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Evaluation of Seed Germinability and Field Emergence Of Some Maize (*Zea mays,* L.) Hybrids Under Salinity Stress Conditions

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ABSTRACT

Laboratory and field emergence under greenhouse experiments were designed to evaluate the germinability and field emergence of eight maize hybrids, i.e.; maize hybrids single white (Pioneer 30K8, Giza 130 and Hi Tech 2031), maize hybrid single yellow (Hi Tech 2066), maize hybrids triple white (Giza 310, Giza 321 and Giza 324) and maize hybrid triple yellow (Giza 352) under some levels of salt concentrations induced by sodium hypochlorite NaCl 1% solution, i.e.; (Tap water 320, 1000, 2000, 3000 and 4000 ppm) during 2015 season. The best results of maize hybrids were obtained by Hi Tech 2031 and the depressed values restricted by Giza 352 and Giza 130, respecting of germination indices i.e. G (%), mean germination time (MGT), germination velocity index (GVI), seedling vigor index (SVI); seedling growth indices i.e. plumule length (cm), radical length (cm), seedling fresh and dry weights (g); salinity stress assay i.e. germination stress index (GSI), seedling length stress tolerance index (SLSI), radical length stress tolerance index (RLSI) and proline content; and field emergence. Results also indicated that, all salinity stress levels while compared with control treatment (320 ppm) recorded the lowest values of all previous studied traits and the lowest values were obtained by NaCl level (4000 ppm) . Regarding to the interaction, all maize hybrids under control treatment (320 ppm) recorded the highest values of all traits compared with all salinity stress levels. The best values recorded by Hi Tech 2031, Pioneer 30K8, Hi Tech 2066, Giza 310 and Giza 321 respectively. Giza 352 and Giza 130 recorded the lowest values under all NaCl concentration levels. There were highly significant differences between studied hybrids and salinity treatments and the mean performance for studied characters was discussed.
Keywords: Maize hybrids; salinity stress; NaCl ; germinability ; seedling growth ; field emergence.

INTRODUCTION

Maize (*Zea mays*, L.) crop is ranked the third most important grain under global cultivation after wheat and rice crops. Maize crop performance a substantial functions in the world economy and is valuable ingredient in produced items, that effectiveness a large attribution of the world population (Alvi *et al*., 2003). Maize crop is normally submissive to salt stress (Maas and Hoffman, 1977). The nature of metabolism in maize is C4, also it`s classified as moderately sensitive to salinity especially at germination stage (Cramer, 1994, Katerji *et al*., 1994 and Maas *et al*., 1986). Many previous researches recommended that the germination and seedling emergence stage of plant life period is more critical to salinity stress than the mature stage (Ashraf *et al*., 1986). Effect of salinity at different growth stages were investigated in many cultivated crops, which found that the early seedling growth stage was the most sensitive part in all the crops and deterioration in growth was observed with rising salinity (Shalhevet, 1995). The osmotic adjustment seems to be implicated with the salt tolerance of certain plant genotypes (Richardson and Mccree, 1985). Although, the effects of salinity stress on maize crop, was genotype specific (Zhang and Zhao, 2011).

Salinity is a great major environmental stress which affecting over 800 million hectares of land throughout the world and accounts for more than 6% of the world total land area (Munns and Tester, 2008). Salinity is significant impendence to agriculture and result in the deterioration of the environmental factors. It`s also play critical role of crop loss worldwide, decreasing intermediate yields for most important crop plants by more than 50% (Boyer, 1982). More, limiting plant germination and early seedling stages is water stress brought about by salinity (Almansouri *et al*., 2001), reduced water potential is a common consequence of both salinity (Legocka and Kluk, 2005). Seed germination is one of the most important stage of plant life and substantially affected by salinity (Misra and Dwivedi, 2004). The high concentration of NaCl in the salt solution increases its osmotic potential (Taiz and Zeiger, 2002). Increasing absorption of Na and Cl ions during seed germination stage might cause cell toxicity that lastly lowering the average of germination and thus decreases the germination percentage, furthermore the germination index of all the cultivars reduces with rising salt stress (Carpici *et al*., 2009).

