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OVERCOMING THE HARMFUL EFFECTS OF NaCl AND $CaCl_2$ SALINITY ON SWEET PEPPER PLANT GROWTH BY USING CERTAIN VITAMINS, BIO-REGULATOR AND YEAST EXTRACT .

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ABSTRACT

An experiment was conducted to study the influence of soaking the seeds of sweet pepper plant in selected chemicals used i.e. bio-regulator (salicylic acid), vitamins (ascorbic acid or α-tocopherol) or yeast extract on sweet pepper plant growth under non-saline or saline conditions.

Low salinity level (2000 mg/L) in most cases, increased significantly sweet pepper growth parameters (plant height, root length, shoot and root fresh as well as dry weights, number of leaves as well as leaf area) after 75 and 90 days from sowing. In the contrast, increasing salinity levels decreased growth parameters. Whereas, NaCl+$CaCl_2$ (1:1) were more effective followed by $CaCl_2$ and NaCl. Moreover, pre-soaking seeds, in vitamins at 50 or 100 mg/L or salicylic acid at 75 or 150 mg/L or yeast extract at 1000 or 2000 mg/L gave a positive effect on growth parameters. Furthermore, salicylic acid at 75 mg/L, ascorbic acid at 50 mg/L or α-tocopherol at 100 mg/L were more effective in this respect.

INTRODUCTION

Sweet pepper (*Capsicum annuum* L.) is among the most important crops for the world human nutrition and its fruits have a good nutritional value in respect to antioxidant compounds, such as vitamin C and carotenoids (Navarro *et al.*, 2006).

It is a moderately-sensitive to salt stress (Lycoskoufis *et al.*, 2005). It cultivated under open field and greenhouses conditions. In Egypt cultivated area is around 71428.57 Feddan in 2008, yielded 475000 tones (FAO, 2008)*[1]. In addition, productions throughout the world are around over 24 million tons every year (Casado-Vela *et al.*, 2007). Soil salinity is one of the major environmental stresses affecting over 20% of the world's irrigated land (Etehadnia, 2009) and 2.1% of the dry-land agriculture existing on the globe (Khosravinejad *et al.*, 2009) and extent throughout the world is increasing regularly (Schwabe *et al.*, 2006). It has now become a very serious problem for crop production (Munns and Tester, 2008), particularly in arid and semi-arid regions. However, the intensity of salinity stress varies from place to place. Irrigated land produces one-third of the world's food approximately

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**"FAO: Food and Agriculture Organization of the united nation, Statistical agricultural database sector.
www.http:// faostat.fao.org/site/567/**

(Munns, 2002) so its salinization, often due to poor irrigation practices, is particularly critical. Dry land salinity is also an important, and increasing, problem in some areas of the world (Tester and Davenport, 2003).

Therefore, the present investigation was performed to study the effect of different sources of salinity (NaCl, $CaCl_2$ and their combination 1:1) on sweet pepper growth. Moreover, it was intended to investigate effects of pre-soaking seeds in some materials such as vitamins (ascorbic acid and α-tocopherol) and bio-regulator (salicylic acid) and Yeast extract to alleviate the harmful effects of such salinity types.

MATEREIALS AND METHODS

The experiment was carried out in the glasshouse of the Agricultural Botany Dept., Fac. of Agriculture, Mansoura Univ. during the growing season of 2008, to study the response of plant growth of sweet pepper to different sources of salinity i.e. NaCl, $CaCl_2$ and their combination (1:1 w/w); and how to minimize its harmful effects through pre-soaking seeds in vitamins (Ascorbic acid or α-tocopherol) or bio-regulator (Salicylic acid) or Yeast extract.

Plant materials

The seeds of sweet pepper (*Capsicum annuum* L. cv. Orlando), a hybrid 'California Wonder' used in this investigation were secured from the Gohara Co. Cairo, Egypt.

Chemicals:-

1. Vitamins, ascorbic acid Vit. C (AsA) and α-tocopherol Vit. E (α-toco.) were supplied by Sigma Chemicals Co., USA and used at the concentration of 50 or 100 mg/L each.
2. Bio-regulator, salicylic acid (SA) (2-hydroxybenzoic acid) was obtained from Sigma Chemicals, Co., USA. and initially dissolved in 100 µL dimethyl sulfoxide and used at the concentrations of 75 and 150 mg/L,
3. Yeast extract, active dry yeast (*Saccharomyces cervisiae*) was applied at the concentration of 1000 or 2000 mg/L.
4. Salts:

4.1. Sodium Chloride (NaCl) from EL-Gomhoria Co., Egypt and was used at the concentrations of 2000 and 4000 mg/L.

4.2. Calcium Chloride (CaCl2) from EL-Gomhoria Co., Egypt and was used at the concentrations of 2000 and 4000 mg/L.

4.3. Their combination, NaCl: CaCl2 1:1 (w/w) was used at the concentrations of 2000 and 4000 mg/L.

Table (1): The Molarity (Mol), Electrical Conductivity (E.C.) and pH values for different nutrient solutions.

Nutrient solution (N.S.) mg/L	N.S.	N.S.+ NaCl		N.S.+ CaCl2		N.S.+ (NaCl+CaCl2) (1:1) w/w			
						2000(NaCl+CaCl2)		4000 (NaCl+CaCl2)	
		2000 NaCl	4000 NaCl	2000 CaCl2	4000 CaCl2	1000 NaCl	1000 CaCl2	2000 NaCl	2000 CaCl2
Mol (M)	0 (Control)	3.4×10-2	6.9×10-2	2.0×10-2	3.6×10-2	1.7×10-2	0.9×10-2	3.4×10-2	2.0×10-2
Ec dSm-1	2.00	5.42	8.42	4.59	7.60	5.08		8.08	
pH	5.50	5.77	5.80	5.19	5.30	5.45		5.34	

Table (2): Weights (g) of pure substances to be dissolved in 1000 liters of water to give the theoretically ideal concentrations (Cooper, 1979).

Substance	Formula	Weight
Potassium dihydrogen Phosphate	KH_2PO_4	263
Potassium Nitrate	KNO_3	583
Calcium Nitrate	$Ca(NO_3)_2$. 4H2O	1003
Magnesium Sulphate	$MgSO_4$. $7H_2O$	513
EDTA Iron	$CH_2.N(CH_2.COO)_2]_2$ Fe Na	79.0
Manganous Sulphate	$MnSO_4.H_2O$	6.10
Boric Acid	H_3BO_3	1.70
Copper Sulphate	$CuSO_4.5H_2O$	0.39
Ammonium Molybdate	$(NH_4)_6Mo_7O_{24}.4H_2O$	0.37
Zinc Sulphate	$ZnSO_4.7H_2O$	0.44

After soaking, the sterilized seeds (25 seeds/dish) were placed in glass Petri dishes (11 cm) with a double layer of Whatman No. 1 filter paper. The dishes were left in an incubator in the dark for seed germination at 25 ± 2^0C and 90% relative humidity, and then dishes were covered with aluminum foils for darkness. In order to avoid water losses, 5 ml of the nutrient solution were added to Petri dishes, every 5 days. Thiram was added to the solution at a concentration of 2% (w/v) to control the fungi infection.

