Egypt. J. Plant Breed. 15 (1): 57 – 67 (2011)

EVALUATION OF SOME MAIZE HYBRIDS UNDER DIFFERENT SALINITY CONDITIONS

M. A. H. Megahed, Eman A. I. Mohamed and Rasha Y. S. Abd El-Khalek

Seed Tech. Res. Dept., Field Crops Res. Inst., A.R.C., Giza. Egypt.

ABSTRACTS

Evaluation of maize hybrids to salinity tolerance is an important objective in breeding programs. Laboratory experiments were carried out at the laboratory of Seed Technology Department to study the effects of salinity on seed germination and seedling growth of five hybrids of maize i.e. SC 10, SC 123, TWC 314, TWC 320 and TWC 324. Seeds were treated during germination with either distilled water or one of the four concentrations of either NaCl or $CaCl_2$ salts in addition to a combination of both salts by in a 1:1 ratio. Seed viability and seedling characteristics were measured. Results showed that hybrid SC 10 gave the highest germination percentage, seedling vigor index, first count, cleoptile length, root length and dry weight followed by hybrid SC123. The longest root was recorded for hybrid SC 123, but the shortest one was for hybrid TWC 320.. Results of SDS-PAGE protein electrophoresis indicated that there were wide differences among hybrids in number and position of bands in each treatment. Three markers were shown to be associated with salt treatment $CaCl_2$ with molecular weight of 95 KDa at 4000ppm for all hybrids under study, except for hybrid SC 123, 30 KDa at 8000 ppm for all hybrids and 15 KDa at 6000 and 8000ppm for all hybrids except for SC 10. While one marker was associated with salt treatment NaCl with molecular weight of 85 KDa in SC 10. Both salts decreased values of the studied characters, but NaCl gave higher values than CaCl2. Results indicated that SC 10 is more tolerant to salinity stress than SC 123, TWC 314 and TWC 324, while TWC 320 is considered a sensitive hybrid to salinity stress. It could be concluded that a better understanding of physiological responses to salinity conditions may help in programs, which are involved in the improvement of salt tolerance of crop cultivars.

Key words: ***Maize, Germination, Seedling characters, Salinity stress, SDS-PAGE.***

INTRODUCTION

Maize (*Zea mays* L.) is one of the important crops, which serves as food and oil for human consumption, feed for livestock and poultry; and raw material for agro-based industries. Salinity tolerance may exist in maize (Paterniani, 1990). Salinity causes not only differences between the mean yield and the potential yield, but also causes yield reduction.

Salinity delays the onset, reduces the rate, and increases the dispersion of germination events, resulting in reducing plant growth and final crop yield (Ashraf and Foolad, 2005). Seeds are particularly vulnerable to stress encountered between sowing and seedling establishment, while plant salt tolerance usually increases with plant ontogeny. Soil salinity may affect the germination of seeds either by creating osmotic potential external to the seeds preventing water uptake or through the toxic effects of Na^+ and Cl^- ions on germinating seed (Khajeh-Hosseini *et al* 2003).

Germination and seedling stage of plant life cycle is more sensitive to salinity than the adult stage (Asbraf *et al* 1986) . Effect of salinity at different growth stages in wheat, sorghum and cowpea was investigated and it was found that the early seedling period was the most sensitive one in all the crops and reduction in growth was observed which decreased with increase of salinity (Shalhevet 1995). In maize, Na and Cl accumulation in root and shoot increased as a result of 50 to 200 mM NaCl treatment, while K^+ content in root and shoot decreased in salinity levels at all the three ages. Beck *et al* (2004) found that accumulation of Na increased and strong inhibition of K and Ca accumulation in the root, stem and leaves with NaCl-induced salinity was observed.

The main objective of the present study was to evaluate the growth pattern of five maize hybrids under two types of salts i.e. sodium chloride (NaCl), calcium chloride ($CaCl_2$) and a combination of the two salts using four concentrations of the salts.

MATERIALS AND METHODS

Seeds of five maize hybrids, namely TWC 314, TWC 320, TWC 324, SC10, and SC123 were used in this study. Two salts were used: sodium chloride (NaCl), calcium chloride ($CaCl_2$) and a combination of the two salts. These salts were used in four concentrations i.e. 2000, 4000, 6000, and 8000 ppm.

