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EFFECT OF SALINITY STRESS ON SEED GERMINATION AND SEEDLING GROWTH OF SOME CROPS

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ABSTRACT

The effect of five artificia soil salinity levels (0.2, 0.4, 0.6, 0.8 and 1.0%) on seed germination, fresh and dry weight of seedling and N, P, K, Ca, Mg and Na contents as well as its uptake by cotton, wheat, barley , faba been and tomato seedlings were studied.

The obtained results could be summarized as follows:

- The mean values of germination percentages were progressivity and significantly decreased as the level of salinity was increased. On the contrary of this trend; the calculated mean values of germination time (MGT) were increased with increasing the salinity levels. The highest salinity level used (1.0%), the long time required to complete the germination process. In addition, germination performance index (GPI) was calculated to integrate mean time to germination performance. The highest value of GPI as affected by salinity levels investigated was obtained from crop seeds in low salinity level of 0.2%.
- Increasing the level of salinity from 0.2 to 1.0%, significantly reduced the average values of fresh and dry weight of crop seedlings.

- Total N, P and K % contents in the seedlings of all crops under study were significantly decreased as the level of salinity was increased and the same trend was realized for the uptake of these nutrients by the seedling of these crops.
- Increasing the level of salinity from 0.2, 0.4, 0.6, 0.8 up to 1.0% significantly increased the concentration of Ca, Mg and Na% in the seedling of the investigated crop. Such effect was happened for the uptake of these nutrients by the seedling of all crops.
- From the results mention: the ability of these plants on resistance of salinity stress can be arranged as barley than cotton than wheat than tomato and lastly faba been

Keywords: Salinity stress, Germination, Seedling characters, field crops.

INTRODUCTION

Soil salinity may affect the germination of seeds either by creating osmotic potential external to seeds preventing water uptake or through the toxic effects of Na^+ and Cl^- ions on germination seeds. (Khajeh-Hossini *et al*. 2003)

The seeds require higher amount of water uptake during the germination under the salt stress due to the accumulation of the soluble solutes around the seeds, which increases the osmotic pressure. This causes excessive uptake of the ions which results in toxicity in the plant. Moreover, water potential gradient (reduced water availability) between the external environment and the seeds also inhibits the primary root emergence. (Delachiave and Dc Pinho, 2003)

The main reason for germination failure was the inhibition of seed water uptake due to a high salt concentration. They determined that seed germination and seedling growth reduced in saline soils with varying responses for cultivars. NaCl affected seed germination by creating an external osmotic potential preventing water uptake. (Mehmet *et al,* 2006)

Fresh and dry weights of root and shoot were decreased with increasing salinity levels. In addition to inhibition of germination and early seedling growth stages also may be sensitive to salinity. It has been reported that soluble salts at high salinity levels significantly suppressed growth in different crop plants. The decrease in the ultimate germination in the present study, may be due to the combined effect of osmotic pressure and toxicity of salts or due to the effect of added Cl^- ions. (Al-Moaikal, 2006), (Siddiqui *et al,* 2008) and (Siddiqui *et al.,* 2009)

Using the lowest salinity levels (1500 and 3000 ppm) had a beneficial effect on some plant traits, as they increased plant height, number of leaves/plant, fresh and dry weights of compound leaves, root length and fresh and dry weights of roots as well as stem diameter with only 3000 ppm of saline water. The contrary action was detected due to increasing salinity levels to 4500 and 6000 ppm. (El-Khateeb , *et al*. 2010)

The effect of NaCI, CaCl and their combinations on germination and early seedling growth stages of *Capsicum annuum* L, were studied. Results indicated that significant increases were recorded in percentage of germination (GP), germination performance index (GPI), as well as seedling fresh and dry weights. Increasing salt concentration in nutrient cooper solution caused significant decrease in all of these parameters. (Arafa *et al.*, 2010)

As for the effect of salinity levels on the chemical composition of plants; El-Arqan *et al.*, (2002) reported that, nutrient uptake (N, P and K) were significantly decreased by increasing soil salinity levels. This indicated that excessive concentration of Na and Cl ions in the growth media has an inhibitory effect on the uptake and possibly also the translocation process of essential nutrients in sugar beet.

Sodium chloride at 5 dSm^{-1} reduced significantly nitrogen, phosphorous, potassium, calcium, magnesium, yield and its components of *Bisum sativym* L.. Nitrogen and protein percentage total sugars, phosphorous and potassium percentage in seeds were increased with low salinity level, and in most cases, moderate and high NaC1 salinity levels decreased all mentioned characters. (Farouk 2005)

This investigation was carrid out to study the effect of different salinity levels on the germination and early seedlings growth as well as the chemical composition of the seedlings of some major field crops.