The present paper was to assess the behavior of seed germinability and field emergence of eight maize hybrids under salinity stress induced by five concentrations of NaCl .in laboratory experiment and field emergence under greenhouse condition. Although, to compare the germination ability of hybrids against salt stress to nominate the most salt tolerant maize hybrids under this study.

MATERIALS AND METHODS

Laboratory and field emergence under greenhouse conditions experiments were carried out at Seed Technology Research Unit, Mansoura, Dakahlia Governorate, Seed Technology Research Department, Field Crops Research Institute, Agricultural Research Center during 2015 year. Seed of maize hybrids: single white (Pioneer 30K8, Giza 130 and Hi Tech 2031); hybrid single yellow (Hi Tech 2066); hybrids triple white (Giza 310, Giza 321 and Giza 324) and hybrid triple yellow (Giza 352), were used to evaluate seed germinability, seedling growth parameters, stress measurements and field emergence under different salinity stress levels induced by sodium hypochlorite (1%) solution ; i.e. Tap water (320 ppm), 1000, 2000, 3000 and 4000 ppm to examine a range of genetic variability for salinity tolerance among the studied hybrids maize. 25 seeds were placed on filter papers located in 15cm diameter sterile Petri dishes which contained four concentrations of 15ml NaCl in addition to control (15ml of distilled water) treatment. Dishes were kept under controlled conditions (25 ± 1°C and 80% humidity) for seven days. Dishes were irrigated with 15ml solutions of the respective treatments daily. Filter papers were changed after 48h to avoid salt accumulation.

Experiments Design

Concerning laboratory, the treatments were arranged in Factorial Design in Randomize Complete Block Design (RCBD) with three replicates .

Table 1. Studied hybrids type and seed source:

No.	Cultivar name	Hybrid type	Source
1	Pioneer 30K8	Hybrids single white	Privet sector
2	Giza 130		Central Administration for Seed Production (CASP)
3	Hi Tech 2031		Privet sector
4	Hi Tech 2066	Hybrid single yellow	
5	Giza 310	Hybrids triple white	Central Administration for Seed Production (CASP)
6	Giza 321		
7	Giza 324		
8	Giza 352	Hybrid triple yellow	

The Studied Traits:-

Germinability measurements:

By the end of the 7th day, germination measurements were estimated.

Germination percentage:

Was measured by counting only normal seedling seven days after planting according to ISTA (1999).

Germination percentage= Number of normal seedlings / Number of total planting seeds x 100.

Mean germination time (MGT):

Was measured by using the following equation (Ellis and Roberts, 1981).

MGT= Σ Dn/Σn, where n is seeds number which were germinated on day time, D is days number which counted from the beginning of the germination test.

Germination Velocity Index (GVI): Germination velocity index was calculated according to Maguire (1962).

GVI= $G_1/N_1 + G_2/N_2 +\cdots+ G_n/N_n$ where G_1, G_2 and G_n were the number of germinated seeds in first, second…..and last count. N_1, N_2 and Nn were the number of sowing days at the first, second…….and last count.

Seedling Vigor Index (SVI): was measured according to Abdul-Baki and Anderson (1970).

SVI = G% × seedling dry weight

Plumule and Radical length (cm): Ten normal seedlings taken randomly per each replicate to evaluate the plumule and radical length at the end of standard germination test.

Seedling fresh and dry weight: Ten seedling were taken at random per each replicate to estimate fresh weight and expressed in milligram (mg), while seedling dry weight were evaluated after oven drying at 70º C until constant weight (Agrawal, 1986).

Proline content: 200 mg of leaf samples were grind in liquid nitrogen and homogenized with 5 ml sulphosalcylic acid. Then 2 ml acid ninhydrine and 2 ml glacial acetic acid were added to the extract. The samples were heated at 100 °C. After that mixture was extracted with toluene and the free toluene was quantified spectrophotometrically at 520 nm (Bates *et al*., 1973).

Stress Measurements

Germination stress index (GSI): Germination stress index was measured according to Bouslama and Schapaugh (1984).

GSI % = (PISS) / (PICS) × 100

PISS is the promptness index of stressed seeds, PICS is the promptness index of control seeds.

PI = nd2 (1.0) + nd4 (0.8) + nd6 (0.6) + nd8 (0.4) + nd10 (0.2)

nd2, nd4, nd6, nd8 and nd10 were represent number of germinated seeds in second, forth, sixth, eighth and tenth days after sowing, respectively.

