Drought tolerance of some bread and durum wheat vareities during germination

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Abstract:

A laboratory experiment was conducted in Phytochemistry lab., Field Crop Science Department, College of Agriculture, University of Sulaimani during summer season of July to August, 2009. This factorial experiment conducted in a Randomized Complete Design with three replications, the factors are: the first was two species of wheat, Bread Wheat ***Triticum aestivum*** : Tammuz, Rabiaa, Rizgary, Sham-6 and Aras, and Durum Wheat ***Triticum durum***: Acsad, Seminto, Crezo, Ovanto and Sham-3 and the second factors was five salt solutions 5000, 10000, 15000, 20000 and 25000 ppm. Various morpho-physiological parameter germination percentage, root length, shoot length, mean germination time were studied. From the results it was observed that Rabbia variety was the mostly drought tolerant among the other bread wheat varieties having significant effect of most germination attributes, Sham-3 variety gave maximum values of germination % and radicle length, while maximum coleoptile length, coefficient of velocity of germination% and minimum days required to germination recorded by Crezo variety. For both bread and durum wheat, the highest values of most germination attributed were obtained by treatment of control. Concerning the interaction between both of bread and durum wheat varieties and NaCl concentration, Tammuz variety with the treatment of control gave maximum values for most characters, while the interaction between Rabbia variety and 20000ppm NaCl recorded minimum days needed to germination. But regarding mean germination time character, interaction of Acsad, and Sham-3 with control treatment gave maximum value. In which all other values of germination attributes were 0.00 for 10000, 15000, 20000 and 25000ppm salt concentration, because all durum wheat varieties had not tolerant for drought condition.

Keywords: Drought tolerance; bread wheat; durum wheat; varieties; germination, salt stress.

تحمل جفاف لبعض اصناق الحنطة الناعمه والخشنه مختبريا اثناء مرحلة الانبات

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المستخلص:

أجريت تجربة مختبرية أجريت تجربة مختبرية في مختبر كيمياء النبات ، قسم علوم المحاصيل الحقلية ، كلية الزراعة ، جامعة السليمانية خلال موسم الصيف من حزيران إلى آب 2009 تم اختيار عشرة أصناف من الحنطة، هذه التجربة التجريبية أجريت في تصميم كامل عشوائي مع ثلاثة مكررات تتضمن التجربة عاملين ، الأول: نوعان الحنطه : الحنطة الناعمة (أراس، وشام 6، تموز، رزكاري، وربيعة) الحنطة الخشنة (أوفانتو، سيمنتو، كريزو ، شام 3، أكساد) و العامل الثاني تراكيز الملح (NaCl) التي كانت كما يلي (5000، 10000، 15000، 20000 و 25000) جزء في المليون، تم دراسة الصفات (نسبة الإنبات، طول الجذير، طول الرويشة، متوسط وقت الإنبات). اظهرت النتائج أن صنف ربيعة الحنطة الناعمة كان اكثر تحملا للجفاف في معظم الصفات من بين أصناف الحنطة الناعمة الأخرى و التي كانت لها تأثير معنوي لمعظم الصفات المدروسة، وفيما يتعلق بأصناف الحنطة الخشنة فقد أعطت صنف شام 3 اعلى قيم في نسبة الإنبات وطول الجذر، في حين أن أقصى طول رويشة، معامل سرعة الإنبات٪، اقل عدد الأيام المطلوبة لإنبات سجلت من قبل صنف كريزو. وبالنسبة لكل من الحنطة الناعمة و الخشنة، ان معاملة المقارنة اعطت اعلى قيم لمعظم الصفات المدروسة. أما فيما يتعلق بالتداخل بين كل من أصناف الحنطة الناعمةو الخشنة وتركيز كلوريد الصوديوم، ان التداخل بين كل من صنف تموز و معاملة المقارنة أعطت اعلى قيم لمعظم الصفات المدروسة، في حين اقل عدد الأيام المطلوبة لإنبات سجلت من قبل التداخل بين صنف ربيعة و 20000 جزء في المليون كلوريد الصوديوم. ولكن فيما يتعلق متوسط الوقت إنبات ، ان التداخل بين كل من صنف أكساد، وشام-3 مع معاملة المقارنة اعطت اعل قيمة . في حين ان جميع قيم الإنبات الأخرى سجلت 0.00 لكل من تراكيز كلوريد الصوديوم 10000، 15000، 20000 و 25000 جزء في المليون، لأن جميع أصناف الحنطة الخشنة لم تتحمل حالة الجفاف.