MATERIALS AND METHODS

A pot experiment was carried out under the green house conditions of El-Mansoura laboratory for Plant nutrition; Agric. Res. Center; Dakahlia Governorate during the successive winter season of 2009 to evaluate the effects artificial of salinity levels; 0.2, 0.4, 0.6, 0.8 and 1.0% on seeds germination of cotton, wheat, barley, faba bean and tomato crops and its effects on chemical composition and dry matter yield of these plants.

Factorial randomized complete block design was followed in this study. Each treatment was replicated three times. 75 polyethylene pots; 35 cm depth and 30 cm width were used. Each pot was uniformly filled with 15 kg of a disturbed clayey non-saline soil on dry weight bases. The experimental soil was taken from the surface layer (0-30 cm) of a special farm near El-Mansoura city and analyzed for some physico – chemical properties as shown in Table 1.

Table 1: Some physical and chemical properties of the experimental soil

Physical analysis							
C.Sands %	**F.Sands %**	**Silt %**	**Clay %**	**T. Class**	**O.M. %**	**$CaCO_3$ %**	**S.P. %**
2.85	20.53	25.16	51.46	Clayey	1.89	2.09	73
Chemical analysis							
Avail. ppm					**EC. dSm^{-1}**		**pH**
N		**P**	**K**		Soil paste	1:5s.e.	1:2.5s.e.
49.2		5.6	337.0		3.12	0.60	7.79

Raw salt crust was obtained from El-Max Saline Co.; Alexandria pulverized and analyzed for chemical and salt composition as shown in Table 2 (A and B)

The potted non - saline soils were artificially salinized by dissolving a calculated amount of the salt crust (was dissolved) in a volume of tap water equivalent to soil field capacity to obtain the desiderated level of salinity. The initial salinity of the experimental soil of (0.2%) was put in consideration; thus the treatments of salinity were: 0.2 (control), 0.4, 0.6, 0.8 and 1.0%

Table 2: Chemical and salt composition of the salt curst.

A- Ions meq./100g. salt							
K^+	**Na^+**	**Mg^{++}**	**Ca^{++}**	**CO_3^{--}**	**HCO_3^-**	**Cl^-**	**SO_4^{--}**
1.71	1516.64	23.00	15.94	__	3.95	1400.00	153.34
B- g./100g. Salt (oven-dry basis)							
NaCl	**$NaSO_4$**	**$MgSO_4$**	**K_2SO_4**	**$CaSO_4$**	**$Ca(HCO_3)_2$**	**Impurities**	
81.9	8.28	1.38	0.15	0.82	0.32	7.15	

Twenty seeds of Giza 86 cotton varity (*Gossypium barbadense* L.), wheat (*Triticum aestivum* L.) , barley (*Hordeum vulgare* L.) faba bean (*Vicia faba* L.) and tomato (*Solanum lycopersicum* L.) were sown on 15 March for cotton seeds and 1st November for the other crops . Germinated crop seeds were counted periodically every 2 days after one week from the beginning of planting. The counting was continued through the first four weeks after planting. After the development of seeds, soil moisture was kept at field capacity till the end of experiment. All other practical cultural processes were carried out as recommended by the Ministry of Agricultures and Soil Reclamation for these crops.

- Germination percentage (GP%) was measured according to the ISTA rules (ISTA; 1999)

- Mean time to germination in day (MGT) was calculated according to the formula MGT= ∑ nd /N ; where n is the number of germinated seed on each day, d the number of days from the beginning of the test , and N the total number of germinated seeds (Edwars and Sundstrom; 1987)
- Germination performance index (GPI) was calculated according to the formula GPI= GP/MGT where GP is germination percentage and MGT is mean time to germination in days (Pill and Fieldhouse, 1982)

After 45 days from sowing, representative samples from each treatment were collected, cleaned thoroughly and fresh weight was weight. Seedlings of the plants were oven dried tell constant, then dry matter yield was calculated in expression of $gplant^{-1}$

The oven dry plant samples were ground and wet digested by sulphuric-prechloric acid mixture as described by (Peterburgski 1968).

Total N% was determined according to the methods described by Pregle (1945); using micro-Kjeldahl.