One hundred seeds of each hybrid were germinated in Petri dishes. Normal seedlings were counted according to the international rules of the International Seed Testing Association (ISTA 1993). Germination percentage was calculated according to Krishnasamy and Seshu (1990).

$$\text{Germination \%} = \frac{\text{Number of normal seedlings}}{\text{Number of tested seed}} \times 100$$

First count: It was recorded at the fifth day and the final percentage was recorded at the end of the experiment according to ISTA (1996).

Germination rate: four replicated dishes, each with 25 seeds were used for each treatment and were placed in an incubator. The germination rate was estimated according to Timson (1965) as modified by Khan and Unger (1984) so that seedling shoot and root length were measured after 7 days of germination. Twenty-five seedlings from each petri dish were randomly selected, then shoot and root length were recorded. Seedling fresh weight was determined, then seedling was placed in oven for drying for 24 hrs at 70°C and dry weight of seedling was determined.

Seedling vigor index was calculated according to ISTA (1985) as follows:
Seedling vigor index = seedling length x germination percentage

Electrophoresis of total soluble proteins: Electrophoresis methods have been proved to be extremely useful tool in variety identification (Cook 1999). Soluble proteins were extracted from seeds and SDS-PAGE was conducted according to the protocol described by Laemmli (1970).

Statistical analysis: Results were statistically analyzed using the oneway analysis of variance (ANOVA) as described by Snedecor and Cochran (1981). Means were compared by LSD at 5 %.

RESULTS AND DISCUSSIONS

Table (1) revealed that there were significant differences between the five studied genotypes in germination percentage and seedling vigor index. Hybrid SC10 gave the highest germination percentage followed by SC123, while the lowest value was recorded for TWC 320, which was the lowest, also, in seedling vigor index and germination rate. In contrast, SC123 was the highest in these two traits.

Results showed different response of these cultivars to the source of salt and salt concentrations. Sources of salt affected the three characters and were significantly different. Treatment of NaCl had high germination percentage, germination rate, and seedling vigor index. The combination of NaCl and $CaCl_2$ gave higher effect on these characters than the treatment by each salt alone.

Germination percentage, germination rate, and seedling vigor index were reduced significantly by increasing the concentration of the salt , where 2000 ppm gave the highest values of these traits. While, higher concentration (8000 ppm) was associated with the lowest values. These results were in agreement with Al-Ansari (2003) who found that germination percentage and germination rate were decreased by increasing salt concentration.

The interaction between the source of salt and the salt concentration showed that the highest germination percentage was recorded by the mixture of the two salts at 2000, 4000, and 6000 ppm. While, at 8000 ppm, the lowest germination percentage observed with $CaCl_2$. Hybrid TWC 314 recorded the highest germination percentage (100%) when treated with 2000 or 4000 ppm of NaCl, while SC 123 recorded the lowest germination percentage when treated with 4000 ppm of NaCl (38%).

Data presented in Table (2) revealed that SC123 recorded the highest values of cleoptile length, radical length and fresh weight. While, TWC320 has the lowest cleaptile and radical length. Hybrid TWC324 had the lowest fresh weight. There were small differences between the five genotypes in

Table1. Effect of cultivar (A) source of salt (B) and salt concentration (C) on germination percentage, germination rate and seed on vigor index.

Treatment	Germination %	Germination rate	Seedling vigor index
Cultivar (A)			
TWC 314	82.80	74.70	1083.0
TWC 320	57.20	43.33	674.7
TWC 324	77.53	71.18	1044.0
SC 10	90.24	74.33	1552.0
SC 123	87.47	77.30	1413.0
LSD (5%)	0.945	1.093	31.68
Sources of Salt (B)			
NaCl	83.27	74.03	1335.0
$CaCl_2$	82.08	69.45	1264.0
$Na^+ + Ca^{++}$	71.80	61.02	861.3
LSD (5%)	0.734	0.847	24.54
Salt conc.(ppm) (C)			
0.00	97.20	85.65	2194.0
2000	84.20	75.25	1327.0
4000	78.87	68.98	1015.0
6000	73.38	59.28	776.3
8000	61.60	51.67	454.0
L.S.D (5%)	0.948	1.093	31.68

Table 2. Effect of cultivar (A) source of salt (B) and salt concentration (C) on cleoptile length, radical length, fresh weigh, and dry weight.