الكلمات المفتاحية: تحمل الجفاف، الحنطة الخشنة، الحنطة الناعمة،الاصناف، الانبات، تحمل الملوحة.

Introduction:

Drought is the most important environmental stresses that affect growth and development of plants. Researchers and plant breeders refer to drought as an important challenge to agricultural. It is one of the environmental stresses that increasing crop production in the majority of agricultural fields of the world (2) and recent global climate change has made this situation more adverse (4). Drought affects physiological, morphological, biochemical and molecular processes in plants resulting in growth inhibition. The extent of these changes is dependent on the time, stage and severity of environmental stress (7).

Because root could absorb water and nutrients from the soil, it act as the key organ of plant against drought (9). The response of root growth to water deficits is important in drought tolerance (8). Salinity, today, affects nearly 7% (950 million ha) of overall (22), 23% of cultivated, and 20% of irrigated land (38) in the world. A worrying 10% annual increase (10) and 30% expected land losses within the next 25 years are anticipated (18). To combat this problem, new genetic resources (12) including salt against a biotic stresses, screening techniques and efficient testing are urgently required (15).

Wheat is the second most important agricultural crop amongst the cereals on a global scale (19), was the first cultivated one thousands of years ago and has kept providing staple nutrition for humans since then (6). Today’s global wheat production of about 670.8 million tons per year directly influences human survival and life quality, by being involved in the production of various foods, including bread, pasta, noodles, cakes, and biscuits (11). Wheat is an important crop in the world, contains protein, starch, sugar and provides food for human population (13). The wheat tested to indicate their response to different salt tolerance indices and differentiates tolerant and susceptible genotypes effectively at different growth stages or against different salt responsive characters results in (5). Among the growth stages, germination is an important one as it particularly determines the good start of crop establishment in saline soils (16), several plants including cereals (25), are sensitive to higher salinity (1) during yield determining germination stages.

The present investigation was carried out to screen out best drought resistant wheat seed variety under laboratory condition and to study the morpho-physiological changes of wheat seedlings grown under drought stress.

Materials and Methods:

This investigation was conducted in Phytochemistry lab., Field Crop Science Department, College of Agriculture, University of Sulaimani. This factorial experiment conducted in a Randomized Complete Design with three replications, the factors are: the first was two species of wheat Bread Wheat ***Triticum aestivum*** : Tammuz, Rabiaa, Rizgary, Sham-6 and Aras, and Durum Wheat ***Triticum durum***: Acsad, Seminto, Crezo, Ovanto and Sham-3 and the second factors was five salt solutions 5000, 10000, 15000, 20000 and 25000 ppm.

Germination Test:

Fifty seeds from each treatment were placed in 9 cm diameter petri dishes on two layer of with man no. 1, with three replications. 40 ml of distilled water and appropriated salt solutions 5000, 10000, 15000, 20000 and 25000 ppm were added to each petri dishes, the germination count was recorded daily up to 15 days. From the germination counts several germination attributes were studied to investigate the effect of salt solution on Coleoptile Length (cm), Radicle Length (cm), Germination Percentage %, Coefficient of Velocity of Germination (CVG), Germination Rate Index (GRI) and Mean Germination Time (MGT), and they were calculated as follow:

$$\text{Seed germination (Percentage)} = \frac{\text{Germinated seeds} \times 100}{\text{Total Seeds}}$$

$$\text{CVG } \left(\% \text{ day}^{-1}\right) = \frac{\sum Ni}{\sum (NiTi)} \times 100,$$

$$\text{GRI } \left(\% \text{ day}^{-1}\right) = \sum \left(\frac{Ni}{i}\right),$$

$$\text{MGT } (d) = \frac{\sum (NiTi)}{\sum Ni},$$

Were N is the number of seeds germinated on day i, and Ti is number of days from sowing. The CVG gives an indication of the rapidity of germination. It increases when the number of germinated seeds increases and the time required for germination decreases. Theoretically, the highest CVG possible is 100. This would occur if all seeds germinated on the first day. The GRI reflects the percentage of germination on each day of the germination period. Higher GRI values indicate higher and faster germination. The lower MGT, the faster a population of seeds has germinated (1, 10).