Table (3): Composition of yeast extract (according to, Nagodawithana, 1991)

Constituents	Value (%)
Protein	47
Carbohydrates	33
Minerals	8
Nucleic acids	8
Lipids	4
Approximate composition of vitamins	
Vitamines	**Value (µg/g)**
Cholin	4000
Niacin	300-500
Thiamine (B_1)	60-100
Pantorhenate (B_5)	70
Riboflavin (B_2)	35-50
Pyridoxine HCL (B_6)	28
Folic acid	5-13
Biotin	1.3
Vit. B_{12}	0.001

Approximate composition of minerals			
Minerals	**Value (mg/g)**	**Minerals**	**Value (µg/g)**
K	21	Cu	8.00
P	13.50	Ni	3.00
S	3.90	Sn	3.00
Mg	1.65	Cr	2.20
Ca	0.75	Mo	0.40
Zn	0.17	Se	0.10
Na	0.12	Li	0.17
Si	0.03	Va	0.04
Fe	0.02	Mn	0.02

The following experiment was carried out in the glasshouse of the Agric. Bot. Dept., Fac. of Agric., Mansoura Univ. during the spring–summer period of 2008 in a glasshouse under conditions of ambient light during winter, spring and early summer, with 10/14 light/dark period at 800–1100 µmol m^{-2s-1} PPFD, a day/night average temperature cycle of 26/15 °C and 65±5% relative humidity.

The focus of the current experiment was to provide fundamental biological understanding and knowledge on sweet pepper plants growing in nutrient film technique (NFT), under different sources of salinity NaCl, $CaCl_2$ and their combinations 1:1 (w/w); and how to minimizing the harmful effects through pre-soaking seeds in vitamins (Ascorbic acid, α-tocopherol) or bio-regulator (Salicylic acid), or Yeast extract. The seeds of sweet pepper were sown on Jan, 13, 2008. A homogenous sweet pepper seeds were placed in 100 ml beakers and 20 ml of 1% sodium hypochlorite was added for sterilization. These were left in the solution for 5 min followed by washing under running tap water and ionized water twice. Then divided into 9 sets.

The first set was soaked (24hours) in distilled water as control and the remaining sets (8) were separately soaked for 24 h in aqueous solution of AsA or α–toco. at (50 or 100 mg/L) each or SA at (75 or 150 mg/L) or Yeast extract at (1000 or 2000 mg/L). Then germinated in seedling trays (209 eye) containing peat moss and perlite (1:1) as a rooting medium moistured by nutrient cooper solution (Cooper, 1979). Trays containing the seeds were placed in a glasshouse at 28 $\pm 2^0$C to germinate.

The experimental layout consisted of 7 automatic hydroponic units (groups) (experimental plots). Each hydroponic unit comprised of two plastic channels (4 m long * 10 cm in diameter) placed on one side of the holder (4m length * 1.5 m height). Each channel had 40 pores (6 cm diameter). Every unit was provided by an electric pump representing seven groups (Table, 1) nutrient solution (2.0 dSm^{-1} as a control), 2000 mg/L NaCl (5.42 dSm^{-1}), 4000 mg/L NaCl (8.42 dSm^{-1}), 2000 mg/L $CaCl_2$ (4.59 dSm^{-1}), 4000 mg/L $CaCl_2$ (7.60 dSm^{-1}), 2000 mg/L NaCl+$CaCl_2$ (1:1) (5.08 dSm^{-1}) and 4000 mg/L NaCl+$CaCl_2$ (1:1) (8.08 dSm^{-1}).

The seedlings were transplanted to the experimental installation on Feb, 26 , 2008 (after 45 days from pre-soaking) at the stage of four/five true leaves. Two uniform seedlings were transplanted to 6 cm perforated pots (reticulated) containing peat moss and perlite (1:1) as a rooting medium.
Every two channels was divided into 9 sets, the first set was soaked in distilled water (control), AsA, α–toco. at (50 or 100 mg/L) each, SA at (75 or 170 mg/L), and Yeast extract at (1000 or 2000 mg/L). Each set contained (8 replicates) 16 seedlings (two seedling/pot) spaced 10 cm representing a Nutrient Film Technique (NFT).

To keep the concentrations of sodium chloride and mineral nutrients constant, the solution was changed every 7 to 10 days and the volume of the solution was maintained by adding distilled water as required after measuring the electrical conductivity by digital conductivity meter Lutron CD-4301. A nutrient solution was pumped into the channels at a flow rate of one liter per minute from a reservoir containing 10 liters.

Sampling dates:

Two samples were taken at 30 and 45 days after transplanting (75 and 90 days from sowing) to study the following measurements.
Plant height (cm).
Root length (cm).

Roots and shoots (leaves and stem) were separated and repeatedly rinsed with ionized water and their fresh and dry weights (g/plant) were immediately determined.
Number of leaves per plant.
leaf area (cm2/plant) was determined using the following formula according to (Koller, 1972)

$$\text{Leaf area/plant} = \frac{\text{Leaves dry weight (g)} * \text{disk area}}{\text{Disk dry weight (g)}} \cdot \text{No. of leaves/plants}$$

Statistical analysis:

The obtained data were subjected to statistical analysis of variance according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Data presented in tables (4-11) showed that low salinity level (2000 mg/L) of all salinity types, in most cases, increased significantly sweet pepper growth parameters in the two sampling dates. Furthermore, NaCl+$CaCl_2$ (1:1) was more effective in this respect followed by $CaCl_2$ and NaCl at 2000 mg/L. In the contrast, growth parameters were decreased gradually with increasing salinity levels from 2000 to 4000 mg/L and the great reduction occurred under NaCl followed by NaCl+$CaCl_2$ (1:1) and $CaCl_2$ at 4000 mg/L each.

The inhibiting effect of salinity on growth parameters in this investigation are in agreement with El-Banna, 2006; Houimli *et al.*, 2008 and khafagy *et al.*, 2009 who concluded that high salinity stress decreased plant growth in *Capsicum annuum* L.