Treatment	Cleoptile length (cm)	Radical length (cm)	Fresh weight (g)	Dry weight (g)
Cultivar (A)				
TWC 314	4.260	7.916	0.294	0.041
TWC 320	4.216	6.910	0.322	0.041
TWC 324	4.834	7.676	0.285	0.041
SC 10	6.437	10.160	0.424	0.056
SC 123	4.956	10.530	0.324	0.051
LSD (5%)	0.159	0.220	0.013	0.0014
Sources of Salt (B)				
NaCl	5.041	10.06	0.376	0.050
$CaCl_2$	5.623	9.003	0.355	0.048
$Na^+ + Ca^{++}$	4.158	6.853	0.259	0.040
LSD (5%)	0.123	0.171	0.010	0.0011
Salt conc.(ppm) (C)				
0.00	8.051	15.85	0.556	0.067
2000	5.771	9.50	0.347	0.053
4000	4.681	7.71	0.300	0.044
6000	3.604	6.24	0.246	0.038
8000	2.596	3.89	0.199	0.027
L.S.D (5%)	0.159	0.220	0.013	0.0014

dry weight. The highest dry weight was recorded for SC10. Source of salt showed significant differences in cleoptile length, radical length, fresh weight and dry weight. The highest value for cleoptile length was associated with $CaCl_2$ treatments. On the other hand, NaCl treatments recorded the highest radical length, fresh weight, and dry weight. In contrary, the lowest values of these traits were achieved by NaCl and $CaCl_2$ combination treatments

In response to salt stress, cleoptile length, radical length, fresh weight, and dry weight were significantly decreased with increasing salt concentration. These results are in agreement with those reported by Hussain *et al* (2009).

Table (3) presents the values of the first count, root/shoot ratio, and seedling growth rate. The first count showed significant differences between the studied genotypes. Hybrid SC123 recorded the highest value for the first count (74.53), while, TWC 320 had the lowest value (44.49). For root/shoot ratio, SC10 recorded the highest value (2.016) but TWC 324 recorded the lowest value. Seedling growth rate ranged between 2.423 in SC123 and 1.592 for T.W320.

Type of salt showed the highest value for the first count in NaCl treatment with no significant difference with $CaCl_2$ treatment. But the combination of the two salts gave the lowest value. Sodium chloride recorded the highest values for root/shoot ratio and seedling growth rate with significant differences with the other treatments. The lowest value of root/shoot ratio was recorded by $CaCl_2$, while, the lowest seedling growth rate was obtained via the combination of the two salts.

The first count and seedling growth rate values significantly decreased by increasing salt concentration compared with the control. The highest value for root/shoot ratio was recorded when 8000 ppm concentration was used without significant difference with 6000 ppm treatment. But the lowest ratio was obtained with 4000 ppm without significant difference with 2000 ppm.

The SDS-PAGE electrophoretic patterns for water soluble proteins in maize under stresses of NaCl, $CaCl_2$ and their combination are shown in Figs (1, 2 and 3) and Tables (4, 5, and 6). Maximum number of 16 bands was detected with a molecular weight M.W ranging from 205 to 20 KDa, where 12 of them were monomorphic and the rest were polymorphic. A band of molecular weight 85 KDa was present in SC10 hybrid and was absent in the other hybrids, which could be considered as a marker for this hybrid and band with M.W of 70 KDa which could be considered as a marker for TWC 324.

Table 3. Effect of cultivar (A) source of salt (B) and salt concentration (C) on the first count, root/shoot ratio, and seedling growth rate.