Statistical analysis:

Analysis of variance as a general test was done according to analysis of 2 factors in CRD, and the means were tested according to least significant difference (L.S.D) using significant level of 0.01 (3).

Results and Discussion:

Data represented in table (1) confirmed that there was highly significant effect of varieties on all germination attributes characters, maximum values of germination percentage and coleoptiles length were recorded by Rabbia variety with (53.33% and 3.47cm) respectively, but maximum length of radicle (2.96cm) exhibited by Sham-6 variety, while the minimum values for germination percentage and coleoptile length were obtained by Rizgary variety were (34.44%and 2.40cm) respectively, and Aras variety gave minimum value of radicle length (2.03cm). The variety were spent maximum days to germination (3.52 day) was Aras variety, while Rizgary variety required minimum days to germination (3.09days). Regarding coefficient of velocity of germination percentage, the highest value was recorded by Rizgary variety (37.72%), while Sham-6 variety gave minimum percentage with (28.78%). Maximum germination rate index (8.66) recorded by Tammuz variety, in which Aras variety gave minimum value of germination rate index was (6.45). Seed germination cannot be used as a criterion for salt stress tolerance because it could not obviously discriminate among the varieties. This result are not in consonance with those of (21) who concluded that seed germination under stress conditions could not distinguish among varieties.

Table 1: Effect of varieties on germination attributes of *Triticum aestivum* under laboratory condition.

Varieties	Germination %	Radicle length (cm)	Coleoptile length (cm)	Mean Germination Time (Days)	Coefficient Velocity of Germination %	Germination Rate Index
Tammuz	37.22	2.73	2.96	3.43	30.06	8.66
Rabbia	53.33	2.87	3.47	3.28	35.89	6.47
Rizgary	34.44	2.04	2.40	3.09	37.72	6.74
Sham-6	43.33	2.96	2.65	3.51	28.78	8.40
Aras	34.72	2.03	2.42	3.52	28.94	6.45
LSD (0.01)	**9.170**	**0.865**	**0.730**	**0.338**	**5.637**	**1.894**

Data present in table 2 showed that the effect of varieties on all germination attributes of *Triticum durum* was highly significant, Sham-3 variety gave maximum values of both traits (germination% and radicle length) with (28.33% and 2.44cm) respectively, while minimum values of this two traits (18.06% and 1.11cm) were obtained by Acsad variety. Regarding the character coleoptile length and coefficient velocity of germination%, the highest values were recorded by Crezo variety with 3.03 cm and 8.0% respectively, but the lowest value of coleoptile length 2.00cm recorded by Seminto variety and minimum percent of coefficient velocity of germination 6.67% produced by Ovanto variety. However Ovanto variety exhibited maximum days of mean germination time and germination rate index with 1.67 day and 3.05 respectively, in which Crezo variety gave minimum days of mean germination time 1.39 day and Acsad variety recorded minimum germination rate index 2.57. Similar to present findings, (20) also noted significant reductions in all seedling traits by osmotic stress, yet some of the varieties gave little decline, and were regarded as drought tolerant.

Table 2: Effect of varieties on germination attributes of *Triticum durum* under laboratory condition.

Varieties	Germination %	Radicle length (cm)	Coleoptile length (cm)	Mean Germination Time (Days)	Coefficient Velocity of Germination %	Germination Rate Index
Acsad	18.06	1.11	2.04	1.56	7.33	2.57
Seminto	23.61	1.84	2.00	1.61	6.83	2.80
Crezo	26.67	1.97	3.03	1.39	8.00	2.81
Ovanto	26.39	1.65	2.06	1.67	6.67	3.05
Sham-3	28.33	2.44	2.48	1.60	7.17	2.72
LSD (0.01)	**5.874**	**0.873**	**0.690**	**0.165**	**0.724**	**0.218**

Table 3 showed that the effect of various NaCl concentrations on germination attributes of *Triticum aestivum* under laboratory condition were highly significant for all germination attributes, the treatment of control (without salt or distil water) gave maximum values of most traits (germination%, radicle length and coleoptile length) with (79.33%, 6.17cm and 9.88cm) respectively. Concerning the mean germination time the minimum days required to germination recorded by (25000pp) which was 2.92 days, but the highest coefficient of velocity of germination 47.27% recorded by 20000ppm) and maximum germination rate index 9.57 exhibited by (5000ppm) NaCl concentration, while (25000ppm) NaCl concentration recorded minimum values