Regarding the effect of selected chemicals on plant growth, data in the same tables pointed out that pre-soaking pepper seeds in such chemicals, in most cases, gave a positive effect on growth parameters as compared with untreated plant (control). In addition, pre-soaked sweet pepper seeds in salicylic acid at 75 mg/L, ascorbic acid at 50 mg/L or α-tocopherol at 100 mg/L were more effective in this respect as compared to remaining treatments including control.

As for the interactions between salinity and selected chemicals used, data in the same tables showed that growth parameters were increased significantly in both samples as compared to untreated plants. In addition, means of (A*B) indicated that growth parameters were increased significantly under low level of salinity 2000 mg/L, the maximum enhanced value was recorded under NaCl+$CaCl_2$ (1:1) followed by $CaCl_2$ at 2000 mg/L each. Meanwhile, under high salinity level application of these chemicals, in most cases, counteracted the harmful effect of salinity on growth especially salicylic acid at 75 mg/L and ascorbic acid at 50 mg/L as compared to untreated plants under such salinity.

The stimulating effect of low salinity level of NaCl (2000 mg/L) on plant growth may be resulted from the beneficial effect of low concentration of chloride on many physiological processes as photosynthesis , enzymes activity as well as osmoregulators, which allow cell enlargement and plant growth at low water availability caused by the presence of ions especially Na^+ and Cl^- (Khan *et al.*, 1997). The stimulation effect of low salinity level of $CaCl_2$ at 2000 mg/L on pepper plant growth may be attributed to increase calcium uptake Ca^{2+} that play a critical role in improving plant growth under saline conditions and/or may be due to reducing permeability of Na^+ through the plasma membrane and prevent loss of K^+/Na^+ ratio . Cramer, 1992 and/or defined as "free cytosplic calcium" participates in regulation of metabolism and growth of plants. Moreover, Ca^{2+} is taken up by plants passively and only by root tips constituent of the middle lamella of cell walls where it helps to bind adjacent cells-together and strengthen overall construction (**Marschner, 1995**) and influences membrane structure and function, stabilizing membranes and influencing permeability by birding phosphate and carboxylate groups of membrane phospholipids and protein (**Davies** and

Monk-Talbot, 1990) and Ca^{2+} serves as an important second messenger in the perception and transduction of environmental and stress signals (**Roos, 2000**).

Furthermore, Ca^{2+} ameliorates the long term negative effects of NaCl on plant growth and protects against the adverse effect of salinity (**Cramer *et al.*, 1989**).

Table (4): Effect of pre-soaking seeds in SA, AsA, α-toco. or Yeast extract on plant height (cm) of sweet pepper grown under non-saline and saline conditions at 75 and 90 days from sowing using NFT.

Salinity (A) / Treatment (C) mg/L		N.S.	N.S.+ NaCl			N.S.+ CaCl2			N.S.+ (NaCl+CaCl2) (1:1) w/w			Mean (C)
			Conc. (B)		Mean	Conc. (B)		Mean	Conc. (B)		Mean	
			2000	4000	(A*C)	2000	4000	(A*C)	2000	4000	(A*C)	
75 days from sowing												
Water		35.93	37.00	27.93	33.62	38.07	33.87	35.96	39.33	31.83	35.70	35.09
SA 75		37.13	38.43	31.83	35.80	39.17	35.97	37.42	41.67	34.33	37.71	36.98
SA 150		36.73	37.93	31.23	35.30	38.57	34.67	36.66	39.87	32.97	36.52	36.16
AsA 50		36.77	38.33	31.83	35.64	39.17	35.17	37.03	41.57	33.87	37.40	36.69
AsA 100		36.70	37.67	31.47	35.28	38.83	34.93	36.82	40.07	33.07	36.61	36.24
α-toco 50		36.70	37.83	31.33	35.29	38.67	34.77	36.71	39.97	32.97	36.54	36.18
α-toco 100		36.83	37.97	31.67	35.49	39.17	34.93	36.98	40.23	33.33	36.80	36.42
Yeast 1000		36.23	37.57	28.17	33.99	38.77	34.17	36.39	39.63	31.83	35.90	35.43
Yeast 2000		36.33	37.77	29.83	34.64	38.37	34.33	36.34	39.63	32.23	36.07	35.69
Mean	A		35.01			36.70			36.58			
	B	36.60	38.93	32.76								
	A*B		37.83	30.59		38.75	34.76		40.22	32.94		
LSD at 0.05			A; 0.09	B; 0.09	C; 0.15	A*B; 0.15		A*C; 0.25	B*C; 0.25			A*B*C; 0.45
90 days from sowing												
Water		56.27	58.50	34.50	49.76	60.50	47.73	54.83	63.77	44.77	54.93	53.17
SA 75		58.33	60.33	44.77	54.48	63.17	55.73	59.08	72.73	48.27	59.78	57.78
SA 150		57.33	59.27	41.17	52.59	62.23	54.27	57.94	67.17	46.70	57.07	55.87
AsA 50		58.27	59.77	44.73	54.26	63.17	55.50	58.98	70.03	47.77	58.69	57.31
AsA 100		58.17	59.73	43.23	53.71	62.27	54.77	58.40	68.23	46.73	57.71	56.61
α-toco 50		57.77	59.50	42.57	53.28	62.27	51.77	57.27	67.17	46.73	57.22	55.92
α-toco 100		58.00	59.73	43.77	53.83	62.53	55.17	58.57	68.50	47.17	57.89	56.76
Yeast 1000		56.70	58.33	35.27	50.10	61.17	49.00	55.62	64.17	39.27	53.38	53.03
Yeast 2000		57.23	58.77	37.77	51.26	61.47	52.00	56.90	64.67	45.17	55.69	54.61
Mean	A		52.58			57.51			56.93			
	B	57.56	62.93	46.53								
	A*B		59.33	40.86		62.09	52.88		67.38	45.84		
LSD at 0.05			A; 0.21	B; 0.21	C; 0.36	A*B; 0.36		A*C; 0.62	B*C; 0.62			A*B*C; 1.08

N.S.= Nutrient Solution (Control) | SA = Salicylic acid

AsA = Ascorbic acid | α-toco. = α-tocopherol

Yeast = Yeast extract

Table (5) Effect of pre-soaking seeds in SA, AsA, α-toco. or Yeast extract on root length (cm) of sweet pepper grown under non-saline and saline conditions at 75 and 90 days from sowing using NFT.

