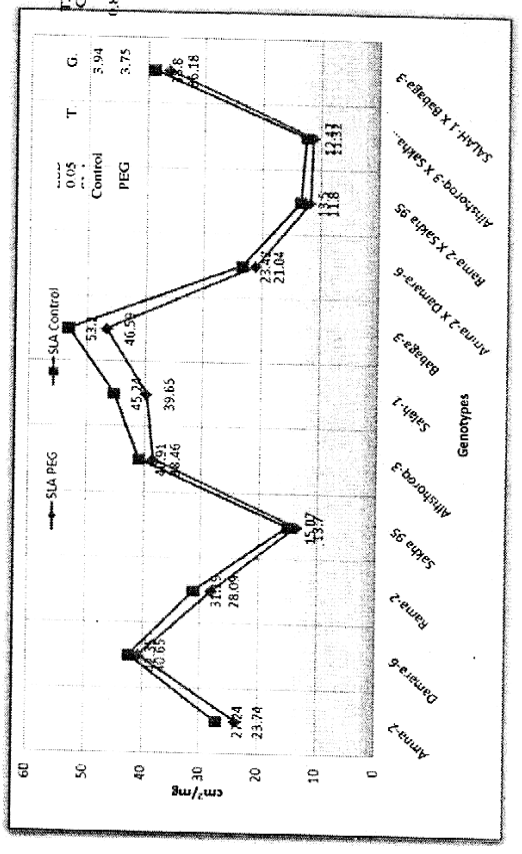


Fig. 10. Effect of dehydration due to PEG-6000 on specific leaf area (SLA) (cm^2/mg) of the tested bread wheat population seedlings

Whereas, the two lowest limits obtained by the same parent Damara-6, while the highest limits recorded by the hybrid Rama-2 X Sakha-95 under normal conditions and by the parent Sakha-95 under the water deficit treatment. Leaf area duration (LAD) is a useful growth parameter not only in depicting the efficiency of photosynthetic system, but also in showing a linear relationship with accumulation of dry matter **(Chetti and Sirohi, 1995)**.

Growth parameters such as CGR indicate the development of crop in a logical sequence and elucidate the causes for differences in yield through the events that have occurred earlier in the growth.

CGR is influenced by LAD, leaf photosynthetic rate and leaf angle and is an index of the light intercepted. Net assimilation rate (NAR) refers to a capacity of green leaves to produce dry matter and it depends on leaf area and the rate of photosynthesis. Leaves play crucial role to improve crop physiological functions and status of crops.

Leaf area duration in this regard is of prime importance as it strongly affects duration of photosynthesis. Crop productivity is directly impacted by leaf area duration maximum leaf area duration and index led to increased dry matter accumulation and yield of crop under environmental variability **(Ozalkan *et al*., 2010).**

Specific leaf area (SLA) (cm^2/mg)

Fig. 10 obviously shows significant differences among genotypes with a respect to the specific leaf area.

In common, water stress reduced range of the SLA from 12.47-53.20 (cm^2/mg) to 11.32-46.59 (cm^2/mg) which recorded by the hybrid Alshoroq-3 X Sakh-95 and the superior parent Babaga-3 concerning the lowest and the highest values under normal and water deficit conditions, respectively.

Various trends of response by such decrease or by increase in SLA under drought stress have been reported by several studies, interpretations also differed concerning the measuring of leaf thickness depending upon SLA. Decreasing trend in bread wheat stated by **Ahmed *et al*. (2014)**.

Since, water stress may reduce the turgor pressure and hence cell expansion, resulting in approximately the same dry mass being contained within a smaller leaf area, thus raising density (**Hsiao, 1973; Rascio *et al*., 1990**).

Fresh-dry weight (FWR)

Significant differences have been recorded among population genotypes and between treatments due to water stress treatment contrary to un-treated plants regarding fresh weight-dry weight as described from Fig. 11. Water deficit stress decreased FWR from 1.73 to 1.42 concerning the lowest limit of variation which obtained by Babaga-3, furthermore, the highest limit which recorded by the hybrid Alshoroq-3 × Sakha-95 decreased from 2.77 under normal culture to 2.27 due to water deficit stress.

It is very difficult to account for yield variation in terms of growth and development, since it involves the effect of both intrinsic and extrinsic factors in all the physiological processes of plant. Various empirical relationships describe the connections between the end point of a long chain of interdependent processes in the environment and the plant **(Watson, 1952)**.

