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Original scientific paper

RESPONS OF WHEAT SPECIES TO IRRIGATION WATER SALINITY

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This study was conducted to investigate the effects of different irrigation water salinity level on chromosomes and shoots of wheat with three different ploidy level (diploid, tetraploid and hexaploid). Greenhouse experiment revealed that irrigation water salinity level had significant effects on shoot dry weight, root dry weight, shoot length and root length (P<0.05). The effects of ploidy level and cultivar shoot dry weight and root dry weight were also found to be significant (P<0.05), but the effects on shoot length and root length were not significant (P>0.05). Negative effects of salinity on shoot and root were started at 8 dS m^{-1}. Also hexaploid wheat was more tolerant then tetraploid and diploid wheat to salinity. It was not determined that possible effects of irrigation water salinity to structure of chromosomes with current equipment and methods. Cell divisions were normal, but decreasing cell division rates were observed with increasing irrigation water salinity levels.

Keywords: ploidy levels, water salinity, wheat

INTRODUCTION

There are culture wheats with 3 different ploidy levels in Triticum genus of Poaceae family: *Triticum monococcum* (diploid: 2n=2x=14 chromosome), *Triticum durum* tetraploid: 2n=4x=28 chromosome) and *Triticum aestivum* (hexaploid: 2n=6x=42 chromosomes). Tetraploid and hexaploid wheat are commonly grown for economic purposes. The wheat can be grown on a wide range of soils Peaty soils containing high sodium, magnesium or iron should be avoided. The optimum pH ranges from 6 to 8 for wheat grown. For good yields the fertilizer requirements are up to 150 kg ha^{-1} N, 35 to 45 kg ha^{-1} P and 25 to 50 kg ha^{-1} K. The crop is grown as a rainfed crop in

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the temperate climates, in the sub-tropics with winter rainfall, in the tropics near the equator (ANONYMOUS, 2016).

Saline irrigation waters negatively influence soils of crop lands. High salt containing soils are classified under problematic soil (KARA *et al.*, 2011). Salinity has an osmotic and toxic impact on plants. It has several negative impacts on plant growth and development through osmotic and ionic potential and hormonal imbalance (ASHRAF and FOOLAD, 2007). Increased osmotic pressure in saline soils hinders plant water uptake and high Na and Cl concentrations may create toxic impacts on plants. High salt intake destroys cell functions of the plants and thus interrupts photosynthesis and respiration processes (KANBER and ÜNLÜ, 2010). Ultimately, a yield decrease is evident with increasing salinity levels based on plant resistance to saline conditions. Wheat is quite resistant to salinity and the threshold salinity level for the initiation of yield decrease is 6 dS m^{-1} and about 50% yield decrease was reported at soil salinity level of 13 dS m^{-1} (KARA *et al.*, 2011; AYERS and WESTCOT, 1989). Salt tension (hypertonic media) by plasmolysis may result in plant cell mortality. Salt accumulation in soils may affect plants at different levels and plant response to salinity may also vary from one plant to another (FELDMAN *et al.*, 2012). Salinity is also the most significant environmental factor influencing concurrent germination in arid and semi-arid regions (DEMIR *et al.*, 2003). In salinity researches, germination (COSKUN *et al.*, 2016) and shoot stage (VAN HOORN *et al.*, 2001) are commonly considered while investigating plant response to salinity. The problems experienced in germination period under high salt concentrations were mainly because of hindered water intake of seeds (MANSOUR 1994). Also under salt stress, excessive Na accumulation in plants hinders K uptake (SIEGEL *et al.*, 1980) and high Cl concentrations hinder NO_3 uptake of plants (INAL *et al.*, 1995) and both ions destroy plant ion balance.

In present study, effects of different irrigation water salinity levels that were created by using different salinity sources (NaCl, $MgCl_2$, $CaCl_2$) on root and shoot development of wheat plants and potential hazards exerted on chromosomes throughout the germination period were investigated.