Salinity (A) / Treatment (C) mg/L		N.S.	N.S.+ NaCl			N.S.+ $CaCl_2$			N.S.+ ($NaCl+CaCl_2$) (1:1) w/w			Mean (C)
			Conc. (B)		Mean	Conc. (B)		Mean	Conc. (B)		Mean	
			2000	4000	(A*C)	2000	4000	(A*C)	2000	4000	(A*C)	
75 days from sowing												
Water		20.7	21.5	17.6	20.0	22.5	20.0	21.1	23.8	19.2	21.3	20.8
SA 75		21.5	22.5	19.3	21.1	23.7	20.5	21.9	27.3	19.9	22.9	22.0
SA 150		24.4	21.8	18.9	21.7	23.0	20.3	22.6	25.5	19.7	23.2	22.5
AsA 50		21.4	21.8	19.2	20.8	23.5	20.5	21.8	27.1	19.8	22.8	21.8
AsA 100		21.2	21.8	19.2	20.8	23.5	20.3	21.7	26.3	19.8	22.5	21.6
α-toco 50		21.2	21.8	19.0	20.7	23.5	20.3	21.7	25.8	19.7	22.3	21.6
α-toco 100		21.5	21.8	19.2	20.9	23.5	20.5	21.9	27.0	19.8	22.8	21.8
Yeast 1000		20.7	21.7	18.3	20.3	22.8	20.0	21.2	23.9	19.3	21.3	20.9
Yeast 2000		20.7	21.8	18.8	20.5	22.8	20.3	21.3	24.8	19.5	21.7	21.2
Mean	A	21.5	20.7			21.7			22.3			
	B		39.3	35.5								
	A*B		38.2	34.1		39.1	36.4		40.8	36.0		
LSD at 0.05		A; 0.07	B; 0.07		C; 0.14	A*B; 0.14		A*C; 0.23	B*C; 0.23			A*B*C; 0.41
90 days from sowing												
Water		36.63	37.17	30.00	34.60	37.27	35.73	36.54	38.00	35.27	36.63	35.93
SA 75		37.83	38.73	35.23	37.27	39.73	36.77	38.11	42.27	36.50	38.87	38.08
SA 150		37.37	38.27	34.77	36.80	39.23	36.50	37.70	40.50	36.33	38.07	37.52
AsA 50		37.77	38.43	35.07	37.09	39.67	36.77	38.07	42.33	36.27	38.79	37.98
AsA 100		37.53	38.40	34.77	36.90	39.33	36.77	37.88	41.27	36.23	38.34	37.71
α-toco 50		37.47	38.27	34.77	36.83	39.27	36.50	37.74	41.23	36.23	38.31	37.63
α-toco 100		37.57	38.50	34.97	37.01	39.33	36.77	37.89	41.50	36.23	38.43	37.78
Yeast 1000		36.93	37.77	32.27	35.66	38.73	35.77	37.14	39.67	35.50	37.37	36.72
Yeast 2000		37.07	38.07	34.60	36.58	39.00	36.27	37.44	40.33	35.77	37.72	37.25
Mean	A	37.35	36.53			37.61			38.06			
	B		39.34	35.50								
	A*B		38.18	34.05		39.06	36.43		40.79	36.04		
LSD at 0.05		A; 0.08	B; 0.08		C; 0.14	A*B; 0.14		A*C; 0.23	B*C; 0.23			A*B*C; 0.42

N.S.= Nutrient Solution (Control) | SA = Salicylic acid

AsA = Ascorbic acid | α-toco. = α-tocopherol

Yeast = Yeast extract

Table (6) Effect of pre-soaking seeds in SA, AsA, α-toco. or Yeast extract on root fresh weight (g) of sweet pepper grown under non-saline and saline conditions at 75 and 90 days from sowing using NFT.

Salinity (A) / Treatment (C) mg/L	N.S.	N.S.+ NaCl			N.S.+ $CaCl_2$			N.S.+ ($NaCl+CaCl_2$) (1:1) w/w			Mean (C)
		Conc. (B)		Mean	Conc. (B)		Mean	Conc. (B)		Mean	
		2000	4000	(A*C)	2000	4000	(A*C)	2000	4000	(A*C)	
75 days from sowing											
Water	3.32	3.61	2.28	3.07	4.03	3.07	3.47	4.35	2.74	3.47	3.34
SA 75	3.61	3.90	2.75	3.42	4.34	3.26	3.74	5.42	3.02	4.02	3.72
SA 150	3.45	3.76	2.55	3.25	4.16	3.22	3.61	4.62	2.98	3.68	3.52
AsA 50	3.57	3.88	2.72	3.39	4.19	3.26	3.67	5.04	3.02	3.88	3.65
AsA 100	3.47	3.82	2.67	3.32	4.18	3.24	3.63	4.65	3.01	3.71	3.55
α-toco 50	3.47	3.77	2.59	3.28	4.16	3.23	3.62	4.62	3.00	3.70	3.53
α-toco 100	3.56	3.84	2.70	3.37	4.19	3.24	3.66	4.86	3.01	3.81	3.61
Yeast 1000	3.11	3.62	2.33	3.02	4.06	3.08	3.42	4.38	2.80	3.43	3.29
Yeast 2000	3.40	3.67	2.48	3.18	4.07	3.12	3.53	4.56	2.94	3.63	3.45
Mean A	3.44	3.26			3.59			3.70			
Mean B		4.21	2.90								
Mean A*B		3.76	2.56		4.15	3.19		4.72	2.95		
LSD at 0.05	A; 0.06	B; 0.06		C; 0.11	A*B; 0.11		A*C; 0.19	B*C; 0.19		A*B*C; 0.33	
90 days from sowing											
Water	13.84	14.41	10.20	12.82	15.79	12.11	13.91	17.31	11.87	14.34	13.69
SA 75	14.64	15.58	12.11	14.11	17.07	13.75	15.15	20.16	13.06	15.96	15.07
SA 150	14.40	15.23	11.74	13.79	16.36	13.33	14.70	18.90	12.72	15.34	14.61
AsA 50	14.57	15.56	12.05	14.06	16.91	13.64	15.04	19.92	12.96	15.82	14.97
AsA 100	14.43	15.56	11.96	13.98	16.72	13.48	14.87	19.24	12.87	15.51	14.79
α-toco 50	14.43	15.27	11.85	13.85	16.64	13.36	14.81	18.83	12.77	15.34	14.67
α-toco 100	14.48	15.51	11.97	13.98	16.92	13.53	14.98	19.55	12.96	15.66	14.87
Yeast 1000	13.98	14.71	10.33	13.01	15.83	13.11	14.31	17.34	12.25	14.52	13.95
Yeast 2000	14.22	14.99	11.13	13.45	16.17	13.31	14.57	18.29	12.57	15.03	14.35
Mean A	14.33	13.67			14.70			15.28			
Mean B		16.84	12.48								
Mean A*B		15.20	11.48		16.49	13.29		18.84	12.67		
LSD at 0.05	A; 0.02	B; 0.02		C; 0.03	A*B; 0.03		A*C; 0.05	B*C; 0.05		A*B*C; 0.09	

N.S.= Nutrient Solution (Control) | SA = Salicylic acid

AsA = Ascorbic acid | α-toco. = α-tocopherol

Yeast = Yeast extract

Table (7) Effect of pre-soaking seeds in SA, AsA, α-toco. or Yeast extract on shoot fresh weight (g) of sweet pepper grown under non-saline and saline conditions at 75 and 90 days from sowing using NFT.