Shoot length stress tolerance index (SLSI):

SLSI = Shoot length of stressed plants / Shoot length of control plants × 100

Root length stress tolerance index (RLSI):

RLSI = Root length of stressed plants / Root length of control plants × 100

SLSI and RLSI were calculated according to Wilkins (1957).

Field Emergence

The impact of salt stress induced by levels of NaCl namely; Tap water (320 ppm), 1000, 2000, 3000 and 4000 ppm on seedling field emergence of eight maize hybrids were studied. Factorial experiment in Completely Randomized Design (FCRD) with six replications for each hybrid and salinity level was used to perform this investigation. Field emergence experiment was performed under greenhouse conditions with average temperature 26±6 °C and 80% humidity, plastic pots of 25cm diameter were filled with 5kg of air dried loamy soil and sterilized by sodium hypochlorite (1%) solution. Maize hybrids seeds were sown at the rate of 25 seeds/pot. Seeds were sown at the depth of 3cm. Irrigation was applied when ever required, data regarding seedling emergence were recorded up to the 10 days of sowing and the plants were harvested after 15 days of germination. Seedling emergence was measured according to the method outlined in the rules for seed testing (ISTA, 1999).

Statistical Analysis

Data were exposed to the proper statistical analysis of variance (ANOVA) of a randomized complete block design (Gomez and Gomez, 1984). LSD at 0.05% level of significance was used to compare among means of different variables.

RESULTS AND DISCUSSIONS

HYBRIDS AND SALINITY STRESS EFFECTS

Table 1, showed the main effects of the eight tested maize hybrids and the salinity concentrations levels induced by NaCl on seed germinability under lab. condition; i.e. Germination percentage (G%), mean germination time (MGT), germination velocity index (GVI) and seedling vigor index (SVI) during 2015 year. Results observed highly significant differences between maize hybrids under study. The Hi Tech 2031 hybrid recorded the highest mean values, while compared with other maize hybrids. The lowest values of G.%, GVI and SVI recorded by Giza 352 and Giza 130 regarding to MGT trait. Our results in agreement with Mohammed *et al*. (2014), they founded that white grain cultivar is more vigorous than the yellow grain cultivar of two tested maize cultivars. The effects of salinity stress on maize growth attributes, were genotype specific (Richardson and Mccree, 1985 and Zhang and Zhao, 2011).

The main effects of salinity stress concentration induced by NaCl on germinability measurements presented also in Table 1, and showed that, all traits significantly affected with increasing concentration of NaCl. The highest values of G. (%), MGT, GVI and SVI were recorded by Control (320 ppm) and the lowest values reserved to salinity level (4000 ppm). Increasing salinity stress levels strongly affected all studied parameters. In agreements with our results, Carpici *et al*. (2009) indicated that the germination indices of all the cultivars reduced with enhancing salt stress (Cramer, 1994, Jamil *et al*., 2006 and Sholi, 2012).

Table 1. Averages of germination (%), mean germination time (MGT), germination velocity index (GVI) and seedling vigor index (SVI) as affected by the studied maize hybrids and salinity stress levels.

Treatments \ Traits	G %	MGT (day)	GVI	SVI
A. Maize Hybrids				
Pioneer 30K8	75	4.1	5.2	2.2
Giza 130	70	4.7	4.5	1.8
Hi Tech 2031	80	4.1	5.7	2.9
Hi Tech 2066	79	4.3	5.3	2.4
Giza 310	78	4.3	5.3	2.3
Giza 321	71	4.4	5.0	2.1
Giza 324	74	4.4	5.1	2.3
Giza 352	61	4.65	4.2	1.5
L.S.D at 0.05	1.2	0.08	0.05	0.03
B. Salinity stress levels				
Control (320 ppm)	86	3.9	6.4	3.3
1000 ppm	84	4.1	5.9	2.8
2000 ppm	74	4.3	5.0	2.1
3000 ppm	64	4.6	4.0	1.5
4000 ppm	59	4.8	3.8	1.2
LSD at 0.05	1.0	0.05	0.02	0.02