MATERIALS AND METHODS

Material and experimental design

Experiments were conducted in laboratory and greenhouses of Lapseki Vocational Collage of Çanakkale Onsekiz Mart University in 2015. Diploid (Siyez), tetraploid (Ege 88, Sarıçanak 98, Fuatbey 2000) and hexaploid (Kaşifbey 95, Menemen, Gönen 98) wheat cultivars (Cv) were used in seedling level and diploid (Siyez), tetraploid (Ege 88) and hexaploid (Gönen 98) wheat cultivars were used in germination level (to observation of metaphase chromosomes. Experiments were carried out in randomized plots experimental design with 4 replications.

Different irrigation water salinity levels were created by using different salinity sources (NaCl, $MgCl_2$, $CaCl_2$) as to have the final Sodium Absorption Ratio 'SAR' value of lower than 3. Ca, Mg and Na are the most common cations in irrigation waters. Therefore, these salts were sued in preparation of saline irrigation waters. Electrical conductivity (EC) of irrigation waters were considered while preparing different salinity levels and irrigation waters were prepared at 0.5 (control: tap water), 2, 4, 8, 16, 20, 30, 40 dS/m concentrations in 25 liter plastic jerry cans. EC and pH of salt solutions were continuously monitored.

Laboratory experiment and chromosome analysis

In each replication of genotype, 20 seeds were placed in Petri dishes with Whatman No.1 filter paper (ATAK *et al.*, 2006). Petri dishes were supplemented with 10 ml solutions with different salt concentrations and covered with para-film to prevent evaporation. Seeds were kept in different salt concentrations for 5 days. Root tip samples with 10-12 mm length were taken from each ploidy level of genotypes on the fifth day of laboratory experiment. Samples were treated with carnoy fixative and kept in a fridge in 70% ethyl alcohol solution. Samples were then removed from alcohol material, washed through distilled water, kept in 1 N HCl at 60°C for 12 minutes and rewashed with distilled water. They were kept in 1-2 drops aceto-carmine for 20 minutes and washed again with distilled water. They were placed in 1 drop of aceto-carmine, preparate were taken from root tips with smashing method and analyzed in a phase contrast microscope at 1000X magnifications.

Greenhouse experiment

In the greenhouse experiment the pots filled with 1600 g dry soil (sandy clay, brown forest soil, pH: 7.82) and 20 seeds were sown in each application. Following the germination, thinning was performed as to have 10 plants (ALPASLAN *et al.*, 1998). Desired irrigation water salinity levels were achieved through dissolving NaCl, $MgCl_2$ and $CaCl_2$ salts in 20 liter water and plants were irrigated with these solutions. To prevent drainage soil was placed in polyethylene bags (AKDOĞAN and ÖZKAN, 2000). As basic fertilizers, 200 mg N kg $soil^{-1}$, 100 mg P_2O_5 kg $soil^{-1}$ and 125 mg K_2O kg $soil^{-1}$ were applied to pots (ALPASLAN *et al.*, 1998). Seeds were sown in April and pot soil was saturated with irrigation water at different salt levels. The EC levels of irrigation water were checked in every other day. Shoot was assessed after 10-week growth period. Shoot length, root length, root dry weight and shoot dry weight were determined (BAĞCI *et al.*, 2003).

Experimental data were subjected to ANOVA with JMP 5 statistical software and differences in treatment means were grouped with Tukey test.

RESULTS AND DISCUSSION

Chromosome analysis

Microscopic analysis revealed that it was not determined that possible effects of irrigation water salinity to structure of chromosomes with current equipment and methods. However, cell division reduced with increasing irrigation water salinity levels. Then new investigations as mitotic index and used technologies with higher magnification than 1000X are recommended for better detection of these cases.

Greenhouse experiment

The effects of irrigation water salinity levels on shoot dry weight, root dry weight, shoot length and root lengths of diploid wheat cultivar were found to be significant ($P<0.05$). Tukey test groups for relevant parameters are provided in Table 1.

Considering the effects of irrigation water salinity levels on shoot dry weight, root dry weight, shoot length and root length of diploid wheat, it was observed that shoot dry weight did not significantly changed in 2, 4 and 8 dS m^{-1} treatments as compared to control treatment and they were placed in the same group, but shoot dry weight decreased in 16 dS m^{-1} treatment and it was placed in a different group. With regard to root dry weight, all treatments were different from the control treatment and formed a separate group. Shoot length was higher in 2 and 4 dS m^{-1}

treatments than in control, 8 and 16 dS m^{-1} treatments and they were placed in a different group. Root length was greater in 2 and 4 dS m^{-1} treatments than in 8 and 16 dS m^{-1} treatments and placed in the same group with the control treatment.