Root-weight ratio (RWR)

Curves which illustrated in Fig. 12 obviously reflect that water stress treatment affected root-weight ratio negatively and significantly. Results are indicating that the used bread wheat genotypes also varied considerably under both control and polyethylene glycol treatment. Under normal germination conditions, the highest ratio of root–weight was 0.043 obtained by Babaga-3, followed by 0.040 which recorded by Salah-1. On contrast, the lowest ratio was 0.024 which obtained by both of the two hybrids of Sakha-95 with each of Rama-2 and Alshoroq-3. Meantime, the mentioned before hybrid recorded the lowest value of RWR (0.021) under water deficit germination environment, while, value of 0.040 was the highest ratio which obtained by the most superior parent Babaga-3

These results may reflect the impact of water stress on root cell development, which would likely impair nutrient uptake as well as having determined effects on photosynthesis, essential for biomass accumulation and therefore on shoot and root elongation **(Guo *et al*., 2013)**.

Chemical Analysis

From Table 4 which pointed out to the analysis of variance under both dehydration and salinity stresses in addition to the control treatment for the tested population of bread wheat, it could be observed that there were high significant differences between, within treatments and their interactions for chemical analysis traits, except, total carbohydrates in genotypes and the interaction.

Plant Pigments

Chlorophyll a content (mg g^{-1} FW)

Respecting the chlorophyll a content, Fig. 13 clearly indicate that there were significant differences among genotypes and between the control and stress treatments. There was marked reduction in chlorophyll a content under both water stress and salinity conditions in all parents and their F_{1s}. It could be indicated that there were insignificant differences between saline and water deficit treatments.

Records varied considerably from 1.37 to 3.43 (mg g^{-1} FW), from 1.16 to 2.28 (mg g^{-1} FW) and from 1.11 to 2.13 (mg g^{-1} FW) regarding to the control, polyethylene glycol and NaCl treatments, respectively. Whereas, lowest values recorded by Sakha-95 and the highest recorded by Babaga-3. The two hybrids Amna-2 X Damara-6 and Salah-1 X Babaga-3 recorded values less than their parents concerning F_1 Performance. While, Rama-2 X Sakha -95 recorded the same value of Rama-2 and the hybrid.

Alshoroq-3 X Sakha-95 averaged its parents. The reduction in chlorophyll contents under saline soil and irrigation with underground saline water as well as solar radiation was attributed to the decrease in absorption of iron and Magnesium needed for chlorophyll synthesis (**Poljakoff-Mayber and Gale, 1975**). Parallel to our results, findings of **Gurmani *et al.* (2007)** and **Balouchi (2010)** were in harmony with our decreasing trend of chlorophyll content under stress conditions.

Chlorophyll b content (mg g^{-1} FW)

It is evident from Fig. 14 that there were significant differences among genotypes regarding to chlorophyll b content (mg g^{-1} FW). There is no clear difference between salinity and water stress treatments, despite of the exhibited both significant and insignificant differences in a comparison with the other two comparisons. In this regard, water deficit and salinity didn't affect genotype Sakha-95 which recorded the lowest values.

Otherwise, Babaga-3 recorded the highest and significant values. Therefore, values varied from 0.22 to 1.23, from 0.19 to 0.91 and from 0.18 to 0.81 (mg g^{-1} FW) under control, water deficit and salinity treatments, respectively. Values of f_{1s} were average between the values of their parents in all populations except Amna-2.

The reduced level of chlorophyll content under high salt stress condition in the leaves which may be due to membrane deterioration of the cell membrane of the chloroplastid leading towards lesser accumulation of chlorophyll and lesser photosynthetic efficiency (**Seeman and Critchley, 1985**). These results are in accordance with those obtained by **Gurmani *et al.* (2007), Balouchi (2010) and Guo *et al*. (2013)**.

Total Chlorophyll content (mg g^{-1} FW)

According to Fig. 15, there is no doubt that stress treatments affected highly significant total chlorophyll content. Therefore, water deficit decreased the range of total chlorophyll content from 1.07-3.71 under control conditions to 0.13-2.02 (mg g^{-1} FW). Similar trend, salinity decreased this range considerably to 0.12-1.86 (mg g^{-1} FW).

Fig. 13. Effects of dehydration due to PEG-6000 and salinity (NaCl) on chlorophyll a content (mg g^{-1}FW)of the tested bread wheat population seedlings