More, salt stress induced by NaCl affects germination in two ways; (1) high salt levels in the medium may decrease the osmotic potential which prevent or inhibit the uptake of necessary water for mobilization of nutrient required for germination; (2) the salt constituents or ions may be toxic to the embryo (Gholamin and Khayatnezhad, 2010 and Khayatnezhad *et al*., 2010). Germination was directly related to the amount of water absorbed and delay in germination due to the salt concentration of the medium (Rahman *et al*., 2000). High concentration of NaCl in the salt solution increases absorption of Na and Cl ions and led to push up osmotic potential during seed germination which causes cell toxicity that finally prevent or slows germination rate and consequently reducing the percent of germination (Taiz and Zeiger, 2002). Finally, the rate of germination had the most substantial effect on stand establishment and plant density under laboratory and greenhouse conditions (Farsiani and Ghobadi, 2009 and Khayatnezhad *et al*., 2010). Moreover, Khodarahmpour *et al*. (2012) found that salt stress significantly reduce germination percentage, germination rate, mean germination time, and seed vigor as respect of 8 hybrids of maize.

Examination of variance in Table 2, showed seedling growth parameters and detected that, Hi Tech 2031 recorded the highest values of all seedling growth parameters; i.e. plumule length, radical length, seedling fresh and dry weights against the other hybrids. More, Giza 352 recorded the lowest values of (Plumule length, radical length and seedling fresh weight) and the lowest value of seedling dry weight reserved to Giza 130.

Cramer (1994) reported that, seedling growth stage appears to be more sensitive than the other growing stages. These results in accordance with Mohammed *et al*. (2014), they founded that white grain cultivar is more vigorous than the yellow grain cultivar of two tested maize cultivars. More, Khodarahmpour *et al*. (2012) studied the response of eight maize hybrids against five different salinity levels (0, 60, 120, 180 and 240 mM) and found that a worthy inter-genotypic variation was spotted under salt stress.

Table 2, also showed the readings of seedling growth parameters. Control treatment is the best level of NaCl concentration in plumule length, radicle length, seedling fresh and dry weights while compared with increased NaCl levels. Salt stress adversely affected the germination percentage, germination rate, mean germination time, length of radical, plumule, seedling fresh and dry weight and seed vigor of 8 hybrids of maize (Khodarahmpour *et al*., 2012). A significant variation in salt tolerance was also observed between all the studied hybrids. Similar data were obtained Shi-yang *et al*. (2010). These results are in agreement with many previous researches (Cramer *et al*., 1994, Hussein *et al*., 2007, Khayatnezhad *et al*., 2010 and Ibne Hoque *et al*., 2014).

Table 2. Averages of plumule length (cm), radical length (cm), seedling fresh and dry weights (g) as affected by maize hybrids and salinity stress levels.

Traits / Treatments	Plumule length (cm)	Radical length (cm)	Seedling fresh weight (g)	Seedling dry weight (g)
A. Maize Hybrids				
Pioneer 30K8	16.2	13.0	2.2	0.358
Giza 130	14.3	10.6	1.9	0.323
Hi Tech 2031	18.4	15.1	2.5	0.500
Hi Tech 2066	16.2	13.4	2.1	0.423
Giza 310	15.7	13.1	2.1	0.373
Giza 321	15.0	12.5	2.0	0.390
Giza 324	16.0	12.6	2.0	0.394
Giza 352	14.0	10.0	1.8	0.334
LSD at 0.05	0.2	0.14	0.15	0.006
B. Salinity stress levels				
Control (320 ppm)	20.3	15.9	2.5	0.507
1000 ppm	19.0	14.4	2.5	0.451
2000 ppm	15.7	12.1	2.2	0.368
3000 ppm	12.7	10.5	1.8	0.322
4000 ppm	10.9	10.0	1.4	0.286
LSD at 0.05	0.1	0.13	0.13	0.005