Total P % was estimated calorimetrically using the chlorostannus- reduce molybdo phosphoric blue color method in sulphuric acid system as described by Jackson (1967).

Na and K % were determined in the digested plant materials using a flame photometer according to Black (1965).

Total Ca and Mg % were measured in the digested plant samples using an Atomic Absorption Spectro Photometer according to (Chapman *et al.*,1961).

Mechanical analysis was determined following the International pipette method (Kilmer; and Alexander, 1949) using NH_4OH as a dispersing agent.

Calcium carbonate; was determined using Collin`s calcimeter method as described by Piper,(1950) .

Organic matter content; was determined using Walkely`s rapid titration method according to Jackson, (1967).

The electrical conductivities of the 1:5 and soil paste extracts were measured by EC meter according to the method of US. Salinity Lab. (1954)

Soil reaction (pH); was measured in 1: 2.5 soil water suspension as described by Jackson (1967).

Available N; was measured using the conventional method of Kjeldahl as described by Bremner and Mulvaby (1982).

Available P; extracted with (0.5 M) Na HCO3 at adjusted pH of 8.5 and was determined at a wavelength 880 nm. By spectrophotometer as described by Olsen and Sommers (1982).

Available K; was determined by using flam photometer according to Black(1965)

The statistical Analyses of the collected data were done according to the methods which described by (Gomez and Gomez 1984) using LSD to compare the means of treatment values.

RESULTS AND DISCUSSION

Germination is important stage in the life cycle of crop plants, particularly in saline soils as it determines the degree of crop establishment. Salinity has toxic effect on germination seeds and excessive salt hinders seeds from water uptake during germination.

Germination Behavior:

Response of seed germination and seedling growth of five crops; cotton, wheat, barley, faba bean and tomato are presented in Table3. Data in Table 3 indicate the mean values of germination percentage (GI%) and its reflection on the calculated values of mean time to germination in days (MGT) and germination performance index (GPI) as well as fresh and dry weight of seedlings g/plant as influenced by the levels of salinity 0.2, 0.4, 0.6, 0.8 and 1.0%.

Table (3): Effect of salinity levels on germination percentage (GI %), mean time to germination in days (MGT), germination performance index (GPI), fresh (F.W.) and dry weight (D.W.) on cotton, wheat, barley, faba been and tomato

Char. / Treat.	GP%	MGT	GPI	F.W	D.W
Cotton					
%0.2	90.98	1.12	81.23	21.05	0.88
%0.4	86.92	1.24	70.09	16.32	0.69
%0.6	70.40	1.49	47.25	13.21	0.56
%0.8	41.56	1.41	29.48	10.02	0.42
%1.0	9.42	1.87	17.65	7.85	0.33
L.S.D0.05	9.85	0.47	2.33	3.41	0.08
Wheat					
%0.2	89.52	1.15	77.84	18.55	0.81
%0.4	85.27	1.27	67.14	14.50	0.63
%0.6	67.86	1.58	42.95	11.63	0.51
%0.8	38.75	1.54	25.16	8.75	0.38
%1.0	4.25	3.61	15.33	6.92	0.30
L.S.D0.05	3.18	0.09	3.49	2.21	0.08
Barley					
%0.2	92.43	1.11	83.27	23.12	0.93
%0.4	88.61	1.24	71.45	17.94	0.72
%0.6	72.9	1.45	50.28	14.94	0.60
%0.8	47.34	1.43	33.10	11.28	0.45
%1.0	15.63	1.54	24.10	9.07	0.36
L.S.D0.05	3.31	0.06	3.45	3.96	0.1
Faba been					
%0.2	86.64	1.21	71.60	14.53	0.69
%0.4	81.86	1.42	57.65	10.95	0.52
%0.6	49.14	1.74	28.24	8.69	0.41
%0.8	16.07	2.51	6.40	6.22	0.3
%1.0	--	--	--	--	--
L.S.D0.05	3.63	0.06	3.52	2.11	0.07
Tomato					
%0.2	88.09	1.17	75.29	16.97	0.77
%0.4	83.56	1.32	63.30	13.05	0.59
%0.6	65.32	1.67	39.11	10.49	0.48
%0.8	32.91	2.16	15.24	7.66	0.35
%1.0	2.10	3.88	8.14	6.10	0.28
L.S.D0.05	2.85	0.07	3.65	2.61	0.08

It can be observed that the mean values of germination percentage were progressivity and significantly decreased as the level of salinity was increased. On the other words; the highest mean values of GP%; 90.98, 89.52, 92.43, 86.64 and 88.09% for cotton, wheat, barley, faba bean and tomato, respectively were obtained from the seeds germinated under the level of 0.2% while, the lowest values of GP% for all crops under study were realized at salinity level of 1.0%, except for faba bean seeds which did not germinated at this level (1.0%) and recorded the lowest values of GP% at salinity level of 0.8%. On the contrary of this trend; the calculated mean values of germination time (MGT) were increased with increasing the salinity levels gradually. The highest salinity level used (1.0%), the long time required to complete the germination process.