Salinity (A) / Treatment (C) mg/L	N.S.	N.S.+ NaCl			N.S.+ $CaCl_2$			N.S.+ ($NaCl+CaCl_2$) (1:1) w/w			Mean (C)
		Conc. (B)		Mean	Conc. (B)		Mean	Conc. (B)		Mean	
		2000	4000	(A*C)	2000	4000	(A*C)	2000	4000	(A*C)	
75 days from sowing											
Water	10.71	11.78	5.73	9.41	12.93	9.17	10.94	14.27	8.23	11.07	10.47
SA 75	11.99	13.15	7.89	11.01	14.19	10.59	12.26	17.93	9.06	13.00	12.09
SA 150	11.16	12.82	7.47	10.49	13.80	9.93	11.63	15.45	8.62	11.75	11.29
AsA 50	11.78	13.10	7.81	10.90	14.05	10.54	12.13	16.82	8.96	12.52	11.85
AsA 100	11.55	12.96	7.73	10.75	13.94	10.19	11.90	15.89	8.82	12.09	11.58
α-toco 50	11.50	12.89	7.64	10.68	13.91	10.04	11.82	15.73	8.81	12.02	11.51
α-toco 100	11.52	13.03	8.11	10.89	13.99	10.52	12.01	16.35	8.88	12.25	11.72
Yeast 1000	10.76	12.04	6.25	9.69	13.18	9.34	11.10	14.41	8.31	11.16	10.65
Yeast 2000	10.89	12.51	6.47	9.96	13.43	9.55	11.29	14.97	8.44	11.44	10.90
Mean A	11.32	10.42			11.68			11.92			
Mean B		14.06	8.64								
Mean A*B		12.70	7.24		13.72	9.99		15.76	8.68		
LSD at 0.05	A; 0.002	B; 0.002		C; 0.003	A*B; 0.003		A*C; 0.01	B*C; 0.01		A*B*C; 0.01	
90 days from sowing											
Water	29.07	33.60	10.40	24.36	37.91	22.95	29.98	45.62	15.98	30.22	28.18
SA 75	33.71	38.50	15.72	29.31	43.86	28.81	35.46	55.36	24.23	37.77	34.18
SA 150	30.88	36.12	14.51	27.17	41.81	27.11	33.27	50.33	20.78	34.00	31.48
AsA 50	32.81	38.39	15.67	28.95	43.61	28.66	35.02	52.50	23.78	36.36	33.45
AsA 100	31.76	37.20	14.91	27.96	42.30	27.74	33.93	51.46	22.47	35.23	32.37
α-toco 50	31.29	37.00	14.60	27.63	42.07	27.64	33.67	50.63	21.94	34.62	31.97
α-toco 100	32.46	37.87	15.45	28.59	42.66	28.17	34.43	51.67	23.52	35.89	32.97
Yeast 1000	29.20	34.30	12.11	25.20	39.39	24.44	31.01	47.93	16.34	31.16	29.12
Yeast 2000	30.01	35.74	14.27	26.68	40.95	26.15	32.37	49.41	18.89	32.77	30.61
Mean A	31.24	27.32			33.24			34.22			
Mean B		42.90	20.64								
Mean A*B		36.52	14.18		41.62	26.85		50.55	20.88		
LSD at 0.05	A; 0.05	B; 0.05		C; 0.09	A*B; 0.09		A*C; 0.16	B*C; 0.016		A*B*C; 0.28	

N.S.= Nutrient Solution (Control) | SA = Salicylic acid
AsA = Ascorbic acid | α-toco. = α-tocopherol
Yeast = Yeast extract

Table (8) Effect of pre-soaking seeds in SA, AsA, α-toco. or Yeast extract on root dry weight (g) of sweet pepper grown under non-saline and saline conditions at 75 and 90 days from sowing using NFT.

Salinity (A) / Treatment (C) mg/L		N.S.	N.S.+ NaCl			N.S.+ $CaCl_2$			N.S.+ ($NaCl+CaCl_2$) (1:1) w/w			Mean (C)
			Conc. (B)		Mean	Conc. (B)		Mean	Conc. (B)		Mean	
			2000	4000	(A*C)	2000	4000	(A*C)	2000	4000	(A*C)	
75 days from sowing												
Water		0.25	0.27	0.18	0.23	0.30	0.24	0.26	0.34	0.22	0.27	0.26
SA 75		0.26	0.31	0.22	0.26	0.34	0.25	0.28	0.40	0.24	0.30	0.28
SA 150		0.25	0.29	0.25	0.26	0.32	0.24	0.27	0.36	0.23	0.28	0.27
AsA 50		0.26	0.31	0.22	0.26	0.34	0.25	0.28	0.37	0.24	0.29	0.28
AsA 100		0.26	0.29	0.22	0.26	0.33	0.24	0.28	0.37	0.23	0.29	0.27
α-toco 50		0.25	0.29	0.22	0.25	0.32	0.24	0.27	0.36	0.23	0.28	0.27
α-toco 100		0.26	0.29	0.22	0.26	0.33	0.24	0.28	0.37	0.23	0.29	0.27
Yeast 1000		0.25	0.28	0.18	0.24	0.31	0.24	0.27	0.35	0.22	0.27	0.26
Yeast 2000		0.25	0.29	0.20	0.25	0.32	0.24	0.27	0.35	0.23	0.28	0.26
Mean	A	0.25	0.25			0.27			0.28			
	B		0.33	0.23								
	A*B		0.29	0.21		0.32	0.24		0.36	0.23		
LSD at 0.05		A; 0.01	B; 0.01		C; 0.02	A*B; 0.02		A*C; 0.03	B*C; 0.03		A*B*C; 0.05	
90 days from sowing												
Water		2.40	2.66	1.67	2.24	2.79	2.18	2.45	3.38	2.08	2.62	2.44
SA 75		2.69	2.97	2.13	2.60	3.32	2.43	2.81	5.24	2.32	3.42	2.94
SA 150		2.60	2.85	1.99	2.48	3.05	2.39	2.68	3.62	2.18	2.80	2.65
AsA 50		2.64	2.89	2.04	2.52	3.26	2.42	2.77	4.64	2.29	3.19	2.83
AsA 100		2.60	2.86	2.03	2.50	3.18	2.40	2.73	4.04	2.23	2.96	2.73
α-toco 50		2.62	2.84	1.99	2.48	3.17	2.40	2.73	3.70	2.22	2.85	2.69
α-toco 100		2.63	2.90	2.00	2.51	3.23	2.38	2.75	4.64	2.23	3.16	2.81
Yeast 1000		2.45	2.71	1.75	2.31	2.83	2.31	2.53	3.46	2.13	2.68	2.51
Yeast 2000		2.55	2.79	1.97	2.44	3.04	2.32	2.64	3.57	2.16	2.76	2.61
Mean	A	2.57	2.45			2.68			2.94			
	B		3.32	2.17								
	A*B		2.83	1.95		3.10	2.36		4.03	2.20		
LSD at 0.05		A; 0.02	B; 0.02		C; 0.04	A*B; 0.04		A*C; 0.06	B*C; 0.06		A*B*C; 0.12	