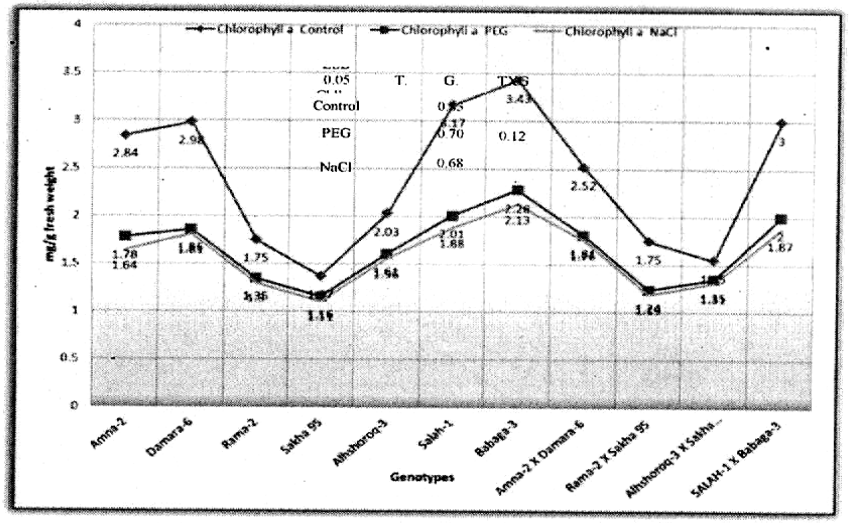


Fig. 14. Effects of dehydration due to PEG-6000 and salinity (NaCl) on chlorophyll b content (mg g^{-1}FW)of the tested bread wheat population seedlings

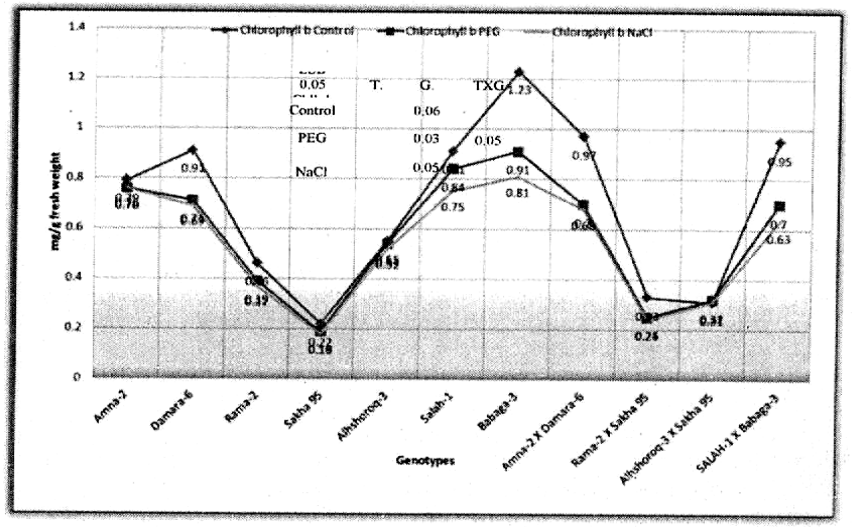


Fig. 15. Effects of dehydration due to PEG-6000 and salinity (NaCl) on total chlorophyll content (mg g^{-1} FW) of the tested bread wheat population seedlings

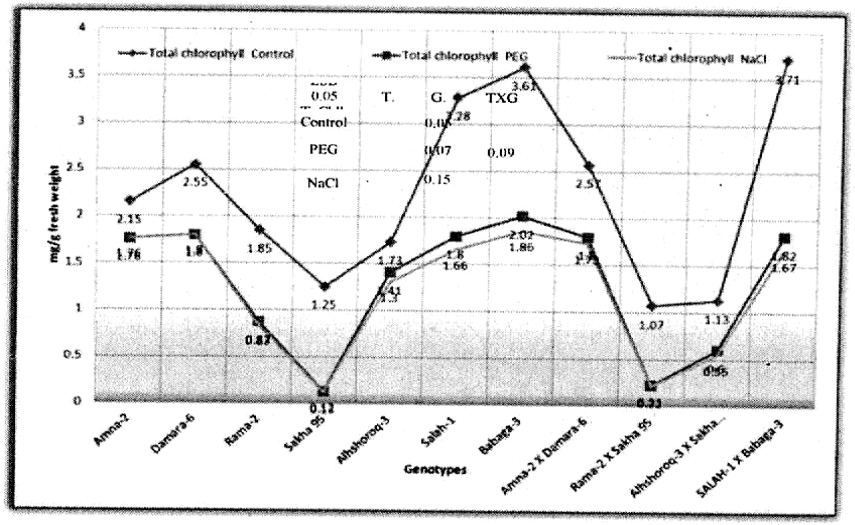


Fig. 16. Effects of dehydration due to PEG-6000 and salinity (NaCl) on total carotenoids content (mg g^{-1} FW) of the tested bread wheat population seedlings