Table 1. Tukey grouping for shoot dry weight, root dry weight, shoot length and root length of diploid wheat germinated under different irrigation water salinity levels

Salinity level (dS m^{-1})	**Shoot dry weight (g)**	**Root dry weight (g)**	**Shoot length (cm)**	**Root length (cm)**
0	1.59 a	1.48 a	37.25 b	25.75 a
2	1.69 a	0.40 b	44.75 a	24.25 a
4	1.68 a	0.36 b	47.50 a	26.00 a
8	1.43 a	0.30 b	11.00 c	11.00 b
16	0.86 b	0.28 b	12.50 c	7.00 b

*: The means in the same column indicated with the same letter are not significantly different, Alpha=0.5 Q:3.08793

Irrigation water salinity levels had significant effects on shoot dry weight, root dry weight, shoot length and root length of tetraploid wheat cultivars (P<0.05). However while the effects of cultivar on shoot dry weight and root dry weight were found to be significant (P<0.05), the effects of cultivar on shoot length and root length were not found to be significant (P>0.05). Tukey test groups for relevant parameters are provided in Tables 2 and 3.

Table 2. Tukey grouping for shoot dry weight, root dry weight, shoot length and root length of tetraploid wheat germinated under different irrigation water salinity levels

Salinity level (dS m^{-1})	**Shoot dry weight (g)**	**Root dry weight (g)**	**Shoot length (cm)**	**Root length (cm)**
0	2.19 b	0.92 ab	30.08 ab	24.00 a
2	2.35 ab	0.76 b	31.42 a	24.67 a
4	2.50 a	0.94 a	31.75 a	26.75 a
8	2.35 ab	0.80 ab	25.92 b	25.92 a
16	2.14 b	0.81 ab	20.17 c	9.75 b

*: The means in the same column indicated with the same letter are not significantly different, Alpha=0.5 Q:2.84145

Table 3. Tukey grouping for shoot dry weight, root dry weight, shoot length and root length of tetraploid wheat cultivars germinated under different irrigation water salinity levels

Cv	Shoot dry weight (g)	Root dry weight (g)	Shoot length (cm)	Root length (cm)
Sarıçanak 98	2.62 a	1.10 a	27.00 ^{ns}	22.70 ^{ns}
Fuatbey 2000	2.56 a	1.02 a	29.30	22.10
Ege 88	1.74 b	0.42 b	27.30	21.85

*: The means in the same column indicated with the same letter are not significantly different,
^{ns}: The means in the same column are not significantly different, Alpha=0.5, Q:2.42362

Considering the effects of irrigation water salinity levels on shoot dry weight, root dry weight, shoot length and root length of tetraploid wheat cultivars; it was observed that the greatest shoot dry weight was obtained from 4 dS m^{-1} treatment and this treatment was placed in same group with the control and 16 dS m^{-1} treatments and different group from 2 and 8 dS m^{-1} treatments. The relevant irrigation water salinity level (4 dS m^{-1}) might have had fertilizer effect. With regard to root dry weight, the greatest value was obtained from again 4 dS m^{-1} treatment and it was placed in the same group with control, 8 and 16 dS m^{-1} treatments and different group from 2 dS m^{-1} treatment. While the greatest shoot length was respectively observed in 4, 2 dS m^{-1} and control treatments, the lowest value was respectively seen in 8 and 16 dS m^{-1} treatments. Root length was higher in control, 2, 4 and 8 dS m^{-1} treatments than in 16 dS m^{-1} treatment. Relevant parameters of tetraploid wheat decreased with increasing irrigation water salinity levels. Shoot dry weight and root dry weights of Sarıçanak 98 and Fuatbey 2000 cultivars were higher than Ege 88 cultivar and these two cultivars were placed in a different Tukey group from Ege 88. There were not significant differences in shoot length and root lengths of cultivar. The differences may be resulted only from the different genetic structures of the cultivars.