N.S.= Nutrient Solution (Control)	SA = Salicylic acid
AsA = Ascorbic acid	α-toco. = α-tocopherol
Yeast = Yeast extract	

Table (9) Effect of pre-soaking seeds in SA, AsA, α-toco. or Yeast extract on shoot dry weight (g) of sweet pepper grown under non-saline and saline conditions at 75 and 90 days from sowing using NFT.

Salinity (A) / Treatment (C) mg/L		N.S.+ NaCl			N.S.+ $CaCl_2$			N.S.+ ($NaCl+CaCl_2$) (1:1) w/w			Mean (C)
	N.S.	Conc. (B)		Mean	Conc. (B)		Mean	Conc. (B)		Mean	
		2000	4000	(A*C)	2000	4000	(A*C)	2000	4000	(A*C)	
75 days from sowing											
Water	0.84	0.88	0.48	0.73	1.08	0.72	0.88	1.25	0.63	0.91	0.84
SA 75	0.91	1.08	0.63	0.87	1.25	0.83	1.00	1.66	0.71	1.10	0.99
SA 150	0.87	1.00	0.56	0.81	1.20	0.78	0.95	1.34	0.68	0.96	0.91
AsA 50	0.90	1.05	0.62	0.86	1.24	0.82	0.99	1.51	0.71	1.04	0.96
AsA 100	0.90	1.02	0.57	0.83	1.22	0.81	0.97	1.39	0.69	0.99	0.93
α-toco 50	0.87	1.03	0.56	0.82	1.21	0.79	0.96	1.36	0.69	0.97	0.92
α-toco 100	0.90	1.03	0.61	0.84	1.23	0.80	0.98	1.40	0.70	1.00	0.94
Yeast 1000	0.84	0.93	0.50	0.76	1.09	0.74	0.89	1.27	0.63	0.91	0.85
Yeast 2000	0.85	0.97	0.54	0.79	1.18	0.76	0.93	1.32	0.67	0.95	0.89
Mean A	0.87	0.81			0.95			0.98			
Mean B		1.19	0.67								
Mean A*B		1.00	0.56		1.19	0.78		1.39	0.68		
LSD at 0.05	A; 0.004	B; 0.004		C; 0.01	A*B; 0.01		A*C; 0.01	B*C; 0.01			A*B*C; 0.02
90 days from sowing											
Water	2.83	3.44	1.12	2.47	4.27	2.45	3.18	4.75	1.74	3.11	2.92
SA 75	3.40	4.14	1.87	3.13	4.86	2.82	3.69	5.98	2.46	3.95	3.59
SA 150	3.11	3.92	1.67	2.90	4.57	2.71	3.46	5.30	2.18	3.53	3.30
AsA 50	3.30	4.07	1.83	3.07	4.81	2.78	3.63	5.77	2.36	3.81	3.50
AsA 100	3.26	3.97	1.71	2.98	4.69	2.76	3.57	5.40	2.31	3.66	3.40
α-toco 50	3.19	3.62	1.74	2.85	4.60	2.73	3.51	5.32	2.29	3.60	3.32
α-toco 100	3.25	4.09	1.76	3.03	4.76	2.79	3.60	5.63	2.32	3.73	3.45
Yeast 1000	2.85	3.58	1.33	2.59	4.29	2.48	3.21	4.96	1.89	3.23	3.01
Yeast 2000	3.05	3.81	1.60	2.82	4.56	2.60	3.41	5.13	2.01	3.40	3.21
Mean A	3.14	2.87			3.47			3.56			
Mean B		4.60	2.16								
Mean A*B		3.85	1.63		4.60	2.68		5.36	2.17		
LSD at 0.05	A; 0.02	B; 0.02		C; 0.03	A*B; 0.03		A*C; 0.05	B*C; 0.05			A*B*C; 0.09

N.S.= Nutrient Solution (Control) | **SA = Salicylic acid**

AsA = Ascorbic acid | **α-toco. = α-tocopherol**

Yeast = Yeast extract

Table (10) Effect of pre-soaking seeds in SA, AsA, α-toco. or Yeast extract on number of leaves per plant of sweet pepper grown under non-saline and saline conditions at 75 and 90 days from sowing using NFT.