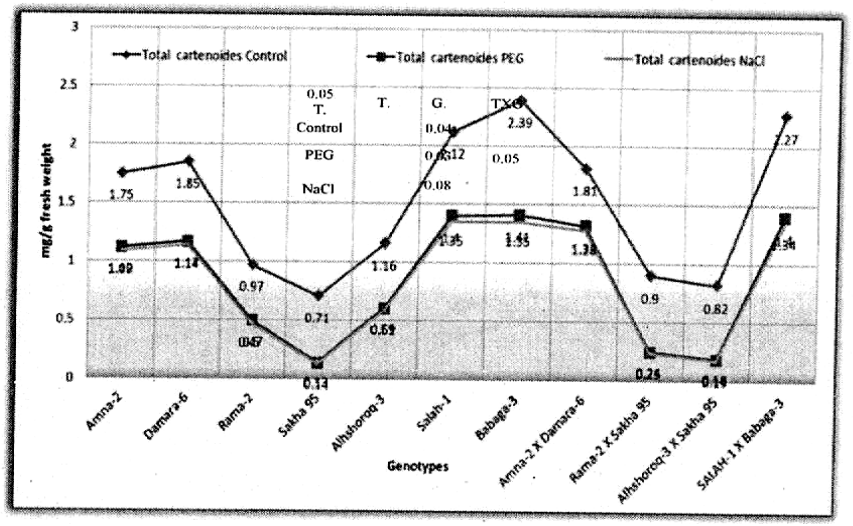


Table (4): Analysis of variance for chemical traits (mg g^{-1} FW) of the tested bread wheat genotypes affected by water stress and salinity.

SOV	d.f	Mean square								
		Chlorophyll A	Chlorophyll B	Total chlorophyll	Total carotenoids	Total carbohydrates	Total phenolic content	Nitrogen content	Phosphorus content	Potassium content
Treatments (T.)	2	6.45**	0.21**	11.14**	5.00**	67051.24**	179.87**	14.31**	2.92**	10.62**
Genotypes (G.)	10	1.98**	0.64**	5.08**	2.73**	1088.93ns	209.04**	5.25**	3.16**	3.01**
T. X G.	20	0.17**	0.02**	0.28**	0.03**	756.20ns	39.09**	0.46**	0.15**	0.03**
Error	66	0.003	0.001	0.003	0.001	1454.15	7.09	0.001	0.003	0.001
Total	98									
C.V (%)		2.71	4.65	3.57	2.93	42.28	9.01	0.98	1.68	1.13
Mean ± STDEV		1.89±0.61	0.60±0.27	1.59±0.90	1.07±0.62	90.19±51.12	29.57±6.15	3.03±0.96	3.21±0.64	2.78±0.73

STDEV: standard deviation, *; significant at 0.05 level of probability, **; significant at 0.01 level of probability and ns; insignificant.

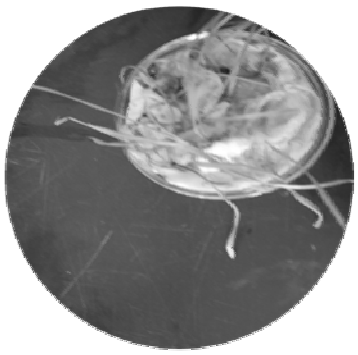


Photo 2. Effect of water stress on bread wheat seedling

Photo 3. Effects of salinity on bread wheat seedling

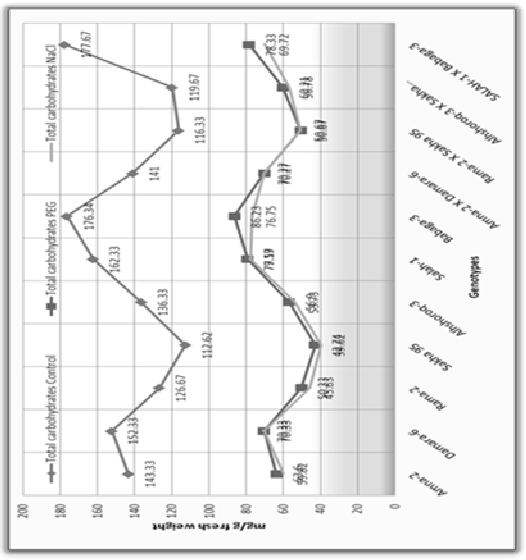


Fig. 17. Effects of dehydration due to PEG-6000 and salinity (NaCl) on total carbohydrates content (mg g^{-1} FW) of the tested bread wheat populations seedlings

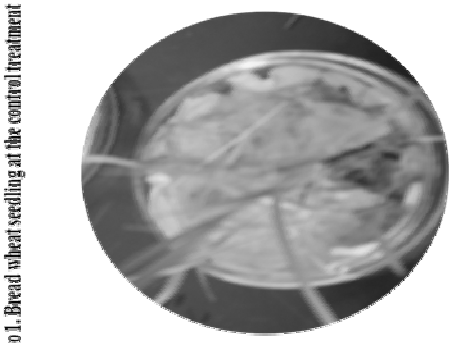


Photo 1. Bread wheat seedling at the control treatment conditions

It is worthy to mention that significant between water deficit and saline stress treatments appeared only in the population of Salah-1 and Babaga-3. In addition, F_{1s} outdid their parents concerning to Amna-2 X Damara-6 and Salah-1 X Babaga-3. On contrast, both of Rama-2 X Sakha-95 and Alshoroq-3 X Sakha-95 recorded values less than those of their parents. Previously, **Reddy and Vora, 1986** and **Ashraf *et* al., 1994** related decrease in chlorophyll concentration under drought stress to the increase in activity of the chlorophyllase enzyme.