Table 3, showed stress measurements of maize hybrids. Results recorded, values of GSI not significant between Pioneer 30K8 and Hi Tech 2031, Hi Tech 2031 and Giza 310, Giza 310, Hi Tech 2066 and Giza 321, while values of all hybrids were significant against Giza 352. Regarding SLSI values, no significant increase were obtained between Pioneer 30K8 and Giza 321, Giza 321, Giza 324, Hi Tech 2031 and Giza 310 and between Giza 352 and Giza 130, otherwise all hybrids recorded significant values against Giza 130=72.60. Respecting to RLSI, the highest values reversed to Hi Tech 2031=81.40, while the lowest values (75.3 and 75.1) were recorded by Giza 352and Hi Tech 2066 respectively. Early researches founded that white grain cultivar is more vigorous than the yellow grain cultivar (Mohammed *et al*., 2014). More that, a significant inter-genotype variation was observed under salt stress (Khodarahmpour *et al*., 2012). Salt tolerance index of cultivars at the early seedling growth also indicated a large genotipic variation (Akram *et al*., 2007).

As shown in Table 3, salinity stress caused by NaCl increasing the amount of salt treatments from (320 ppm to 4000 ppm) caused significant decrease in all traits of stressful seedling growth (GSI, SLSI and RLSI). Control treatment at (320 ppm) indicated the best values, while salinity level (4000 ppm) recorded the most reduction of all characters. Taiz and Zeiger (2002) reported that salinity stress decrease germination rate and led to reducing the germination percentage. Cramer *et al*. (1994) and Hussein *et al*. (2007) founded a negative relationship between vegetative growth traits and enhancing salinity levels.

Table 3. Averages of germination stress index (GSI), seedling length stress tolerance index (SLSI) and radical length stress tolerance index (RLSI) as affected by studied maize hybrids and salinity stress levels.

Traits / Treatments	GSI	SLS1	RLS1
A. Maize Hybrids			
Pioneer 30K8	81.0	79.6	76.8
Giza 130	76.9	72.6	78.2
Hi Tech 2031	80.4	77.1	81.4
Hi Tech 2066	78.4	75.0	75.1
Giza 310	79.4	77.1	76.6
Giza 321	78.1	78.2	77.4
Giza 324	77.0	78.0	78.0
Giza 352	72.3	73.6	75.3
LSD at 0.05	1.4	1.5	1.2
B. Salinity stress levels			
Control (320 ppm)	97.2	96.9	96.5
1000 ppm	91.1	92.4	90.1
2000 ppm	77.1	77.2	76.2
3000 ppm	65.1	62.8	65.9
4000 ppm	59.2	52.8	58.0
LSD at 0.05	1.0	1.0	0.8

Table 4, indicated that the main effect of maize hybrids on proline content and field emergence, data showed that Hi Tech 2031 hybrid recorded the best tolerance to all NaCl concentrations followed by other hybrids, more, Giza 352 and Giza 130 were the most sensitive hybrids to NaCl salinity. The superiority of Hi Tech 2031 may be attributed to it is genetic make up to ability to gave the highest yield components led to raising grain yield/fed. Concerning proline content, Jiping and Kang Zhu (1997) reported that Arabidopsis mutant sensitive to salt stress had a higher content of proline compared to the less sensitive control.

Moreover, results showed positive relationship between increasing NaCl concentration and proline content, where 4000 ppm treatment recorded the highest values compared with the lower NaCl levels and the lowest values reserved to control (320 ppm). The proline accumulation under stress conditions protects the cell by balancing the osmotic pressure of cytosol with that of vacuole and external environment (Gadallah, 1999). Proline play a critical role as enzyme stabilizing agent under NaCl salinity stress (Demir and Kocacaliskan, 2001). During salinity stress course, active soluble accumulation of osmotic solutes such as proline is seems to be an effective stress tolerance mechanism. The adaptability of plant species to high salt concentrations in soil by lowing tissue osmotic potential was accompanied by accumulation of these osmotic solutes (proline) as suggested by Zhu (2002). Moreover, proline may interact with cellular macromolecules such as enzymes and stabilize the structure and function of such macromolecules (Smirnoff and Cumes, 1989).

Table 4. Proline content and field emergence as affected by maize hybrids and salinity stress levels.