Salinity (A) / Treatment (C) mg/L		N.S.	N.S.+ NaCl			N.S.+ $CaCl_2$			N.S.+ ($NaCl+CaCl_2$) (1:1) w/w			Mean (C)
			Conc. (B)		Mean	Conc. (B)		Mean	Conc. (B)		Mean	
			2000	4000	(A*C)	2000	4000	(A*C)	2000	4000	(A*C)	
75 days from sowing												
Water		11.33	12.67	8.33	10.78	12.33	11.33	11.67	13.33	11.33	12.00	11.48
SA 75		12.33	12.67	10.67	11.89	13.33	11.33	12.33	14.67	11.33	12.78	12.33
SA 150		12.33	12.33	10.33	11.67	12.33	11.33	12.00	13.33	11.00	12.22	11.96
AsA 50		12.33	12.33	10.33	11.67	12.67	11.33	12.11	14.33	11.67	12.78	12.19
AsA 100		11.67	12.33	10.33	11.44	12.33	11.33	11.78	13.33	11.33	12.11	11.78
α-toco 50		12.33	12.33	10.67	11.78	12.33	11.33	12.00	13.33	11.00	12.22	12.00
α-toco 100		12.00	12.33	10.67	11.67	13.00	11.67	12.22	14.00	11.33	12.44	12.11
Yeast 1000		11.33	13.00	9.33	11.22	12.33	11.33	11.67	13.00	11.33	11.89	11.59
Yeast 2000		11.67	12.33	10.33	11.44	12.67	11.33	11.89	13.33	11.00	12.00	11.78
Mean	A	11.93	11.51			11.96			12.27			
	B		12.90	10.91								
	A*B		12.48	10.11		12.59	11.37		13.63	11.26		
LSD at 0.05		A; 0.39	B; 0.39		C; 0.67	A*B; 0.67		A*C; 1.17	B*C; 1.17			A*B*C; 2.02
90 days from sowing												
Water		17.67	19.67	13.00	16.78	21.33	16.33	18.44	21.67	15.67	18.33	17.85
SA 75		19.67	21.67	15.33	18.89	22.67	18.33	20.22	25.67	16.67	20.67	19.93
SA 150		18.33	20.33	14.33	17.67	21.67	17.67	19.22	25.33	16.33	20.00	18.96
AsA 50		19.67	21.00	15.00	18.56	23.00	17.33	20.00	25.33	16.00	20.33	19.63
AsA 100		18.67	20.67	14.33	17.89	21.67	17.67	19.33	25.33	15.67	19.89	19.04
α-toco 50		18.67	20.67	14.00	17.78	21.67	17.67	19.33	25.33	15.67	19.89	19.00
α-toco 100		19.33	22.00	14.67	18.67	21.33	17.67	19.44	24.43	15.67	19.81	19.31
Yeast 1000		17.33	20.00	13.67	17.00	20.67	17.00	18.33	23.33	15.67	18.78	18.04
Yeast 2000		19.00	20.00	14.33	17.78	22.67	17.33	19.67	24.67	16.33	20.00	19.15
Mean	A	18.70	17.89			19.33			19.74			
	B		22.36	15.90								
	A*B		20.67	14.30		21.85	17.44		24.57	15.96		
LSD at 0.05		A; 0.33	B; 0.33		C; 0.58	A*B; 0.58		A*C; 0.99	B*C; 0.99			A*B*C; 1.73

N.S.= Nutrient Solution (Control) **SA = Salicylic acid**

AsA = Ascorbic acid **α-toco. = α-tocopherol**

Yeast = Yeast extract

Table (11) Effect of pre-soaking seeds in SA, AsA, α-toco. or Yeast extract on leaf area (cm^2) of sweet pepper grown under non-saline and saline conditions at 75 and 90 days from sowing using NFT.

Salinity (A) / Treatment (C) mg/L		N.S.	N.S.+ NaCl			N.S.+ $CaCl_2$			N.S.+ ($NaCl+CaCl_2$) (1:1) w/w			Mean (C)
			Conc. (B)		Mean	Conc. (B)		Mean	Conc. (B)		Mean	
			2000	4000	(A*C)	2000	4000	(A*C)	2000	4000	(A*C)	
75 days from sowing												
Water		303.9	355.9	176.1	278.6	400.6	254.9	319.8	434.4	209.4	315.9	304.8
SA 75		351.6	400.0	204.0	318.5	432.1	298.9	360.9	532.5	252.6	378.9	352.8
SA 150		338.2	385.4	200.9	308.1	418.5	282.3	346.3	479.5	232.0	349.9	334.8
AsA 50		347.9	399.6	202.8	316.8	430.7	296.6	358.4	506.4	248.7	367.7	347.6
AsA 100		342.5	387.2	201.6	310.4	421.9	283.6	349.3	480.7	243.8	355.7	338.5
α-toco 50		340.9	387.1	201.5	309.8	419.3	282.6	347.6	479.8	232.8	351.2	336.2
α-toco 100		342.9	395.6	202.1	313.5	426.2	287.9	352.4	506.3	246.4	365.2	343.7
Yeast 1000		314.2	365.7	184.5	288.1	404.7	266.6	328.5	444.2	213.4	323.9	313.5
Yeast 2000		324.2	379.2	188.1	297.2	414.3	275.4	338.0	461.9	229.8	338.6	324.6
Mean	A		304.6			344.6			349.7			
	B	334.0	427.8	237.0								
	A*B		384.0	195.7		418.7	281.0		480.6	234.3		
LSD at 0.05		A; 12.0	B; 12.0	C; 20.9		A*B; 20.9		A*C; 36.1	B*C; 36.1		A*B*C; 62.6	
90 days from sowing												
Water		716.7	1010.9	304.6	677.4	1149.6	559.8	808.7	1256.8	457.1	810.2	765.5
SA 75		1004.0	1147.2	454.5	868.5	1248.8	704.4	985.8	1416.9	542.4	987.8	947.4
SA 150		918.0	1054.0	411.6	794.5	1196.1	665.3	926.4	1336.0	506.1	920.0	880.3
AsA 50		992.6	1130.4	442.3	855.1	1238.3	701.8	977.6	1416.6	540.5	983.2	938.6
AsA 100		968.0	1074.5	429.9	824.1	1213.8	688.8	956.9	1377.1	527.2	957.4	912.8
α-toco 50		947.6	1059.0	420.9	809.2	1203.3	681.8	944.2	1365.5	518.5	943.9	899.1
α-toco 100		972.3	1089.8	438.1	833.4	1221.3	690.5	961.3	1393.9	528.1	964.8	919.8
Yeast 1000		738.8	1021.1	374.6	711.5	1162.1	606.2	835.7	1264.8	472.2	825.3	790.8
Yeast 2000		820.1	1042.1	407.5	756.6	1172.0	647.7	879.9	1306.3	503.9	876.7	837.7
Mean	A		792.3			919.6			918.8			
	B	897.6	1206.2	526.9								
	A*B		1069.9	409.3		1200.6	660.7		1348.2	510.7		
LSD at 0.05		A; 53.2	B; 53.2	C; 92.1		A*B; 92.1		A*C; 159.5	B*C; 159.5		A*B*C; 276.3	

N.S.= Nutrient Solution (Control) | **SA = Salicylic acid**

AsA = Ascorbic acid | **α-toco. = α-tocopherol**

Yeast = Yeast extract

The reduction effect of salinity on root length and plant height may be due to the suppressing effects of salinity on meristematic cell division and

elongation as well as root penetration (Hatung, 2004) and/or reduction in the length of root tip elongation zone (Zidan *et al.*, 1990) and/or reduction in the root extension rates might come from the marked lowering of root radial hydraulic conductivity (Azaizeh *et al.*, 1992) and/or reduces the ability of plants to take up water, this quickly causes reduction in growth rate and the initial reduction in shoot growth is probably due to hormonal signals generated by the roots (Munns, 2002), and/or inhibited apical growth in plants as well as internal hormonal imbalance (Younis *et al.*, 2003).