The reduction in chlorophyll contents is to be expected under stress, being membranous bound; its stability is dependent on membrane stability, which under saline condition seldom remains intact (**Iqbal *et al.,* 2006**). Our results are also coping with **Abdalla and El-Khoshiban (2007), Tas and Tas (2007), Balouchi (2010), Mohamed (2010) and Moaveni (2011)**. Data obtained by **Guo *et al*. (2013)** concerning some drought treatments caused by PEG6000 in different concentrations on bread wheat seedlings, suggested that wheat seedlings may initially sense high drought environments, the harmful effects of water stress on the distribution and carbohydrates accumulation; it was reflecting the specific detrimental effects of a drought environment. It implies that there was a closed relationship between effects of water stress on chlorophyll fluorescence parameters of wheat seedlings.

Total carotenoids content(mg g^{-1}FW)

It is well appeared from Fig. 16 that total carotenoids decreased considerably as a result to both water deficit or saline water treatment. The decrease due to salinity was greater than water deficit treatment, relatively. Hence, there is no significance between the two stressed conditions. However, genotypes content of the total carotenoids differed significantly all over treatments. Values ranged from 0.71 (mg g^{-1} FW) by Sakha-95 to 2.39 (mg g^{-1} FW) by Babaga-3 under the well-watered conditions, from 0.14 to 1.41 (mg g^{-1} FW) recorded by the same genotypes under water deficit treatment and from 0.13 (mg g^{-1} FW) recorded by the most affected parent Sakha-95 to 1.35 (mg g^{-1} FW) by each of Salah-1 and Babaga-3 under saline environment. These results are in agreement with **Tas and Tas (2007), Balouchi (2010), Mandhania *et al*. (2010) and Guo *et al*. (2013).** caused by PEG6000 in different concentrations on bread wheat seedlings, suggested that wheat seedlings may initially sense high drought environments, the harmful effects of water stress on the distribution and carbohydrates accumulation; it was reflecting the specific detrimental effects of a drought environment. It implies that there was a closed relationship between effects of water stress on chlorophyll fluorescence parameters of wheat seedlings.

Total Carbohydrates (mg g^{-1} FW)

In the respect of study the effect of water deficit stress and saline water stress on total carbohydrates content for the tested bread wheat seedlings in a comparison with their controlled environmental cultivating plants, it could be understood from Fig. 17 that there were highly significant differences due to both water stresses contrary to the control. So that wide ranges under different treatments were overestimated concerning the various responses to stress factors which exhibited considerably by the used genotypes. Thus, Sakha-95 recorded the lowest values: 112.62, 42.74 and 39.62 (mg g^{-1} FW) concerning control, water deficit and salinity treatments, respectively.

In this regard, the highest value under control germination was 177.67 (mg g^{-1} FW) recorded by hybrid Salah-1 X Babaga-3, the highest value under water deficit conditions was 86.23 (mg g^{-1} FW) of the total carbohydrates content which recorded by the superior parent Babaga-3 and the

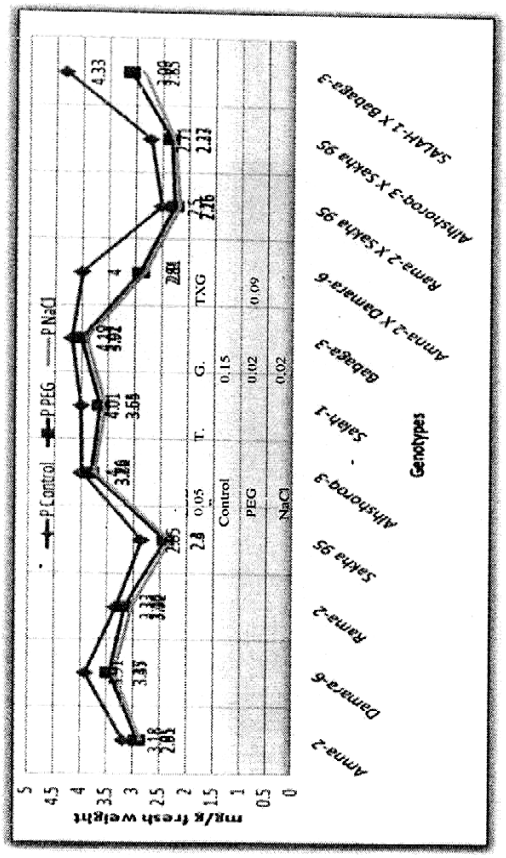


Fig. 20. Effects of dehydration due to PEG-6000 and salinity (NaCl) on phosphorus (P) content (mg g^{-1} FW) of the tested bread wheat population seedlings