In addition, germination performance index (GPI) was calculated to integrate mean time to germination (MGI) and germination percentage (GP). As shown in Table 3; the greater the GPI, the greater the seed germination performance. The highest value of GPI as affected by salinity levels investigated was obtained from crop seeds in low salinity level of 0.2%.

Seedling characteristics:

Statistical analysis of data in Table 3 indicate that significant differences were obtained between the average values of fresh and dry weights of the studied crop seedlings as affected by salinity levels of 0.2, 0.4, 0.6, 0.8 and 1.0%

Regarding to the effect of salinity levels on the values of fresh weight; g/plant, data in Table 3 reveale that increasing the level of salinity from 0.2 to 1.0% significantly reduced the average values of fresh weight from 21.05 g/plant to 16.32, 13.21, 10.02 and 7.85 for salinity levels of 0.2, 0.4, 0.6, 0.8 and 1.0%, respectively for the seedlings of cotton plants. The same trend was realized for wheat, barley, faba bean and tomato crops.

Concerning the effect of salinity levels on dry weight, data at same Table 3 show that; seedling dry weight of the investigated plants were negatively affected by increasing salinity levels i.e. 0.4, 0.6, 0.8 and 1.0% whereas, the low salinity level (0.2%) was realized the heights level of seedling dry weight. Comparing with the lowest level of salinity the rate of decreases were 21.6, 36.4, 52.3 and 62.5% for cotton, 22.22, 37.04, 53.09 and 62.96% for wheat, 22.58, 35.48, 51.56 and 61.29% for barley, 23.38, 37.66, 54.54 and 63.63% for tomato (for salinity levels of 0.4, 0.6, 0.8 and 1.0% respectively). The rate of decreases for faba bean seedling were 24.64, 40.58 and 56.52% for salinity levels of 0.4, 0.6 and 0.8%

The reduction of the germination percentage and delaying in the onset of germination and poor seedling establishment, specially with increase in NaCl concentrations may be due to creating osmotic potential external to the seeds preventing water uptake or thought the toxic effects of Na^+ and Cl^- ions on germination seeds. Moreover, salinity reduces fresh and dry weight of seedling due to reduce root hair formation by increasing solute concentration in the germination environment.

These results in accordance with those obtained by Mohammadi and Eskandari (2011)**,** Reza *et al.,* (2011), Kaveh *et al*, (2011) and Bahrani and Hagh (2011)

Chemical composition

Data presented in Table 4 show the effect of salinity levels on N, P and K % as well as its uptake in the five plants. The N, P and K concentrations in the seedlings of cotton, wheat, barley, faba been and tomato plants were decreased gradually with increasing salt levels in soil solution. The mean values of N% in cotton plant were 33.17, 20.07, 13.03, 7.20 and 4.10%. The same values of N% decreased wheat to be 32.0, 19.17, 12.27, 6.73, and 4.10%, another decrease happened in barley which the values of N% were accounted to be 34.57, 21.03, 14.33, 8.07 and 5.03% at the salinity levels of 0.2, 0.4, 0.6, 0.8 and 1.0% respectively. The reduction rates of 0.4, 0.6 and 0.8% compared with 0.2% salt level in faba been could be calculated as 43.97, 68.05 and 83.73%, and in tomato as 42.10, 65.63, 82.16 and 90.33% at 0.4, 0.6, 0.8 and 1.0% respectively. P and K% have the same trend of these values. At the same time, the values of N, P and K uptake by the investigated plants were decreased and realized the same trend of its concentrations.