Traits / Treatments	Proline content	Field Emergence%
A. Maize Hybrids		
Pioneer 30K8	1.876	74
Giza 130	2.490	71
Hi Tech 2031	1.763	79
Hi Tech 2066	2.380	77
Giza 310	2.114	75
Giza 321	2.070	74
Giza 324	2.120	76
Giza 352	2.727	64
LSD at 0.05	0.083	2.0
B. Salinity stress levels		
Control (320 ppm)	0.649	88
1000 ppm	0.972	82
2000 ppm	1.586	74
3000 ppm	3.432	65
4000 ppm	4.323	60
LSD at 0.05	0.250	1.0

Regarding to field emergence readings as shown in Table 4, salinity stress level 320 ppm (control) recorded the highest values of field emergence (88%) against the other NaCl concentrations and 4000 ppm recorded the lowest reduction (60%). The same findings recorded by Khodarahmpour *et al*. (2012), they found germination percentage and germination rate were linearly reduced by lowering in osmotic potential of NaCl solution, while the maximum rate of germination and percentage were obtained at zero level of applied salts. The decrease of germination rate at high salt concentrations might be fundamentally due to osmotic stress (Heenan *et al*., 1988).

Interaction Effects

Analysis of variance presented that the interaction effects between maize hybrids and salinity stress caused by NaCl on germinability parameters under lab. experiment (G%, MGT, GVI and SVI) as shown in Table 5, germination assay characters of all hybrids were adversely affected due to the application of NaCl levels (Cont. 320, 1000, 2000, 3000 and 4000 ppm). Data showed that Hi Tech 2031 recorded the greatest values of G% under all NaCl levels except control (320 ppm) treatment, which reserved to Pioneer 30K8 and Giza 310, while the lowest values recorded by Giza 352 with all NaCl levels except control (320 ppm) reserved to Giza 130. Respecting to MGT, Hi Tech 2031 and Pioneer 30K8 were the best hybrids in all salinity levels while Giza 130 and Giza 352 were the worst. Finally, Hi Tech 2031 recorded the best results against Giza 352 which recorded the biggest reduction of GVI and SVI at LSD=0.05 level of probability. Our results in agreement with earlier studies which reserved to Mohammed *et al*. (2014) regarding to seedling vigorous indices (SVI), they indicated that white grain cultivar is more vigorous than the yellow grain cultivar of two tested maize cultivars. Moreover, salt stress hardly led to decrease all traits of maize hybrids, Our study in agreement with earlier studies on maize (Zahoor *et al*., 2011). More, the reduction of germination vigor at the higher levels of salt might be due to osmotic stress (Heenan *et al*., 1988) and numerous effects on metabolism of plant cell that are able to dissolve due to salt stress (Hussain *et al*., 2010).

The mean germination time was delayed with increasing the levels of NaCl concentrations. A significant inter-genotypic variation was shown under salt stress conditions. More, earlier studies by Ibne Hoque *et al*. (2014) and Khodarahmpour *et al*. (2012) found that germination percentage (GP), germination index (GI) and seed vigor index (SVI) were all decreased as the level of NaCl was increased

Table 5. Germination (%), mean germination time (MGT), germination velocity index (GVI) and seedling vigor index (SVI) as affected by the interaction between maize hybrids and salinity stress levels.

Traits / Treatments	Germination (%)					MGT					GVI					SVI				
	Cont	1000	2000	3000	4000	Cont	1000	2000	3000	4000	Cont	1000	2000	3000	4000	Cont	1000	2000	3000	4000
Pioneer 30K8	89	85	71	66	63	3.9	3.9	4.0	4.3	4.5	6.4	6.2	4.9	4.5	3.9	3.32	2.91	2.06	1.66	1.28
Giza 130	83	79	71	63	55	4.3	4.4	4.7	4.9	5.0	5.9	5.3	4.5	3.3	3.2	2.95	2.37	1.66	1.26	0.94
Hi Tech 2031	87	89	83	72	71	3.6	3.8	4.2	4.4	4.5	7.0	6.8	5.6	4.7	4.4	4.01	3.79	2.84	1.98	1.68
Hi Tech 2066	88	87	76	72	68	4.0	4.2	4.3	4.5	4.7	6.6	6.0	5.2	4.4	4.4	3.76	3.07	2.23	1.69	1.43
Giza 310	89	88	82	69	62	3.8	3.8	4.3	4.5	4.8	6.6	6.3	5.1	4.3	4.3	3.39	3.08	2.36	1.58	1.22
Giza 321	88	83	72	61	53	3.9	4.2	4.3	4.6	5.0	6.4	5.8	5.4	3.8	3.7	3.27	2.75	1.93	1.35	1.06
Giza 324	86	87	81	63	54	3.8	3.9	4.4	4.6	5.2	6.7	6.2	5.3	4.0	3.4	3.46	2.95	2.29	1.53	1.04
Giza 352	81	73	57	49	47	3.8	4.4	4.6	5.0	5.3	5.8	4.7	4.0	3.3	3.1	2.48	1.93	1.30	0.95	0.69
L.S.D at 0.05			2.8					0.14					0.07					0.1		