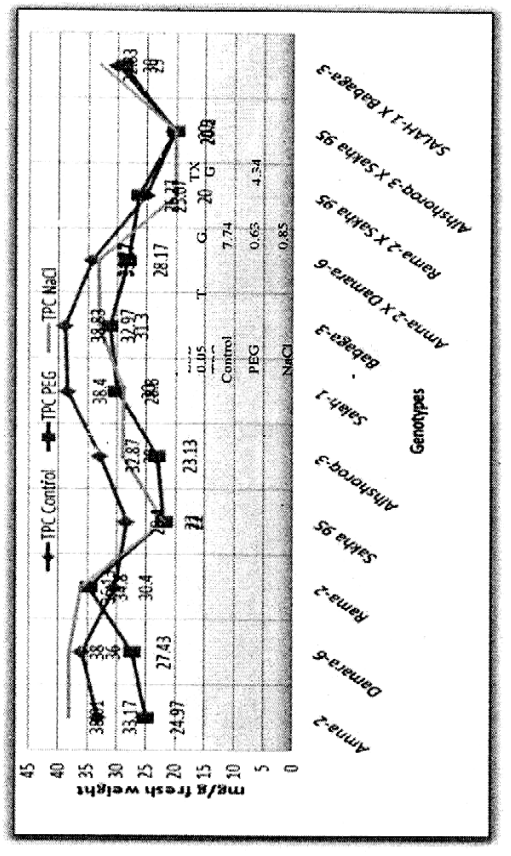


Fig. 18. Effects of dehydration due to PEG-6000 and salinity (NaCl) on total phenolic content (mg g^{-1} FW) of the tested bread wheat population seedlings

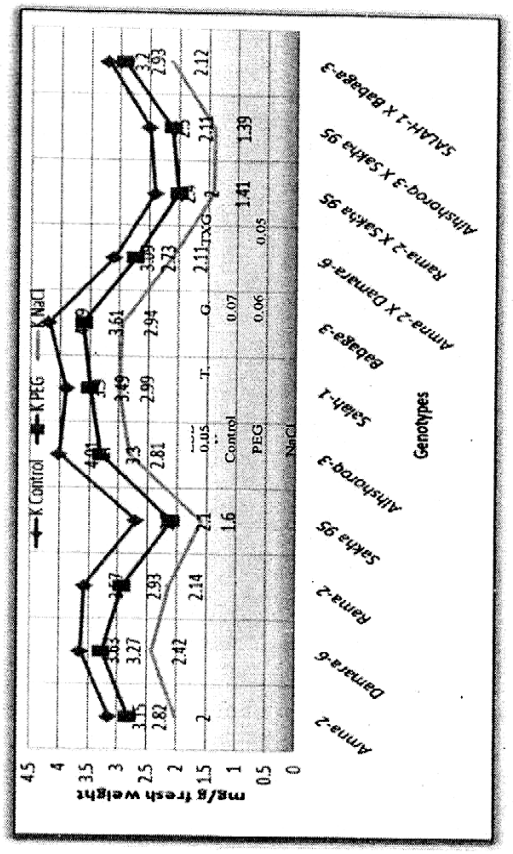


Fig. 21. Effects of dehydration due to PEG-6000 and salinity (NaCl) on potassium (K) content (mg g^{-1} FW) of the tested bread wheat population seedlings

