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RESPONSE OF YIELD AND ITS QUALITY OF SWEET PEPPER PLANT TO CERTAIN BIO-STIMULANTS UNDER TWO TYPES OF SALINITY

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ABSTRACT

Number of fruits and its fresh weight per plant were significantly increased under low salinity level of NaCl+$CaCl_2$ in the early 4th picking and total yield. While, plants grown under NaCl salinity did not produced fruits in the early 4th picking. However, increasing salinity levels caused a significant decrease in this respect. In addition, pre-soaking seeds in selected chemicals used at both levels caused a significant increase in sweet pepper fruit number and its fresh weight per plant (early 4th picking and total yield) under non-saline conditions. Moreover, salicylic acid at 75 mg/L or ascorbic acid at 50 mg/L was more effective in this respect under non-saline or salinity conditions.

Ascorbic acid as well as total carbohydrates concentrations in sweet pepper fruits were increased significantly with increasing salinity levels. In addition, ascorbic acid and total carbohydrates concentrations were greatly increased in plants growing under NaCl followed by NaCl+$CaCl_2$ and $CaCl_2$ as compared to control. On the other hand, pre-soaking seeds in SA, AsA, α-tocopherol and yeast extract at both levels increased ascorbic acid and total carbohydrates concentrations under non-saline or salinity conditions. Furthermore, AsA at both levels or SA at 75 mg/L was more effective in this respect.

Total soluble solids (TSS %) were significantly increased under low salinity level (2000 mg/L), thereafter decreased with increasing salinity level to 4000 mg/L. In addition, the great reduction in TSS % occurred under NaCl at high salinity levels as compared with the other salinity type. Moreover, pre-soaking seeds in chemicals used at both levels increased TSS % under non-saline or saline conditions. Furthermore, SA at 75 mg/L or AsA at 50 mg/L was more effective in this respect.

Keywords: Salinity , Bio-stimulants , Sweet Pepper

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 tons (**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 (**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 its combination 1:1) on yield and its quality of sweet pepper plant. Moreover, it was intended to investigate effects of pre-soaking seeds in some materials such as vitamins (ascorbic acid and α-tocopherol, 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 yield and its quality 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-regulators (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-tocopherol.) 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.

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

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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.+ $CaCl_2$		N.S.+ {NaCl+$CaCl_2$} (1:1) w/w			
						2000(NaCl+$CaCl_2$)		4000 (NaCl+$CaCl_2$)	
		2000 NaCl	4000 NaCl	2000 $CaCl_2$	4000 $CaCl_2$	1000 NaCl	1000 $CaCl_2$	2000 NaCl	2000 $CaCl_2$
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	
Vitamins	**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 ^{o}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–tocopherol 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 moistened by nutrient cooper solution (**Cooper, 1979**). Trays containing the seeds were placed in a glasshouse at 28 ±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–tocopherol at (50 or 100 mg/L) each, SA at (75 or 150 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:

- **Yield and its components:**
  - Harvesting was performed weekly throughout the cropping period, starting after 80 DAT and terminating after 160 DAT. At each harvest:
  - Fruits number per plant and fruits fresh weight (kg/plant) first 4th pickings and total yield.
  - Ascorbic acid and total soluble carbohydrates (TSC) according to **(Sadasivam** and **Manickam, 1996), t**otal soluble solids (TSS %) estimated by hand refractometer according to **Cox** and **Pearson (1962)**.

Statistical analysis:

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

RESULTS AND DISCUSSION

Fruit yield

Data presented in Tables (4-5) , in general, indicated that the number of fruits and fruits fresh weight per plant were significantly increased under low salinity level of NaCl+CaCl2 in the first 4th pickings. However, CaCl2 salinity at 2000 mg/L led to a decrease in this respect. While, plants grown under NaCl salinity did not produced fruit yield in the first 4th picking. Increasing salinity levels caused a significant decrease in this respect. Moreover, the great reduction was occurred under NaCl followed by NaCl+CaCl2 and CaCl2 at 4000 mg/L as compared to the untreated plants.