The effects of irrigation water salinity level and cultivar on shoot dry weight, root dry weight, shoot length and root length of hexaploid wheat cultivars were found to be significant (P<0.05). Tukey test groups are provided in Tables 4 and 5.

Considering the effects of irrigation water salinity levels on shoot dry weight, root dry weight, shoot length and root length of hexaploid wheat; it was observed that the greatest shoot dry weight was obtained from 4 dS m^{-1} treatment and this treatment was placed in same group with the control, 8 and 16 dS m^{-1} treatments and different group from 2 treatment. In this case, the relevant irrigation water salinity level (4 dS m^{-1}) might have had fertilizer effect. With regard to root dry weight, the greatest value was obtained from again 4 dS m^{-1} treatment and it was placed in the same group with control and different group from 2, 8 and 16 dS m^{-1} treatments. While the greatest shoot length was observed in 2 and 4 dS m^{-1} treatments, the lowest value was respectively seen in 8 and 16 dS m^{-1} treatments. Root length was higher in control, 2 and 4 dS m^{-1} treatments than in 8 and 16 dS m^{-1} treatments. Relevant parameters of hexaploid wheat decreased with increasing

irrigation water salinity levels. The cultivar Gönen 98 had higher shoot dry weight, shoot length and root length than the other cultivars and it was placed in a different group. With regard to root dry weight, Gönen 98 and Kaşifbey 95 had higher values and placed in a different group from cultivar Menemen. The differences are assumed to be resulted from the different genetic structures of the cultivars. Current findings comply with the results of earlier studies (JBIR *et al.,* 2001; SINCLAIR and HOFFMANN, 2003; TASLAK *et al.,* 2007; KARA *et al.,* 2011; HEIDARI *et al.,* 2016; COSKUN *et al.,* 2016).

Table 4. Tukey grouping for shoot dry weight, root dry weight, shoot length and root length of hexaploid wheat cultivars germinated under different irrigation water salinity levels

Salinity level (dS m^{-1})	**Shoot dry weight (g)**	**Root dry weight (g)**	**Shoot length (cm)**	**Root length (cm)**
0	2.86 bc	1.29 ab	28.50 b	27.41 a
2	2.93 ab	1.18 b	32.08 a	26.58 a
4	3.21 a	1.44 a	29.67 ab	25.42 ab
8	2.74 bc	0.88 c	23.75 c	23.33 b
16	2.61 c	1.12 b	21.67 c	7.83 c

*: The means in the same column indicated with the same letter are not significantly different, Alpha=0.5 Q:2.84145

Table 5. Tukey grouping for shoot dry weight, root dry weight, shoot length and root length of hexaploid wheat cultivars germinated under different irrigation water salinity levels

Cv	**Shoot dry weight (g)**	**Root dry weight (g)**	**Shoot length (cm)**	**Root length (cm)**
Gönen 98	3.18 a	1.24 a	29.70 a	24.50 a
Kaşifbey 95	2.76 b	1.25 a	24.95 b	19.95 c
Menemen	2.68 b	1.05 b	26.75 b	21.90 b

*: The means in the same column indicated with the same letter are not significantly different, Alpha=0.5 Q:2.42362

While the effects of wheat ploidy level on shoot dry weight and root dry weight were significant ($P<0.05$), the effects on shoot length and root length were not found to be significant ($P>0.05$). Tukey test groups are provided in Table 6.

With regard to shoot dry weight, root dry weight, shoot length and root length of what irrigated with different irrigation water salinity levels based on their ploidy levels, it was observed

that hexaploid had the greatest shoot dry weight and root dry weight and they were followed respectively by tetraploid and diploid. Different shoot dry weights and root dry weights of different ploidy levels may be explained by additive gen effects because of large genomes. Current findings comply with the results of previous studies (KONAK *et al.,* 1999; JBIR *et al.,* 2001; SINCLAIR and HOFFMANN, 2003; MAJEED *et al.,* 2016; HEIDARI *et al.,* 2016; KAMYAB and HEIDARI, 2016). Increasing ploidy levels in wheat may improve physiological and ecological adaptation, therefore hexaploid wheat can adapt to different conditions better than diploid and tetraploid wheat. Current finding comply with the results of earlier studies reporting better adaptation for hexaploid wheat (MESTA, 1995; ÇAVDAR, 1997; MUNNS *et al.,* 2006; DUBCOVSKY and DVORAK, 2007; FELDMAN *et al.,* 2012; YANG *et al.,* 2014; COSKUN *et al.,* 2016).