Treatment	First Count	Root/Shoot ratio	Seedling growth rate
Cultivar (A)			
TWC 314	66.98	1.881	1.741
TWC 320	44.49	1.881	1.592
TWC 324	61.04	1.529	1.790
SC 10	74.53	2.016	2.423
SC 123	57.60	1.604	2.157
LSD (5%)	1.557	0.075	0.044
Sources of Salt (B)			
NaCl	63.64	2.069	2.156
$CaCl_2$	63.63	1.554	2.095
$Na^{+} + Ca^{++}$	55.52	1.723	1.571
LSD (5%)	1.206	0.058	0.034
Salt conc.(ppm) (C)			
0.00	80.44	2.021	3.415
2000	67.91	1.664	2.186
4000	59.80	1.660	1.770
6000	53.82	1.768	1.403
8000	42.67	1.798	0.929
L.S.D (5%)	1.557	0.075	0.044

Table 4. SDS-PAGE of total proteins extracted from the leaves of five maize hybrids under NaCl and $CaCl_2$ treatments.

M.W	TWC 324					SC. 10					TWC 320					TWC 314					SC. 123				
(KDa)	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	c	1	2	3	4	C	1	2	3	4
205	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
170	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
145	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
130	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
110	+	-	-	-	+	+	-	-	-	-	-	-	-	+	-	+	+	+	-	-	-	-	-	-	-
95	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
85	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
70	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	+	+	+	-	-
60	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+
50	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
40	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
30	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
25	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
20	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

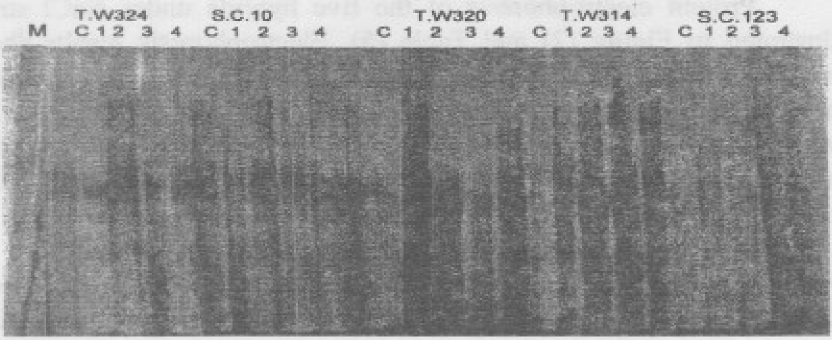

Fig 1. SDS– PAGE protein banding patterns for seed proteins of maize hybrid under salinity with NaCl + CaCl2 salts.

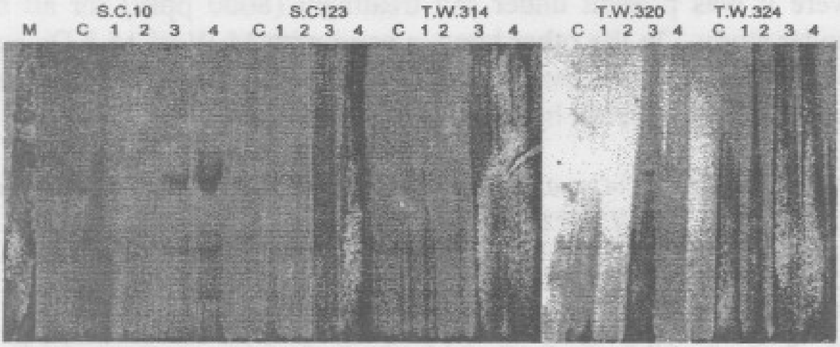

Fig 2. SDS– PAGE protein banding patterns for seed proteins of maize hybrids under salinity with NaCl salt.