Table 6, showed stress assay traits; GSI%, SLSI and RLSI of maize hybrids in different salinity stress levels. Results indicated that, raising level of NaCl concentration lead to decrease values of all traits, and the most reduction was induced by salt stress level (4000 ppm), on the other hand 320 ppm recorded the best values. The impacts of salinity on plants might be due to osmotic stress, ion imbalance and cell toxicity. More, osmotic effects are due to salt-induced decrease in the soil water potential (Munns and Tester, 2008). Cramer *et al*. (1994) and Hussein *et al*. (2007) reported that, vegetative growth parameters decreased with increasing salinity stress concentrations. The salt tolerance index of cultivars at the early stage also showed a large genotipic variation as indicated by Akram *et al*. (2007). Confirming the finding from previous researches that growth of maize is highly sensitive to salt stress (Rodriguez *et al*., 2004 and Schmidhalter *et al*., 1998).

Table 7, showed that the interaction between maize hybrids and salt stress had highly significant effect on proline content and field emergence. Increasing salinity concentrations led to enhancing proline content in all maize hybrids. More, Hi Tech 2031 with NaCl level at control (320 ppm) recorded the lowest values of proline content against the rest of all interaction values and the most increase reserved to Giza 352 at 4000 ppm treatment.

Table 6. Germination stress index (GSI %), seedling length stress tolerance index (SLSI) and radical length stress tolerance index (RLSI) as affected by the interaction between maize hybrids and salinity stress levels.

Traits / Treatments	(GSI %)					(SLSI)					(RLSI)				
	Cont.	1000	2000	3000	4000	Cont.	1000	2000	3000	4000	Cont.	1000	2000	3000	4000
Pioneer 30K8	99	99	76	73	60	98	97	78	65	58	98	88	77	63	56
Giza 130	99	88	76	64	55	97	88	69	59	48.	96	93	76	67	58
Hi Tech 2031	98	94	79	67	63	96	92	81	63	51	98	94	80	72	61
Hi Tech 2066	97	89	76	65	63	96	90	76	60	51	96	85	74	61	58
Giza 310	96	94	76	65	64	96	94	79	61	54	96	93	74	63	55
Giza 321	96	90	83	61	58	96	94	79	64	56	95	91	76	65	58
Giza 324	96	93	79	61	54	96	94	80	66	52	96	89	77	66	61
Giza 352	93	82	69	62	54	96	87	72	62	49	95	84	73	68	54
LSD at 0.05			2.8					3.0					2.4		

Table 7. Proline content and field emergence% as affected by the interaction between maize hybrids and salinity stress levels.

Traits / Treatments	Proline content µmol/g FW					Field emergence%				
	Cont.	1000	2000	3000	4000	Cont.	1000	2000	3000	4000
Pioneer 30K8	0.535	0.709	1.124	3.075	3.936	85	82	74	66	63
Giza 130	0.711	1.205	2.225	3.596	4.713	86	80	71	63	54
Hi Tech 2031	0.513	0.657	1.005	2.872	3.768	86	87	82	70	69
Hi Tech 2066	0.746	1.115	1.822	3.665	4.550	92	85	73	70	66
Giza 310	0.646	0.995	1.278	3.557	4.095	90	85	82	64	58
Giza 321	0.587	0.926	1.333	3.358	4.144	90	80	73	66	59
Giza 324	0.639	0.884	1.418	3.458	4.202	92	85	77	66	58
Giza 352	0.815	1.282	2.485	3.875	5.176	84	70	62	55	49
LSD at 0.05			0.235				1.24			