Table 6. Tukey grouping for shoot dry weight, root dry weight, shoot length and root length of different ploidy levels germinated under different irrigation water salinity levels

Ploidy level	**Shoot dry weight (g)**	**Root dry weight (g)**	**Shoot length (cm)**	**Root length (cm)**
Hexaploid	2.87 a	1.17 a	27.13^{ns}	22.12^{ns}
Tetraploid	2.30 b	0.84 b	27.87	22.22
Diploid	1.45 c	0.57 c	30.60	18.80

*: The means in the same column indicated with the same letter are not significantly different,
^{ns}: The means in the same column are not significantly different, Alpha=0.5 Q:2.36950

Different responses of cultivars to salinity levels may be resulted from the differences in their genetic structures. The primary reason for negative influences of high salt concentrations in germination period is the inhibition of required water intake of seeds for germination (MANSOUR, 1994).

Damages on cell nucleus and chromosomes negatively influence cell division and thus germination. Chromosome damages result in chromosome anomalies through external and internal gen-toxic agents. Such anomalies usually create heterochromatic regions mostly in repeated series (SCHUBERT *et al.,* 2004).

In previous salinity studies, SAR values, a significant parameter to be considered for irrigation water quality, were usually ignored. Most of them put forth sodium hazard on plants. However, apart from sodium salt (NaCl), there are several other dissolved salts in natural irrigation waters [Na_2SO_4, Na_2CO_3, $MgSO_4$, NaCl, $MgCl_2$, $CaCl_2$, $CaSO_4$] (COSKUN *et al.,* 2016).

Under green house conditions, plant growth is hindered when the electrical conductivity of irrigation water went above 16 dS m^{-1}. The primary reason for cease of plant development is salt stress created by saline irrigation waters. Increasing irrigation water salinity levels result in significant differences in salt contents of both the soils and the plants. Therefore, irrigation water

quality parameters should definitely be taken into consideration and relevant measures like leaching should be taken in case of low quality irrigation waters.

CONCLUSION

The following messages have taken from the current work:

Possible effects of irrigation water salinity to structure of chromosome were not determined with current microscopic equipment and methods. However, cell division reduced with increasing irrigation with water salinity levels. Then new investigations as mitotic index and used technologies with higher magnification than 1000X are recommended for better detection of these cases.

When the SAR values were kept below 3, salt could have made fertilizer effect with lower levels than 8 dS m^{-1}.

Negative effects of salinity on shoot and root of wheat were started to be observed at 8 dS m^{-1} salinity level.

Under green house conditions, plant growth is hindered when the electrical conductivity of irrigation water went above 16 dS m^{-1}.

Hexaploid wheat was more tolerant then tetraploid and diploid wheat to irrigation water salinity.

Different responses of wheat genotypes to irrigation salinity levels may be resulted from the differences in their genetic structures.

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REFERENCES

AKDOĞAN, S., I. ÖZKAN (2000): Gelişmenin Değişik Dönemlerinde Uygulanan Su Noksanlığı Geriliminin Biber Bitkisinin Tuza Duyarlılığı Üzerine Etkisi. Tarım Bilimleri Dergisi, *6(3)*:1-8. (In Turkish).

ALPASLAN, M., A. GÜNEŞ, S. TABAN (1998): Tuz Stresinde Çeltik ve Buğday Çeşitlerinin Kalsiyum, Fosfor, Demir, Bakır, Çinko ve Mangan İçeriklerinde Değişmeler. Turk. J. Agric. For., *22*:227-233. (In Turkish).

ANONYMOUS (2016): FAO Water Development and Management Unit Crop Water Information: Wheat (http://www.fao.org/nr/water/cropinfo_wheat.html)

ASHRAF, M., M.R. FOOLAD (2007): Improving Plant Abiotic-Stress Resistance by Exogenous Application of Osmoprotectants Glycine Betaine and Proline. Environ. Exp. Bot., *59*:206–216.