Table 4: Effect of salinity levels on N, P and K uptake and concentration by cotton, wheat, barley , faba been and tomato.

sailniy level	%			mg plant^{-1} uptake Plant		
	N	P	K	N	P	K
			cotton			
0.20%	3.77	0.23	1.92	33.17	2.03	16.9
0.40%	2.91	0.182	1.45	20.07	1.27	10
0.60%	2.33	0.151	1.16	13.03	0.83	6.47
0.80%	1.71	0.109	0.85	7.2	0.47	3.57
1.00%	1.25	0.091	0.61	4.1	0.3	2.03
L.S.D0.05	0.05	0.02	0.1	2.24	0.22	1.35
			Wheat			
0.20%	3.95	0.41	4.15	32	3.33	33.63
0.40%	3.04	0.31	3.12	19.17	1.97	19.63
0.60%	2.4	0.25	2.41	12.27	1.4	12.33
0.80%	1.77	0.18	1.75	6.73	0.63	6.63
1.00%	1.36	0.14	1.33	4.1	0.4	4
L.S.D0.05	0.06	0.23	0.08	2.17	1.43	2.25
			Barley			
0.20%	3.72	0.42	4.07	34.57	3.87	37.87
0.40%	2.91	0.33	3.19	21.03	2.37	22.97
0.60%	2.39	0.27	2.65	14.33	1.63	15.87
0.80%	1.79	0.21	1.98	8.07	0.97	8.93
1.00%	1.40	0.16	1.55	5.03	0.57	5.6
L.S.D0.05	0.83	0.01	0.07	2.43	0.29	2.51
			Faba been			
0.20%	3.21	0.36	2.53	22.13	2.5	17.47
0.40%	2.39	0.27	1.82	12.4	1.37	9.47
0.60%	1.72	0.19	1.29	7.07	0.8	5.3
0.80%	1.19	0.13	0.89	3.60	0.4	2.67
1.00%	--	--	--	--	--	--
L.S.D0.05	0.04	0.01	0.06	1.81	0.2	1.69
			Tomato			
0.20%	4.66	0.49	4.31	35.87	3.77	33.47
0.40%	3.52	0.38	3.29	20.77	2.2	19.43
0.60%	2.57	0.21	2.45	12.33	1.03	11.77
0.80%	1.83	0.19	1.70	6.40	0.7	5.9
1.00%	1.24	0.13	1.13	3.47	0.33	3.17
L.S.D0.05	0.06	0.02	1.33	2.53	0.29	1.15

It could be concluded that N, P and K concentration and its uptakes by the seedlings of these plants were highly depresses due to increasing salinity levels in this investigation. This depression effect could be explained on the basis of increasing the osmotic potential of saline substrates as well as the competition existing between ions (chloride and phosphorous).

Similar results were reported by Kaya *et al,* (2001) El-Arqan *et al.*, (2002) and Abd El-Hameed (2009)

It is clear from the data of Table 5 that increasing salt concentration from 0.2, 0.4, 0.6 and 0.8% up to 1.0% caused significant increase in concentrations of Ca, Mg and Na at seedling stage of cotton, wheat, barley, faba been and tomato plants. The higher the concentration of salt levels, the higher the concentration of these nutrients in studied plants.

Table 5: Effect of salinity levels on Ca, Mg and Na concentration and uptake by cotton, wheat, barley , faba been and tomato

sailniy level	%			Plant uptake mg plant^{-1}		
	Ca	Mg	Na	Ca	Mg	Na
			Cotton			
0.20%	1.09	0.41	0.25	9.6	3.63	2.17
0.40%	1.18	0.5	0.31	8.13	3.43	2.13
0.60%	1.3	0.58	0.36	7.3	3.23	2.03
0.80%	1.45	0.67	0.41	6.1	2.8	1.73
1.00%	1.66	0.79	0.48	5.47	2.6	1.57
L.S.D0.05	0.05	0.06	0.05	0.94	0.51	0.4
			Wheat			
0.20%	0.75	0.23	0.17	6.1	1.87	1.37
0.40%	0.81	0.26	0.19	5.1	1.63	1.2
0.60%	0.9	0.3	0.22	4.6	1.5	1.17
0.80%	1.03	0.35	0.26	3.9	1.33	0.97
1.00%	1.18	0.42	0.3	3.53	1.27	0.9
L.S.D0.05	0.06	0.07	0.05	1.05	0.38	0.33
			Barley			
0.20%	0.69	0.28	0.18	6.4	2.6	1.67
0.40%	0.76	0.32	0.2	5.47	2.3	1.47
0.60%	0.86	0.37	0.24	5.17	2.23	1.47
0.80%	0.98	0.43	0.29	4.37	1.93	1.33
1.00%	1.14	0.51	0.33	4.13	1.87	1.2
L.S.D0.05	0.83	0.05	0.06	3.24	0.4	0.42
			Faba been			
0.20%	1.33	0.52	0.36	9.17	3.63	2.47
0.40%	1.45	0.58	0.4	7.53	3.03	2.07
0.60%	1.61	0.66	0.46	6.60	2.67	1.87
0.80%	1.85	0.77	0.54	5.57	2.33	1.63
1.00%	--	--	--	--	--	--
L.S.D0.05	0.04	0.05	0.03	1.24	0.44	0.31
			Tomato			
0.20%	3.45	0.62	0.43	26.57	4.77	3.33
0.40%	3.62	0.7	0.49	21.33	4.13	2.9
0.60%	3.87	0.79	0.55	18.6	3.77	2.67
0.80%	4.18	0.93	0.65	14.63	3.27	2.27
1.00%	4.45	1.12	0.78	12.5	3.17	2.2
L.S.D0.05	0.06	0.07	0.07	3.11	0.64	0.68