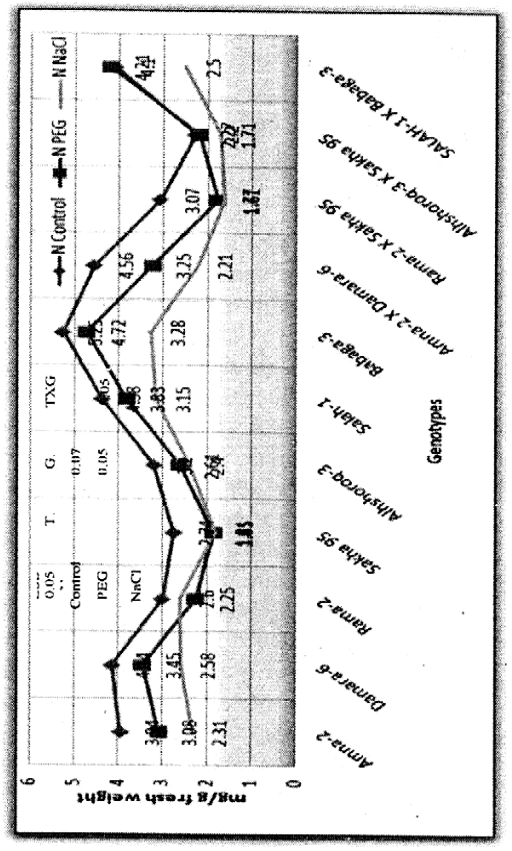


Fig. 19. Effects of dehydration due to PEG-6000 and salinity (NaCl) on nitrogen (N) content (mg g^{-1} FW) of the tested bread wheat population seedlings

highest value under salinity treatment was 77.59 (mg g^{-1} FW) recorded by the another superior parent Salah-1. There were no clear significance between the water deficit stress and the saline water stress treatments. F_1 Amna-2 X Damara-6 recorded a value less than those of their parents. Otherwise, Salah-1 X Babaga-3 outdid their parents. While, the 2 hybrids of Sakha-95 recorded values in the averaged of the parents.

Increment in total carbohydrates under water deficit and saline conditions may be associated with osmotic regulation of plant cells as a mechanism of salt tolerance for wheat plants. Depression effects of salinity on carbohydrates might be attributed to reduction in photosynthetic as result of chlorophyll decrease (**Khafaga and Abd-Elnaby, 2007**).

Total phenolic content (TPC) (mg g^{-1} FW)

From Fig. 18, it could be concluded that there was no clear indication to depend on the total phenolic contents as a selective criterion under such abiotic stresses in this study. Therefore, different responses were detection under the different three treatments. In the same time, water deficit stress and salinity water stress decreased the total phenolic content for some bread wheat genotypes and increased the total phenolic content for another some of the tested genotypes as well as the other some was not affected.

Therefore, both significant and insignificant differences have been recorded among these evaluated populations of the bread wheat plants. In view of these irregular trend, the hybrid Alshoroq-3 X Sakha-95 ranked the lowest by values of 20.39, 20.20 and 20.00 mg g^{-1} FW under the control, water deficit and salinity treatments, respectively. In addition, the hybrid Rama-2 X Sakha-95 toke placed the same rank under the salinity stress treatment.

Under the same treatment conditions, the highest values recorded 38.83, 34.80 and 38.01 mg g^{-1} FW by each of Babaga-3, Rama-2 and Amna-2, respectively. Concerning gene action studies, F_{1s} of the hybrid Amna-2x Damara under control treatment recorded an averaged value of their parents and other hybrids recorded values less than those of their parents.

Nitrogen, phosphorus and potassium (NPK) contents (mg/g FW)

Mineral nutrient components have been affected negatively, significantly and high significantly due to the two undertaken stresses of water deficit and salinity. Whereas, the exposed plants exhibited marked decrease contrary to the well quality watered plants as shown in Figures 19, 20 and 21 concerning the evaluated parents and their F_1 of bread wheat (*Triticum aestinum* L.) plants.

These figures are also clearly indicated that there were significant differences among genotypes and treatments. Stress effect significance was more exhibitions in latest Figure which presents potassium content under control and stresses treatments than the other two figures of the nitrogen and phosphorus.

Concerning phosphorus content, there were no significant differences between water deficit and salinity treatments. In details, water deficit decreased the lowest limit of nitrogen content under control from 2.27 to 1.77 mg g^{-1} FW which recorded by the hybrid Alshoroq-3 X Sakha-95. Moreover, the highest limit from 5.25 mg g-1 FW which recorded by the superior parent Babaga-3 to 4.72 mg g^{-1} FW which recorded by the same superior parent (Fig. 19).

Water shortage stress also decreased the lowest level of phosphorus content under control treatment from 2.50 mg g^{-1} FW which recorded by the hybrid Rama-2 X Sakha-95 to 2.26 mg g^{-1} FW. Likewise, the highest content was decreased from 4.33 to

2.85 mg g^{-1} FW which recorded by the superior hybrid Salah-1 X Babaga-3. Similarly, the hybrid Rama-2 X Sakha-95 and the superior parent Babaga-3 exhibited the lowest and the highest content of potassium, respectively. Thus, water shortage stress decreased potassium content from 2.40 to 2.00 and 4.19 to 3.61 mg g^{-1} FW regarding to the lowest and the highest limits, respectively.

In this respect and concerning saline water stress, it could be noticed that salinity decreased the lowest limit of nitrogen to 1.61 mg g^{-1} FW which recorded by the hybrid Rama-2 X Sakha-95 and the highest limit to 3.28 mg g^{-1} FW which recorded by the superior parent Babaga-3 (Fig. 19).