ATAK, M., M.D. KAYA, G. KAYA, Y. KILLI, C.Y. CIFTCI (2006): Effects of NaCl on the Germination, Shoot Growth and Water Uptake of Triticale. Turk. J. Agric. For., *30*: 39-47.

AYERS, R.S., D.W. WESTCOT (1989): Water Quality for Agriculture. FAO Irrigation of the Drainage Paper, *29*:163 pp.

BAĞCI, S.A., H. EKIZ, A. YILMAZ (2003): Determination of the Salt Tolerance of Some Barley Genotypes and the Characteristics Affecting Tolerance. Turk. J. Agric. For., *27*:253-260.

COSKUN, Y., I. TAS, T. YETER (2016): Effects of Different Irrigation Water Salinity Levels on Germination of Diploid, Tetraploid and Hexaploid Wheat. Agriculture & Food, 433-441.

ÇAVDAR, H. (1997): Bazı Yerel ve Islah Edilmiş Makarnalık Buğday Çeşitlerinde *(Triticum durum Desf.)* Tuz ve Su Stresinin Karbonhidrat ve Proline Etkilerinin İncelenmesi. Çukurova University, M.Sc. Thesis. (In Turkish).

DEMIR, I., K.M. MAVI, G. OKÇU (2003): Effect of Salt Stress on Germination and Shoot Growth in Serially Harvested Aubergine (*Solanum melongena* L.) Seeds During Development. Israel J. Plant Sci., *51*:125-131.

DUBCOVSKY, J., J. DVORAK (2007): Genom plasticity a key factor in the success of polipoid wheat under domestication. Science, *316*(5883):1862-1866.

FELDMAN, M., A.A. LEVY, T. FAHIMA, A. KOROL (2012): Genomic asymmetry in allopolyploid plants: Wheat as a model. J. Exp. Bot., *63*(14):5045-5059.

FRANCOIS, L.E., E.V. MASS (1986): Effect of Salinity on Grain Yield and Quality, Vegetative Growth and Germination on Semi-Dwarf and Durum Wheat. Agros. J., 1053-1058.

HEIDARI, B., M. LATIFI, A. DADKHODAIE, N. SHARIATIPOUR (2016): Selection of Salt- tolerant Triticale (X triticosecale Wittmack) and Genetic Variation Assay for Agronomic and Physiological Traits. Int. J. Plant Soil Sci., *12*(1): 1-13.

INAL, A., A. GUNES, M. AKTAS (1995): Effects of Chloride and Partial Substitution of Reduced Forms of Nitrogen for Nitrate in Nutrient Solution of the Nitrate, total Nitrogen and Chlorine Contents of Onion. J. Plant Nutr. *18*:2219-2227.

JBIR, A., W. CHAIBI, S. AMMAR, A. JEMMALI, A. AYADI (2001): Root Growth and Lignification of Two Wheat Species Differing in Their Sensitivity to NaCl, in Response to Salt Stress. Comptes Rendus de l'Académie des Sciences - Series III - Sciences de la Vie, *324*(9):863-868.

KAMYAB, S., B. HEIDARI (2016): Investigation of the Salt Tolerance of Wheat Genotypes: Changes in Antioxidants, Total Protein, K+/Na+ Ions and Grain Yield. British Biotech. J., *15*(1): 1-10.

KANBER, R., M. ÜNLÜ (2010): Tarımda Su ve Toprak Tuzluluğu. Ç.Ü. Ziraat Fak. Gen. Yay. No:281. Ders Kitapları Yay. No:A-87:307p. (In Turkish).

KARA, B., I. AKGÜN, D. ALTINDAL (2011): Tritikale Genotiplerinde Çimlenme ve Fide Gelişimi Üzerine Tuzluluğun (NaCl) Etkisi. Selçuk Tarım ve Gıda Bilimleri Dergisi, *25*(1):1-9. (In Turkish).

KAYDAN, D., M. YAGMUR, N. OKUT (2007): Effects of Salicylic Acid on the Growth and Some Physiological Characters in Salt Stressed Wheat (*Triticum aestivum* L.). Tarım Bilimleri Dergisi, *13*:114-119. Turkish.