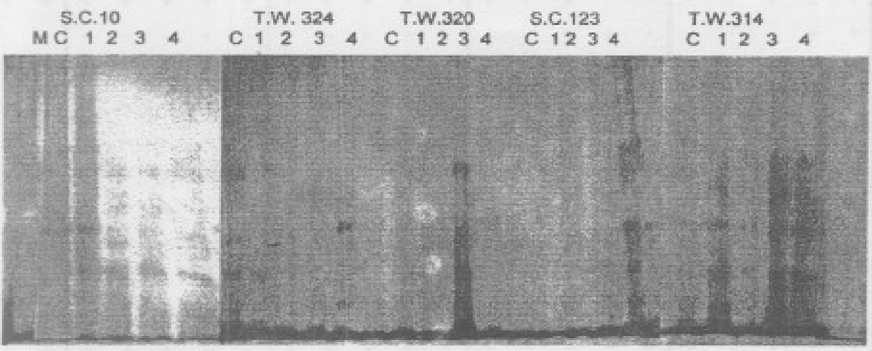

Fig 3. SDS–PAGE protein banding patterns for seed proteins of maize hybrids under salinity with CaCl2 salt.

Protein electrophoresis of the five hybrids under NaCl stress are illustrated in Figure (2) and Table (5). Electrophoresis results showed a maximum number of 16 bands of M.W ranging from 140- to15 KDa, where three of them were monomorphic and the rest were polymorphic. A band with mw of about 20 KDa was absent in the control of four hybrids and present under stress, which may be considered as a marker for NaCl tolerance.

Results of electrophoresis under $CaCl_2$ stress for the five maize hybrids are shown in Figure (3) and Table (6). Total number of bands were 12 bands of M.W ranging from 105 to 10 KDa. Two bands were monmorphic, while the rest were polymorphic. A band with M.W of 95 KDa could be considered as a positive marker for salt stress tolerance because it was present under salt treatment (4000ppm) for all hybrids under study, except for SC123. Similarly a band with M.W of 30 KDa were it was present under salt treatment (8000 ppm) for all hybrids under study. On the other hand, a band with M.W of 15 KDa could be considered as a positive marker associated with salt tolerance at (6000 and 8000ppm) for all hybrids, except for SC 10.

Table 5. SDS-PAGE of total proteins extracted from the leaves of five maize genotypes under NaCl treatments.

M.W	SC 10					SC 123					TWC 314					TWC 320					TWC 324				
(KDa)	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	c	1	2	3	4	C	1	2	3	4
140	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
135	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
115	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
100	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
95	+	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	+	-	+	-	-	-	+
90	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
80	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
45	-	-	-	-	-	+	+	+	-	-	-	+	+	-	-	-	-	-	-	-	+	-	-	-	+
40	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
35	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
30	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
25	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
20	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Table 6. SDS-PAGE of total proteins extracted from the leaves of five maize genotypes under CaCl2 treatments.

M.W	SC10					TWC 324					TWC 320					SC123					TWC 314				
(KDa)	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	c	1	2	3	4	c	1	2	3	4
105	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	+	-	-	-
95	-	-	+	-	-	-	-	+	-	-	-	+	+	-	-	-	-	-	-	-	-	-	+	+	+
85	-	+	-	-	-	-	-	+	+		-	-	-	+	-	-	-	-	-	+	-	-	+	-	-
70	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	+	+	+	-	-	-	+	+
65	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55	-	-	-	-	-	-	-	-	+	+	-	-	-	+	+	-	-	-	-	-	-	-	-	+	+
40	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
30	-	-	+	-	+	-	-	-	+	+	-	-	-	-	+	-	-	+	+	+	-	+	+	+	+
25	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
20	+	+	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	+	+	+	-	+	+	+	+
15	-		-	-	-	-	-	-	+	+	-	+	+	+	+	-	-	-	+	+	+	+	+	+	+
10	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

In conclusion, three markers were associated with $CaCl_2$ tolerance while one marker associated with NaCl. Tolerance. Similar conclusions were recorded by Zeid (2006) who studied the effect of salinity stress on the metabolic activity of maize seedling and found five new bands having molecular weights of 18,17,16,15, and 14 KDa under salt stress leaves. Garcia *et al* (2007) noticed that increased soil salinity promoted by irrigation with saline water increased the sodium content and also the relationships Na/Ca, Na/Mg and Na/k, but decreased the contents of Ca, Mg, and K therefore, characterizing the unbalance and the nutritional stress consequent to the progressive saline stress. Zhang *et al* (2008) indicated that under high salt stress, maize transgenic plants compartmentalized more Na in the roots and kept a relative high K/Na ratio in the leaves compared with wild-type plants.Stepien and Klobus (2005) and Azevedo *et al* (2006) reported similar results in response to salinity stress. Christian et al (2004) studied the biochemical reation of maize to salt stress at the level of proteins in root and shoot.. They reported that high as well as low NaCl treatment of maize led to an unexpected high number of differentially regulated proteins in root and shoots. Moderate salt stress (25mM NaCl) led to a differential regulation of 31% of shoot proteins and 45% of root proteins, without any effect on the morphology and Na and Cl concentrations of the plant