Moreover, salinity decreased the range of phosphorus significantly to 2.16-3.91 mg g^{-1} FW which obtained by the abovementioned two genotypes, respectively. Similar trend, range of potassium content was reduced significantly due to salinity stress to 1.39-2.94 mg g^{-1} FW, since the lowest value obtained by the hybrid Alshoroq-3 X Sakha-95 and the highest value was obtained by the superior parent Babaga-3 (Fig. 21).

On the other hand, for gene action, firstly Amna-2x Sakha-95 outdid its parents concerning N and P content, while it recorded value less than those which recorded by its parents concerning K content. Secondly, Rama-2 X Sakha-95 recorded values greater than those which obtained by each of the two parents Rama-2 and Sakha-95 concerning N content contrary to the results of both P and K contents. Thirdly, Alshoroq-3 X Sakha-95 recorded value less than those which obtained by its parents for all NPK contents.

Fourthly, Salah-1 X Babaga-3 outdid its parents concerning N and P contents contrary the K content which gave values less than those of its parents. Water stress can reduce NPK content, this reduction might occur due to water deficit induced reduction in transpiration rate and stomatal conductance (**Pessarakli, 1999; Ali *et al.*, 2007**). **Janardan *et al.* (1976)** reported that K plays a role in raising salt tolerance of wheat crops. Sodium competes with K^+ for uptake through common transport system and dose this effectively since the Na^+ concentration in saline environments is usually considerably greater than that of K^+. Sensitivity of some crops to salinity is due to the inability to keep Na^+ and Cl^- out of transpiration streams (**Munns *et al.*, 2002**).

The decrease in K is due to the presence of excessive Na^+ in the growth medium because high external Na content is known to have an antagonistic effect on K uptake in plant, since; salt tolerance is associated with K content because of its involvement in osmotic regulation and competition with Na.

Furthermore, regulation of K uptake, prerention of Na entry and efflux of Na from cell are the strategies commonly used by plants to maintain desirable K/Na ratio in the cytosol (**Sarwar and Ashraf, 2003**). While, **Abdelsalam (2012)** reported that all wheat genotypes in his study showed decreasing trend in K content due to salinity stress.

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Conclusion

Our current breeding program is still continual, program needs mainly such this

evaluating study just before decide, which may support our understanding of the genetic behavior under stressed conditions for different mechanisms stand against. Logically, stress was negatively affected the studied characters. Nevertheless, observations led to high genetic gain, since, the phenotypic variance reflects clearly the genotypic variance under the same environmental conditions. Consequently, In the future, we expect not only accepted hybrids but also epistatic varieties.

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الملخص العربى

تأثيـــر الإجهـــاد المائـــي علـــى بادرات بعض هجـــن قمـــح الخبـــز

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١- الهيئة العامة للرقابة على الصادرات والواردات بالعريش، شمال سيناء، مصر.

٢- قسم الإنتاج النباتى، كلية العلوم الزراعية البيئية، جامعة العريش، مصر.

تعرضت بادرات أحد عشر تركيباً ورائياً (أربعة هجناً بالمقارنة بآبائها السبعة) من قمح الخبز فى اليوم السابع من الزراعة فى مرحلة الإنبات لكل من إجهاد النقص المائى بفعل البولى إيثيلين جليكول (٦٠٠٠) والإجهاد الملحى الناشئ عن كلوريد الصوديوم بهدف بحث استجابة تلك البادرات لهذين الإجهادين. حيث تمت الزراعة على أطباق بترى بورق الترشيح وتم الرى أسبوعياً حسب كل معاملة، حيث تم رى نباتات معاملة الجفاف بمحلول البولى إيثيلين جليكول – ٦٠٠٠ بتركيز ٢٠٠ جم/ لتر، أما معاملة الملوحة فتم رى نباتاتها بمحلول كلوريد الصوديوم ٢٠٠٠ جزء فى المليون، علماً بأن رية الزراعة لكل المعاملات كانت باستخدام محلول هوجلند الذى تم تخصيصه لرى نباتات الكنترول أسبوعياً، تم تقدير القراءات حتى نهاية الشهر الثاني للإنبات وأظهرت النتائج فروقاً معنوية بين المعاملات واستجابة التراكيب الوراثية لتلك المعاملات فى صفات الثغور وتحليل النمو وبعض الصفات الكيميائية، كما أشار تحليل التباين إلى تفوق بعض من هجن الجيل الأول فى قدرتها على تحمل الظروف غير الملائمة للانبات من حيث الجفاف والملوحة.

الكلمات الاسترشادية: قمح الخبز، مرحلة إنبات البادرات، الإجهاد المائى، الملوحة، تحليل النمو، هجن الجيل الأول.