(8.00%, 0.29cm, 0.02cm and 4.31) for these germination attributes (germination%, radicle length, coleoptile length and germination rate index) respectively. In which minimum values of mean germination time and coefficient of velocity of germination (2.44 days and 25.67%) produced by (20000ppm) and (10000ppm) respectively. In the present investigation the reduction in germination might be due to the less availability of free water to the seeds. This result agrees with the previous results of (17, 23, 24) which was found that germination percentage and germination rate generally decrease as soil water potential decreases by drought.

Table 3: Effect of various NaCl concentrations on germination attributes of *Triticum aestivum* under laboratory condition.

NaCl Concentration ppm	Germination %	Radicle length (cm)	Coleoptile length (cm)	Mean Germination Time (Days)	Coefficient of Velocity of Germination %	Germination Rate Index
Control	79.33	6.17	9.88	3.83	26.33	8.23
5000ppm	66.33	4.10	4.49	3.67	27.33	9.57
10000ppm	48.67	2.54	1.68	3.85	25.67	7.42
15000ppm	27.67	1.25	0.40	3.49	30.60	7.20
20000ppm	13.67	0.79	0.19	2.44	47.27	7.34
25000ppm	8.00	0.29	0.02	2.92	36.47	4.31
LSD (0.01)	10.045	0.948	0.800	0.370	6.175	2.075

Data represented in table 4 confirmed that there was a highly significant effect of NaCl concentration on all germination attributes of *Triticum durum* under laboratory condition. The highest values of most traits (germination%, radicle length, coleoptile length and coefficient of velocity of germination) were (93.33%, 9.35cm, 12.33cm and 22.6%) recorded by control treatment, while minimum values of these traits were achieved by (5000ppm) with 54.33%, 1.46cm, 1.59cm and 20.6% respectively. Concerning the characters coefficient of velocity of germination and germination rate index, the minimum days required to germination was 4.47 day and minimum germination rate index was 7.83 were exhibited by treatment of 5000ppm. In which the values of all germination attributes was zero for other concentrations (10000, 15000, 20000 and 25000). Salt stress delayed the emergence of the radicle and further development of the seedling, similar to the report of (14).

Table 4: Effect of various NaCl concentrations on germination attributes of *Triticum durum* under laboratory condition.

NaCl	Germination	Radicle	Coleoptile	Mean	Coefficient of	Germination

Concentration	%	length(cm)	length(cm)	Germination Time (Days)	Velocity of Germination %	Rate Index
Control	93.33	9.35	12.33	4.47	22.6	7.83
5000ppm	54.33	1.46	1.59	4.92	20.6	8.91
10000ppm	0.00	0.00	0.00	0.00	0.00	0.00
15000ppm	0.00	0.00	0.00	0.00	0.00	0.00
20000ppm	0.00	0.00	0.00	0.00	0.00	0.00
25000ppm	0.00	0.00	0.00	0.00	0.00	0.00
LSD (0.01)	6.435	0.956	0.756	0.181	0.793	0.239

Data in table 5 showed the Effect of interactions between varieties and NaCl concentrations on germination attributes of Wheat under laboratory condition. The differences between varieties and salt concentration were highly significant for all germination attributes with the exception of the character radicle length and germination rate index which was found to be not significant. Maximum percent of germination and coleoptile length exhibited by the interaction of Rabiaa variety with the treatment of control were 88.33% and 11.93cm respectively, while the minimum percent of germination was 0.00% which was obtained by the interaction between Aras variety and (25000ppm), the minimum length of coleoptile was 0.00cm which recorded by interaction of Rizgary, Aras varieties with the (20000 and 25000ppm) concentrations. Regarding mean germination time character, the minimum days required to germination were 1.47 days and maximum coefficient of velocity of germination 69.67% were recorded by interaction of Rabiaa variety with (20000ppm). So it can be regarded as an inappropriate test for drought tolerance screening. Similar to present results, (24) noted significant decrease in radicle and plumule length.

Table 5: Effect of interactions between varieties and NaCl concentrations on germination attributes of *Triticum aestivum* under laboratory condition.