REFERENCES

Al-Ansari, F.M. (2003). Salinity tolerance during germination in two arid-land varieties of wheat. Seed Sci and Technol. 31: 597-603.

Ashraf, M., T.Mcneilly and A.D.Bradshaw (1986). The response to NaCl and ionic contents of selected salt tolerant and normal lines of three legume forage species in sand culture. New Phytol., 104: 403-471.

Ashraf, M. and M.R. Foolad, (2005). Pre-sowing seed treatment-a shotgun approach to improve germination growth and crop yield under saline and non-saline conditions, Advan. Agron. 88, 223-271.

Azevedo, N.A.D.d., J.T. Prisco, F.J. Eneas,C.E.B.d. Abreu and F.E. Gomes (2006). Effect of salt stress on antioxidative enzymes and lipid peroxidation in leaves and roots of salt-tolerant and salt-sensitive maize genotypes. Environ. Exp. Bot. 56: 87-94.

Beck, E., W. Netondo and J.C. Onyango (2004). Response of growth water relations and ion accumulation to NaCl salinity. Crop Sci. 44: 797-805.

Christian Zorb, Sigrid Schmitt, Angelika Neeb, Sandra Karl, Monica Linder and Sven Schubert (2004). The biochemical reaction of maize (*Zea mays* L.) to salt stress is characterized by a mitigation of symptoms and not by a specific adaptation. Plant Sceince 167 : 91-100.

Cook, R. J. (1999). Modern methods for cultivar verification and the transgenic plant challenge verification. Seed Sci. annd Technol. 27: 669-680.

Garcia, G.d.O., P.A. Ferreira, G.V. Miranda, J.C.L.Neves, W.B. Moraes and D.B.d. Santos (2007). Leaf contents of cationic macronutrients and their relationships with sodium in maize plants under saline stress. IDESIA 25: 93-106.

Hussain, K., A. Majeed, K. Nawaz, K.H. Bhatti and M.F. Nisar (2009). Effect of different levels of salinity on growth and ion contents of black seeds. Curr. Res. J. Biol. Sci. 3: 135-138.

ISTA (1985). International Seed Testing Association. International rules for seed testing. Proc. Int. Seed Test. Assoc. 31, 1-52.

ISTA (1993). International Seed Testing Association. International rules for seed testing. Seed Sci. and Technol. 21: 187-209.

ISTA (1996). International Rules for Seed Testing. Seed Sci. and Technol. 24: 155-202.

Khaje-hosseini M., A.A. Powell and I.J. Bingham (2003). The interaction between salinity stress and seed vigour during germination of soybean seeds, Seed Sci. and Technol. 31, 715–725.

Khan, M.A. and I.A. Ungar (1984). The effect of salinity and temperature on the germination of polymorphic seeds and growth of *Atriplex triangularis* Willd. Amer. J. Botany 71: 481-489.

Krishnasamy, V. and D.V. Seshu (1990). Germination after accelerated ageing and associated characters in rice varieties. Seed Sci. and Technol. 18: 147-156.

Laemmli, U. K. (1970). Cleavage of structural proteins during the assembly of the head of bacteriophage T4. Nature (London), 227: 680-685.

Paterniani, E. (1990). Maize breeding in tropics. Cri. Rev. Plant Sci., 9: 125-154.

Shalhevet, J. (1995). Using marginal quality water for crop production. Int. Water Irrig. Rev. 15(1):5-10.

Snedecor, G.W. and W.G. Cochran (1981). Statistical Methods. 7thEd, Iowa State Univ. Press, Ames, Iowa, USA.