In the present investigation, plant height of sweet pepper plants was less sensitive to salt stress than root length. Salinity induced a rapid reduction in root length than shoot height which may be due to, the fact that root system is directly in contact with salinity and is potentially the first line of defense, (Cramer *et al.,* 1994), depletion of O_2 deprives those plants of its primary energy source and root growth declines. Also, Mohamed *et al.* (1998) revealed that root morphology parameters are additional sensitive parameters which are affected by salt stress. Therefore, can be employed as criteria for monitoring plant response mechanisms to salt stress. Thus, roots are reported to be among the first organs affected by salt stress and are most sensitive.

The retardation in plant growth caused by salinity may be attributed mainly to the osmotic stream, which reduced availability and uptake of water and essential nutrients (Neumann, 1997) as well as the excessive accumulation of both toxic ions (Na^+ and Cl^-) and intermediate compounds such as reactive oxygen species (Rodriguez *et al.*, 2004) which cause damage to DNA, lipid and proteins and consequently a decrease in plant growth. In addition, Fricke *et al.* (2004) found that salinity increased ABA and ethylene concentration in plant tissue, and decreased endogenous level of IAA, GA_3 and auxin content.

Generally, the reduction in sweet pepper fresh and dry weights in the present study might be attributed to a decrease in either leaf number (Table, 10) or leaf area per plant (Table, 11) and decreased stomatal conductance (AL-Kahafaf *et al.*, 1990) and consequently less CO_2 available for carboxylation reactions in the photosynthesis apparatus ((Yadav *et al.*, 1996), which lead to reduction of photosynthetic capacity resulting less net assimilation and relative growth rates, ribulose-1,5-bisphosphate carboxylase/ oxygenase activity (Fedina and Tsonev, 1997).

In this respect, Khavari-Nejad (1988) proposed that the mechanism by which salt reduces leaf area expansion during mechanism is the reduction in water potential in the root zone which transmitted via the xylem to the leaves and reduced cell turgor and consequently decreased cell division and expansion.

Presoaking seeds in SA and their enhancement in growth of salt stressed plants might have been due to SA-induced changes in the biochemical or physiological processes (Hussein *et al.,* 2007), increased auxin and zeatin as well as gibberellin in leaves (Shehata *et al.*, 2000); and increased the level of cell division within the apical meristem of seedling roots causing an increase in plant growth (Sakhabutdinova *et al.*, 2003). Moreover, Ashraf (2004) suggested that SA-induced enhancement in growth by

adversely affecting various physiological and biochemical processes including photosynthesis, antioxidant capacity and ion homeostasis. In this respect, El-Tayeb (2005) reported that SA-induced increase in growth could be related to enhanced activity of antioxidants that protect the plants from oxidative damage. Furthermore, Afzal *et al.* (2006) mentioned that SA treatment prevented decrease in IAA and cytokinin content completely, which reduced stress-induced inhibition of wheat growth.

Concerning the enhanced effect of pre-soaking seeds with AsA on plant height it may be due to that AsA is a major primary antioxidant (Nijs and Kelley, 1991), plays an important role in preserving the activity of enzymes (Padh, 1990), implicated in the regulation of the cell division, cell cycle progression (Smirnoff, 1996) cell elongation (De Tullio *et al.*, 1999) and is the major antioxidant that scavenges H_2O_2 (Chen and Gallie, 2004), which may be cause deterioration of membrane lipids, leading to increased leakage of solutes from membranes (Mishra and Choudhuri, 1999).

Concerning the positive effect of AsA on leaf number it may be due to the beneficial role of this organic acid in plant metabolism (Smirnoff, 1996) and/or nutrient uptake (Gonzalez-Reyes *et al.*, 1995). Moreover, the positive effect of ascorbic acid on leaf area per plant may be due to its involvement in the regulation of the fundamental cellular processes of photosynthetic and regulation of photosynthesis, cell vacuolarization, cell expansion and cell division (Smirnoff, 1996).

Concerning the positive effect on sweet pepper plant growth by yeast extract treatment it was also obtained by Skoog and Miller, (1957), who mentioned that yeast via its cytokinins content improved plant growth. In addition, El-Desouky *et al.* (1998) revealed that soaking squash seeds in yeast extracts caused an increase in the size of the root system that reached the high level of significance. Simultaneously all vegetative growth aspects i.e. stem length, internodes length, number of internodes, number of leaves and total leaf area per plant were positively responded.

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التغلب على التاثيرات الضارة لملوحة كلوريدى الصوديوم والكالسيوم على نمو نبات الفلفل الحلو بإستخدام بعض الفيتامينات والمنظمات الحيوية ومستخلص الخميرة .

عرفه أحمد عرفه ، محمود عبد المنعم خفاجى ، عبد الله محمد أبو الخير ، رمضان عبد المنعم فوده ومصطفى فؤاد البنا
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تمت هذه التجربة بهدف دراسة تأثير نقع بذور الفلفل الحلو في حمض الأسكوربيك أو الألفاتوكوفيرول أو حمض السالسليك أو مستخلص الخميرة تحت الظروف العادية أو ظروف الملوحة علي نمو نبات الفلفل الحلو.

في معظم الحالات أدي التركيز المنخفض من الأملاح المختلفة (2000 جزء في المليون) إلي حدوث زيادة معنوية في صفات النمو (إرتفاع النبات، طول الجذر، الوزن الغض والجاف للمجموع الخضري والجذري، وكذلك عدد الأوراق والمساحة الورقية) بعد 75 و90 يوم من النقع. كما لوحظ أن مخلوط الملحين كان الأكثر تأثيراً يليه ملح كلوريد الكالسيوم ثم كلوريد الصوديوم. وقد أدت زيادة تركيز الملوحة إلي 4000 جزء في المليون إلي نقص معظم صفات النمو. كما أدي نقع البذور إلي إحداث زيادة وتحسين صفات النمو. ولقد لوحظ أن حمض الأسكوربيك بتركيز 50 جزء في المليون أو حمض السالسليك بتركيز 75 جزء في المليون أو الألفاتوكوفيرول بتركيز 100 جزء في المليون الأكثر تأثيراً.

قام بتحكيم البحث

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