Varieties	NaCl Concentration	Germination %	Radicle length (cm)	Coleoptile length (cm)	Mean Germination Time (Days)	Coefficient Velocity of Germination %	Germination Rate Index

Tammuz	**Control**	81.67	5.60	9.01	3.87	26.00	8.95
	5000ppm	56.67	4.31	4.80	3.55	28.00	9.85
	10000ppm	31.67	3.29	3.27	4.00	25.00	7.94
	15000ppm	20.00	1.45	0.31	3.61	28.00	7.31
	20000ppm	18.33	1.20	0.35	3.18	30.67	10.85
	25000ppm	15.00	0.54	0.00	2.37	42.67	7.07
Rabbia	**Control**	88.33	7.27	11.93	3.93	26.33	7.14
	5000ppm	78.33	4.86	6.79	4.00	25.00	7.44
	10000ppm	66.67	1.94	1.20	4.01	23.00	5.85
	15000ppm	50.00	1.79	0.79	4.01	25.33	7.85
	20000ppm	20.00	0.86	0.08	1.47	69.67	5.65
	25000ppm	16.67	0.49	0.02	2.24	46.00	4.89
Rizgary	**Control**	75.00	5.44	9.72	3.70	27.00	8.94
	5000ppm	76.67	3.54	3.84	3.49	28.67	11.38
	10000ppm	26.67	1.83	0.56	3.67	27.33	7.66
	15000ppm	15.00	1.07	0.25	2.70	43.00	6.74
	20000ppm	10.00	0.36	0.00	1.48	69.00	4.89
	25000ppm	3.33	0.00	0.00	3.49	31.33	0.84
Sham-6	**Control**	78.33	6.56	8.61	3.77	26.33	8.90
	5000ppm	68.33	4.55	3.76	3.68	27.33	12.36
	10000ppm	56.67	3.31	2.50	3.73	27.33	9.08
	15000ppm	36.67	1.35	0.45	3.56	28.33	7.23
	20000ppm	15.00	1.53	0.50	3.07	32.67	7.59
	25000ppm	5.00	0.43	0.07	3.25	30.67	5.25
Aras	**Control**	73.33	5.98	10.14	3.86	26.00	7.20
	5000ppm	51.67	3.26	3.27	3.63	27.67	6.81
	10000ppm	61.67	2.31	0.88	3.82	25.67	6.57
	15000ppm	16.67	0.61	0.22	3.56	28.33	6.90
	20000ppm	5.00	0.00	0.00	2.99	34.33	7.73
	25000ppm	0.00	0.00	0.00	3.27	31.67	3.49
LSD (0.01)		**22.462**	**N.S**	**1.789**	**0.828**	**13.808**	**N.S**

N.S: Not Significant

Data in table 6 showed the effect of interactions between varieties and NaCl concentrations on germination attributes of *Triticum durum* under laboratory condition. Which was found that the effects were highly significant, the highest percent of germination and maximum length of radicle were obtained by interaction of Sham-3 with control treatment were 96.67% and 13.32cm respectively. Maximum length of coleoptile 14.41cm recorded by interaction of Crezo variety with treatment of control, in which minimum days required to germination was 4.00 days exhibited by interaction of Acsad and Crezo varieties with the treatment of control. Regarding coefficient of velocity of germination, maximum value 25.00% recorded by interaction of Acsa and Sham-3 variety with control and Crezo with 5000ppm, maximum germination rate index 9.86 produced by interaction between Ovanto variety with 5000ppm. All other values of germination attributes were 0.00 for 1000, 15000, 20000 and

25000ppm salt concentration, because all durum wheat varieties had not tolerant for drought condition.

Table 6: Effect of interactions between varieties and NaCl concentrations on germination attributes of *Triticum durum* under laboratory condition.