Stepien, P. and G. Klobus (2005). Antioxidant defense in the leaves of C3 and C4 plants under salinity stress. Physiol. Plant 125: 31-40.

Timson, J. (1965). New methods of recording germination data. Nature 207: 216-217.

Zeid, I.M., (2006). Trehalose as osmoprotectant for maize under salinity-induced stress. Research Journal of Agriculture and Biological Science 5(5): 613-622.

Zhang, G.H., Q. Su, L.J. An and S. Wu (2008). Characterization and expression of a vacuolar antiporter gene from the monocot halophyte *Aeluropus littoralis*. Plant Physiol. Biochem. 46:117-126.

تقييم بعض هجن الذرة الشامية تحت ظروف مختلفة من الملوحة

مجاهد احمد حلمى مجاهد – ايمان انور ابراهيم محمد – رشا يوسف سيد عبد الخالق

قسم بحوث تكنولوجيا البذور – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية – جيزة

إن تقييم صفات جودة هجن الذرة الشامية لمقاومة الملوحة يعتبر هدف هام فى برامج التربية. وقد اجريت هذه الدراسة بقسم بحوث تكنولوجيا البذور لدراسة تأثير الملوحة على انبات البذور ونمو البادرات فى خمسة هجن هى: (هجين فردى ١٠، هجين فردى ١٢٣، هجين ثلاثى ٣١٤، هجين ثلاثى ٣٢٠، هجين ثلاثى ٣٢٤). وتم معاملة حبوب الذرة بواسطة اربعة تركيزات من كلوريد الصوديوم ، كلوريد الكالسيوم ، ومخلوط منهما بنسبة ١:١ وهى (٢٠٠٠، ٤٠٠٠، ٦٠٠٠، ٨٠٠٠ جزء فى المليون) بالاضافة الى معاملة المقارنة.

تم تقدير حيوية الحبوب وصفات البادرة وحيوية البادرة وكذلك التفريد الكهربى للبروتينات باستخدام SDS-PAGE . وقد اشارت النتائج الى ان الهجين الفردى ١٠ اعطى اعلى نسبة انبات ودليل حيوية البادرة والعد الاول وطول الريشة والجذير والوزن الجاف، يليه الهجين الفردى ١٢٣ . اطول جذير كان فى الهجين الفردى ١٢٣ بينما اقل طول جذير كان فى الهجين الثلاثى ٣٢٠.

اشارت نتائج التفريد الكهربى للبروتين الى وجود اختلافات بين هذه الهجن فى عدد ومواقع الحزم البروتينية فى كل معاملة. تم الحصول على ثلاثة معلمات جزيئية بالمعاملة بواسطة كلوريد الكالسيوم عند الاوزان الجزيئية ٩٥ كيلو دالتون (٤٠٠٠ جزء فى المليون) فى كل الهجن ما عدا الهجين الفردى ١٢٣. اما الثانية كانت عند الوزن الجزيئى ٣٠ كيلو دالتون (٨٠٠٠ جزء فى المليون) وظهرت فى كل الهجن عند ١٥ كيلو دالتون عند التركيزات ٦٠٠٠،٨٠٠٠ جزء فى المليون ما عدا الهجين الفردى ١٠. بينما لوحظ معلم واحد فقط مرتبط بالمعاملة بكلوريد الصوديوم عند وزن جزيئى ٨٥ كيلو دالتون فى الهجين الفردى ١٠.

من النتائج المتحصل عليها يمكن القول ان كلا الملحين ادى الى نقص فى الصفات المدروسة بزيادة تركيز الملح ولكن كلوريد الصوديوم اعطى قيم اعلى من كلوريد الكالسيوم وتشير النتائج الى ان الهجين الفردى ١٠ اكثر تحملاً للملوحة من الهجين الفردى ١٢٣ والهجين الثلاثى ٣١٢ والهجين الثلاثى ٣٢٤ بينما يعتبر الهجين الثلاثى ٣٢٠ حساس للملوحة.

لذا فأن التفهم الافضل للاستجابة الفسيولوجية لظروف الاجهاد الملحى ربما تساعد فى برامج التربية والانتخاب لتحمل الملوحة.