Data also revealed that; there are significant increase in the uptake of these nutrients by cotton, wheat, barley, faba been and tomato plants due to increasing salt concentration in soil solution. While, the highest values of Ca-uptake by cotton, wheat, barley, faba been and tomato plants were obtained at the lowest salt level under study (0.2%), while the lowest values were recorded at the highest salt level under study (1.0%). The same trend was ralized for Mg and Na uptake for all crops under investigations.

The possible explanation of this behavior is that; the amount of calcium and magnesium required promoting good root growth increases under such adverse conditions of salinity which prominently decrees Ca and Mg concentration in the leaves of these plants as plant matured this handicapped the plant for exploiting new portion of soluble Ca from soil solution until the maturity stage. Mean while, dry matter production of the leaves of these plants were more strongly depressed with progressing of plant growth particularly under salinity conditions. At the same time, the values of Ca and Mg uptakes by the seedlings of these plants were decreased.

It could be concluded that; seedlings of these plants were able to tolerate the effect of soil salinity up to the level of 0.6%. Increasing the rate of salinity from 0.6% to 0.8 and 1.0% had a depressing effect on Na-uptake as a result of the negative effect of salinity on plants provoked osmotic potential by salt in soil solution, so root cells cannot obtain required water from the medium. Thus, Na-uptake as a mineral nutrient dissolved in water is also districted.

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تأثير الإجهاد الملحي علي انبات البذور و نمو بادرات بعض المحاصيل

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تم دراسة تأثير 5 مستويات من الملوحة الصناعية (0.2 ، 0.4 ، 0.6 ، 0.8 ، 1.0%) علي إنبات البذور ، و الوزن الطازج و الوزن الجاف للبادرات ، و تركيز النيتروجين و الفوسور و البوتاسيوم و الكالسيوم و الماغنسيوم و الصوديوم بالإضافة إلي إمتصاص العناصر بواسطة بادرات القطن ، و االقمح ، و الشعير ، و الفول البلدي ، و الطماطم .

و يمكن تلخيص النتائج التي تم الحصول عليها كما يلي :

- زيادة مستويات الملوحة أدت إلي حدوث نقص تدريجي و معنوي في النسبة المؤية للإنبات و علي العكس من ذلك فقد حدثت زيادة معنوية في الوقت اللازم لإنبات البذور كلما زادت مستويات الملوحه و قد إنعكس ذلك علي دليل الانبات الذي زاد بزيادة مستويات الملوحه
- زيادة مستويات الملوحة من 0.2 الي 1.0% أدي الي حدوث نقص معنوي في قيم كلا من الوزن الطازج و الوزن الجاف للبادرات .
- محتوي البادرات من النيتروجين و الفوسفور و البوتاسيوم لجميع النباتات موضوع الدراسه انخفض معنويا بزيادة مستويات الملوحة و قد تحقق نفس الإتجاه بالنسبة لامتصاص هذه العناصر بواسطة بادرات هذه المحاصيل.
- بزيادة مستويات الملوحة حدثت زياده معنوية في محتوي الشتلات من الكالسيوم و المغنسيوم و الصوديوم للمحاصيل موضع الدراسة ، و حدث نفس الإتجاه بالنسبة لإمتصاص هذه العناصر بواسطة الشتلات .
- و مما تقدم يمكن ترتيب النباتات بالنسبه لقدرتها علي تحمل الملوحه علي النحو التالي : الشعير ثم القطن ثم القمح ثم الطماطم ثم اخيرا الفول

قام بتحكيم البحث

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