Varieties	NaCl Concentration	Germination %	Radicle length (cm)	Coleoptile length (cm)	Mean Germination Time (Days)	Coefficient Velocity of Germination %	Germination Rate Index
Acsad	Control	91.67	6.28	12.26	4.00	25.00	7.25
	5000ppm	16.67	0.37	0.00	5.33	19.00	8.20
	10000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	15000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	20000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	25000ppm	0.00	0.00	0.00	0.00	0.00	0.00
Seminto	Control	96.67	9.48	11.14	4.67	21.00	8.12
	5000ppm	45.00	1.54	0.85	5.00	20.00	8.67
	10000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	15000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	20000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	25000ppm	0.00	0.00	0.00	0.00	0.00	0.00
Crezo	Control	86.67	9.58	14.41	4.33	23.00	7.78
	5000ppm	73.33	2.26	3.74	4.00	25.00	9.08
	10000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	15000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	20000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	25000ppm	0.00	0.00	0.00	0.00	0.00	0.00
Ovanto	Control	95.00	8.09	11.24	5.33	19.00	8.43
	5000ppm	63.33	1.83	1.11	4.67	21.00	9.86
	10000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	15000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	20000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	25000ppm	0.00	0.00	0.00	0.00	0.00	0.00
Sham-3	Control	96.67	13.32	12.61	4.00	25.00	7.58
	5000ppm	73.33	1.29	2.27	5.67	18.00	8.72
	0000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	15000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	20000ppm	0.00	0.00	0.00	0.00	0.00	0.00
	25000ppm	0.00	0.00	0.00	0.00	0.00	0.00
LSD (0.01)		**14.389**	**2.138**	**1.691**	**0.405**	**1.773**	**0.534**

Conclusion:

From the results of this study we concluded that Rabbia variety were found to be mostly drought tolerant among the other bread wheat varieties having significant effect of most germination attributes, and regarding durum wheat varieties, Sham-3 variety gave maximum values of germination % and radicle length, while maximum coleoptile length, coefficient of velocity of germination% and minimum days required to germination recorded by Crezo variety. For both of bread and durum wheat, the highest values of most germination attributed were obtained by treatment of control. Concerning the interaction between both of bread and durum wheat varieties and NaCl concentration, Tammuz variety with the treatment of control gave maximum values for most characters, while the interaction between Rabbia variety and 20000ppm NaCl recorded minimum days needed to germination. But regarding mean germination time character, interaction of Acsad, and Cha-3 with control treatment gave maximum value. In which all other values of germination attributes were 0.00 for 10000, 15000, 20000 and 25000ppm salt concentration, because all durum wheat varieties had not tolerant for drought condition.

References:

1. **Abdoli, M.; and Saeidi, M. (2012).** Effects of water deficiency stress during seed growth on yield and its components, germination and seedling growth parameters of some wheat cultivars. *International Journal of Agriculture and Crop Sciences*, *4*(15), 1110-1118.
2. **Abdoli, M.;Saeidi M. (2012)** Effects of water deficiency stress during seed growth on yield and its components, germination and seedling growth parameters of some wheat cultivars. Ann Biol Res 3: 1322-1333.
3. **Abedi T.and Pakniyat H. (2010)** Antioxidant enzyme changes in response to drought stress in ten cultivars of oilseed rape (*Brassica napus* L.). *Czech Journal of Genetics and Plant Breeding*, 46: 27–34.
4. **Al–Rawi, K.M. and Khalafallah, A.A.M. (1980)** Agriculture Experimental Design and Analysis. Ministry of Higher Education. College of Agriculture and Forestry. Musul University.
5. **Anand, A.; Trick, H.N.and Gill B.S. (2003)** Stable transgene expression and random gene silencing in wheat. *Plant Biotechnology Journal*, 14: 241–251.
6. **Askari, H.; Kazemitabar, S.K.; Zarrini, H.N.and Saberi,M.H. (2016)** Salt tolerance assessment of barle (*Hordeum vulagare* L.). Open *Agriculture* 1(1): 37-44.
7. **Braun, H.J.; Zencirci, N.; Altay, F.; Atli, A.; Avci, M.; Eser, V.; Kambertay, M. and Payne, T.S. (2001)** Turkish wheat pool. In: Bonjean AP, Angus WJ, editors. World Wheat Book – A History of Wheat Breeding, Paris, France: Laroisier Publishing, pp. 851-879.
8. **Cao, H.X.;Sun, C.X.; Shao, H.B. and Lei X.T. (2011)** Effects of low temperature and drought on the physiological and growth changes in oil palm seedlings. *African Journal of Biotechnology*, 10: 2630–2637.
9. **Carvalho, P.; Azam-Ali, S. and Foulkes, M. J. (2014)** Quantifying relationships between rooting traits and water uptake under drought in Mediterranean barley and durum wheat. *Journal of integrative plant biology*, 56: 455-469.
10. **Cseuz, L.;Pauk, J.; Lantos, C. and Kovacs, I. (2009)** Wheat breeding for drought tolerance.(Efforts and results.). *Cereal Research Communications*, 37, 245-248.