KONAK, C., R. YILMAZ, O. ARABACI (1999): Ege Bölgesi Buğdaylarında Tuza Tolerans. Turk. J. Agric. For., *5*:1223-1229.

AJEED, A., M. ANWAR-UL-HAQ, A. NIAZ, J. AKHTAR, Z.A. AHMAD, A. MUHMOOD, M.A. ANJUM, S.S.H. SHAH (2016): Gas Exchange Traits and Biplot Analysis Method can be used as Screening Criteria for Salt Tolerance in Maize (*Zea mays* L.) Cultivars. Am. J. Exp. Agric., *11*(2): 1-11.

MANSOUR, M.M.F. (1994): Changes in Growth, Osmotic Potential and Cell Permeability of Wheat Cultivars under Salt Stress. Biol. Plant., *36*:429-434.

MESTA, B. (1995): Buğday ve Arpa Çeşitlerinin Tuzluluğa Tepkileri Üzerine Araştırma. Ankara University, M.Sc. Thesis. (In Turkish).

MUNNS, R., R.A. JAMES, A. LAUSCHLI (2006): Approaches to Increasing the Salt Tolerance of Wheat and Other Cereals. J. Exp. Bot., *57*:1025-1043.

SCHUBERT, I., A. PECINKA, A. MEISTER, V. SCHUBERT, M. KLATTE, G. JOVTCHEV (2004): DNA damage processing and aberration formation in plants. Cytog. Genome Res., *104*:104–108.

SIEGEL, S.M., B.Z. SIEGEL, J. MASSEY, P. LAHNE, J. CHEN (1980): Growth of Corn in Saline Water. Physiol. Plant., *50*:71-73.

SINCLAIR, C., A.A. HOFFMANN (2003): Monitoring Salt Stress in Grapevines: Are Measures of Plant Trait Variability Useful? J. App. Ecol., *40*:928-937.

TASLAK, I., Ö. ÇAĞLAT, S. BULUT, Ş. AKTEN (2007): Bazı Arpa Genotiplerinin Tuzluluğa Toleranslarının Belirlenmesi I. Çimlendirme Denemesi. VII. Tarla Bitkileri Kongresi, 188-192. (In Turkish).

VAN HOORN, J.W., N. KATERJI, A. HAMDY, M. MASTRORILLI (2001): Effect of Salinity on Yield and Nitrogen Uptake of Four Grain Legumes and on Biological Nitrogen Contribution from the Soil. Agric. Water Manag., *51*:87–98.

YANG, C., L. ZHOA, H. ZHANG, Z. YANG, H. WANG, S. WEN, C. ZHANG, S. RUSTGI, D. VON WETTSTEIN, B. LIU (2014): Evolution of Physiological Rresponses to Salt Stress in Hexaploid Wheat. PNAS, *111*(32):1882-11887.

ODGOVOR PŠENICE NA ZALIVANJE VODOM RAZLIČITOG SALINITETA

Yalçın COŞKUN i İsmail TAŞ

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Izvod

U radu je proučavan efekat različitog saliniteta vode za zalivanje odnjavanje na hromozome i nadzemni deo pšenice sa tri tipa ploidije (diploidne, tetraploidne i heksaploidne). Eksperiment u stakleniku pokazao je da nivo saliniteta u vodi za zalivanje ima značajan uticaj na suvu težinu nadzemnog dela biljke, suvu težinu korena, kao i na dužinu korena i nadzemnog dela biljke (P<0.05). Efekat tipa ploidije na suvu masu korena i nadzemnog dela je takođe bio značajan (P<0.05), ali nije bio značajan za dužinu korena i nadzemnog dela biljke (P>0.05). Negativan efekat saliniteta na koren i nadzemni deo biljke, počeo je na 8 dS m^{-1}. Pored toga, heksaploidna pšenica je bila tolerantnija na salinitet vode u odnosu na tetraploidnu i diploidnu. Ovom opremom i metodom nije bilo moguće utvrditi efekat zalivanja zaslanjenom vodom na strukturu hromozoma. Deoba ćelija je bila normalna, ali je bila smanjena sa povećanjem nivoa saliniteta vode.

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