Our results in agreement with Thomas *et al.* (1992), they reported that proline content increases under salinity stress up to 100 times the normal level, which makes up to 80% of the total amino acid pool. An increment in the proline content was observed during high salinity conditions (Kholova *et al*., 2009 and Radyukina *et al*., 2011). Regarding field emergence, Hi Tech 2031 was the most tolerant hybrid under all salinity levels except control (320 ppm) reserved to Hi Tech 2066 and Giza 324. On the other hand, Giza 352 was the most sensitive maize hybrids to salinity stress and recorded the lowest values of germination percentage, these results in agreements with Mohammed *et al*. (2014). The reduction of maize seed growth parameters as a result of increasing salinity levels up to 4000 ppm might be due to that salinity is one of the primary abiotic stresses which adversely affect seed growth and development. The high concentration of NaCl increases the osmotic potential and causes high absorption of Na and Cl ions during seed germination, which causes cell toxicity and inhibits or slows the rate of germination and finally led to decreases the germination percentage (Taiz and Zeiger, 2002). Moreover, the germination assay of all the cultivars decreased with increasing salt stress (Carpici *et al*., 2009) and maize seeds are highly sensitive to salinity stress especially at seedling growth stage. These data are in accordance with those reported by (Munns and Tester, 2008 and Ibne Hoque *et al*., 2014).

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تقييم حيوية التقاوي والانبثاق الحقلي لبعض هجن الذرة الشامية تحت ظروف الملوحة

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أقيمت تجربة معملية وأخري في الأصص تحت ظروف الصوبة الزراعية بوحدة بحوث تكنولوجيا البذور بالمنصورة بهدف تقييم القدرة على الإنبات والانبثاق في الحقل لبعض هجن الذرة الشامية: هجين فردي أبيض (بايونير ٣٠ك٨ ، جيزة ١٣٠، هاي تك ٢٠٣١) ، هجين فردي أصفر (هاي تك ٢٠٦٦) ، هجين ثلاثي أبيض (جيزة ٣١٠ - جيزة ٣٢١ - جيزة ٣٢٤) وهجين ثلاثي أصفر (جيزة ٣٥٢) تحت عدة مستويات مختلفة من الملوحة (كنترول ٣٢٠ - ١٠٠٠ - ٢٠٠٠ - ٣٠٠٠ - ٤٠٠٠ جزء في المليون ملح كلوريد صوديوم/لتر ماء) خلال موسم ٢٠١٥. أشارت النتائج إلي الأتي: اختلاف هجن الذرة الشامية تحت الدراسة في النسبة المئوية للإنبات المعملي، الانبثاق الحقلي، متوسط زمن الانبات، دليل سرعة الانبات، دليل قوة الإنبات، طول الريشة والجذير، الوزن الغض والجاف للبادرات وصفات الاجهاد.أظهرت النتائج أن هجين الذرة (هاي تك ٢٠٣١) كان أكثر الهجن تحملا للملوحة، بينما كان هجين الذرة (جيزة ٣٥٢) و (جيزة ١٣١) الأقل تحملاً للملوحة خلال مرحلة الإنبات ونمو البادرات.أدت زيادة مستوي الملوحة حتى ٤٠٠٠ جزء في المليون الي انخفاض صفات انبات وقوة البادرات، صفات تحمل الملوحة، الانبات الحقلي ونسبة البرولين مقارنة بمعاملة الكنترول (٣٢٠ جزء في المليون) وكانت أقل المتوسطات عند مستوي ٤٠٠٠ جزء في المليون. أثر التفاعل بين هجن الذرة الشامية ومستويات الملوحة تأثيرا معنوياً على جميع الصفات المدروسة. توصي هذه الدراسة بأن هجن الذرة الشامية الفردية سواء كانت هجين فردي ابيض مثل (هاي تك ٢٠٣١ – بايونير ٣٠ك٨) أو هجين فردي أصفر مثل (هاي تك ٢٠٦٦) كانت الأكثر تحملاً لارتفاع مستويات الملوحة حتى ٤٠٠٠ جزء في المليون من بين ثمانية هجن (هجن فردية – هجن ثلاثية) كانت تحت الدراسة وسجلت أفضل انبات ونمو للبادرات تحت ظروف الملوحة خلال مرحلة إنبات البادرات.