11. **El-Hendawy, S. E.;Hu, Y.; Yakout, G. M.; Awad, A. M.; Hafiz, S. E. and Schmidhalter, U. (2005)** Evaluating salt tolerance of wheat genotypes using multiple parameters. *European journal of agronomy*, 22(3), 243-253.

12. **Eren, H.;Pekmezci, M.Y.; Okay, S.; Turktas, M.; Inal, B.; Ilhan, E.; Atak, M.; Erayman, M.; Unver, T. and Unver CT (2015).** Hexaploid wheat (*Triticum aestivum*) root .

13. **Karagoz, A.; Zencirci, N.; Tan, A.; Taşkın, T.; Köksel, H.; Sürek, M.; Toker, C. and Özbek K (2010).** Conservation and use of plant genetic resources. *In Seventh Technical Congress of Agricultural Engineers Chamber* 1: 11-15.

14. **Liu, X.F., X.F. Zhu, Y.Z. Pan, S.S. Li, Y.X. Liu and Y.Q. Ma, (2016)** Agricultural drought monitoring: progress, challenges, and prospects. J. Geogr. Sci., 26: 750-767.

15. **Maliwal, G.L. and Paliwal K.V. (1970)** Salt Tolerance Studies in some Varieties of Wheat and Barley at Germination Stage. *Indian Journal Plant Physiol10*:26 – 35.

16. **Mostek, A.; Börner, A.; Badowiec, A. and Weidner, S. (2015)** Alterations in root proteome of salt-sensitive and tolerant barley lines under salt stress conditions. *Journal of plant physiology*, *174*, 166-176.

17. **Moud, A. and Maghsoudi K (2008)** Salt stress effects on respiration and growth of germinated seeds of different wheat (*Triticum aestivum L.*) cultivars. *World Journal Agriculture* 4: 351-358.

18. **Murillo-Amador, B.; López-Aguilar, R.; Kaya, C.; Larrinaga-Mayoral, J. and Flores-Hernández, A. (2002)** Comparative effects of NaCl and polyethylene glycol on germination, emergence and seedling growth of cowpea. *Journal of Agronomy and Crop Science*, *188*(4), 235-247.

19. **Radi, A. A.; Farghaly, F. A. and Hamada, A. M. (2013)** Physiological and biochemical responses of salt-tolerant and salt-sensitive wheat and bean cultivars to salinity. *Journal of Biology and Earth Sciences*, *3*(1), 72-88.

20. **Rahaie, M.; Xue, G. P. and Schenk, P. M. (2013)** The role of transcription factors in wheat under different abiotic stresses. In *Abiotic stress-plant responses and applications in agriculture*. InTech.

21. **Rauf, M.; Munir, M.; Ul Hassan, M.; Ahmad, M. and Afzal, M. (2007)** Performance of wheat genotypes under osmotic stress at germination and early seedling growth stage. *African journal of biotechnology*, *6*(8).

22. **Sayar, R.; Khemira, H.; Kameli, A. and Mosbahi, M. (2008)** Physiological tests as predictive appreciation for drought tolerance in durum wheat (Triticum durum Desf.). *Agronomy research*, *6*(1), 79-90.

23. **Shavrukov, Y.; Shamaya, N.; Baho, M.; Edwards, J.; Ramsey, C..; Nevo, E.; Langridge, P.; and Tester M (2011).** Salinity tolerance and Na + exclusion in wheat: variability, genetics, mapping populations and QTL analysis. *Czech Journal Genet Plant Breed* 47: 85-93.

24. **Song J., Feng G., Tian C., Zhang F., (2005).** Adaptive Mechanisms of Halophytes in Desert Regions. Ann Bot 96: 399–405.
25. **Sosa L., Llanes A., Reinoso H., Reginato M., Luna V. (2005).** Drought, salinity and heat differently affect seed germination of Pinus pinea. Ann Bot 96: 261–267.
26. **Vardar Y, Çifci EA (2014).** Salinity effects on germination stage of bread and durum wheat cultivars. J Yuzuncu Yıl Uni 24: 127-139.