Table (4) Effect of pre-soaking seeds in SA, AsA, α-tocopherol or Yeast extract on **fruits number per plant and fruits fresh weight kg/plant (first 4th pickings)** of sweet pepper grown under non-saline and saline conditions 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)
		Conc. (B)		Mean (A*C)	Conc. (B)		Mean (A*C)	Conc. (B)		Mean (A*C)	
	N.S.	2000	4000		2000	4000		2000	4000		
Fruits number per plant											
Water	1.67	0.00	0.00	0.56	2.33	1.00	1.67	2.33	1.33	1.78	1.33
SA 75	2.67	1.67	0.00	1.44	3.67	2.67	3.00	5.00	2.67	3.44	2.63
SA 150	1.67	1.00	0.00	0.89	3.00	2.33	2.33	4.67	2.33	2.89	2.04
AsA 50	2.67	1.67	0.00	1.44	2.67	1.67	2.33	3.67	1.67	2.67	2.15
AsA 100	1.00	1.33	0.00	0.78	2.33	1.33	1.56	2.67	1.67	1.78	1.37
α-toco 50	2.00	1.67	0.00	1.22	2.33	1.33	1.89	2.67	2.33	2.33	1.81
α-toco 100	2.33	2.00	0.00	1.44	3.33	2.33	2.67	3.33	2.33	2.67	2.26
Yeast 1000	1.67	0.00	0.00	0.56	2.33	1.33	1.78	2.67	1.67	2.00	1.44
Yeast 2000	2.67	1.67	0.00	1.44	2.67	1.67	2.33	3.33	2.00	2.67	2.15
Mean A	2.04	1.09			2.17			2.47			
Mean B		2.44	1.25								
Mean A*B		1.22	0.00		2.74	1.74		3.37	2.00		
LSD at 0.05	A; 0.17	B; 0.17	C; 0.29	A*B; 0.29		A*C; 0.50		B*C; 0.50		A*B*C; 0.87	
Fruits fresh weight (kg/plant)											
Water	0.23	0.00	0.00	0.08	0.35	0.10	0.23	0.33	0.11	0.22	0.17
SA 75	0.40	0.16	0.00	0.19	0.55	0.35	0.43	0.74	0.23	0.46	0.36
SA 150	0.24	0.09	0.00	0.11	0.46	0.27	0.32	0.59	0.21	0.35	0.26
AsA 50	0.34	0.15	0.00	0.16	0.44	0.20	0.33	0.53	0.14	0.34	0.28
AsA 100	0.17	0.11	0.00	0.09	0.29	0.17	0.21	0.41	0.13	0.24	0.18
α-toco 50	0.30	0.16	0.00	0.15	0.34	0.15	0.26	0.39	0.18	0.29	0.24
α-toco 100	0.33	0.18	0.00	0.17	0.51	0.26	0.37	0.49	0.20	0.34	0.29
Yeast 1000	0.22	0.00	0.00	0.07	0.37	0.20	0.26	0.39	0.18	0.26	0.20
Yeast 2000	0.36	0.14	0.00	0.17	0.41	0.21	0.33	0.49	0.17	0.34	0.28
Mean A	0.29	0.13			0.30			0.31			
Mean B		0.34	0.13								
Mean A*B		0.11	0.00		0.41	0.21		0.48	0.17		
LSD at 0.05	A; 0.02	B; 0.02	C; 0.04	A*B; 0.04		A*C; 0.07		B*C; 0.07		A*B*C; 0.11	

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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-tocopherol or Yeast extract on **fruits number per plant and fruits fresh weight kg/plant (total yield)** of sweet pepper grown under non-saline and saline conditions 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 (A*C)	Conc. (B)		Mean (A*C)	Conc. (B)		Mean (A*C)	
		2000	4000		2000	4000		2000	4000		
Fruits number per plant											
Water	20.00	17.00	12.00	16.33	22.33	16.33	19.56	22.67	14.33	19.00	18.30
SA 75	24.67	19.33	14.67	19.56	24.67	19.67	23.00	25.67	17.67	22.67	21.74
SA 150	23.67	18.33	14.00	18.67	23.00	18.67	21.78	24.67	16.67	21.67	20.70
AsA 50	23.67	18.33	13.33	18.44	21.67	19.33	21.56	24.67	17.33	21.89	20.63
AsA 100	20.33	18.00	13.00	17.11	21.00	19.00	20.11	23.67	17.00	20.33	19.19
α-toco 50	23.00	18.33	13.33	18.22	21.00	18.67	20.89	24.00	16.67	21.22	20.11
α-toco 100	24.33	18.00	13.33	18.56	21.33	19.33	21.67	24.33	17.33	22.00	20.74
Yeast 1000	21.67	18.00	12.67	17.44	20.67	17.00	19.78	22.67	15.00	19.78	19.00
Yeast 2000	22.67	18.67	13.67	18.33	21.33	17.67	20.56	24.00	15.67	20.78	19.89
Mean	A	22.67	18.07			20.99			21.04		
	B		21.38	16.05							
	A*B		18.22	13.33		21.89	18.41		24.04	16.41	
LSD at 0.05	A; 0.25	B; 0.25	C; 0.43		A*B; 0.43	A*C; 0.75		B*C; 0.75		A*B*C; 1.30	
Total yield (kg/plant)											
Water	2.76	1.30	0.80	1.62	2.92	1.83	2.50	3.09	1.13	2.33	2.15
SA 75	3.43	1.88	1.25	2.19	3.56	2.02	3.01	3.73	1.48	2.88	2.70
SA 150	3.60	1.76	1.21	2.19	3.44	2.02	3.02	3.58	1.47	2.88	2.69
AsA 50	3.40	1.68	1.12	2.07	3.44	2.00	2.94	3.52	1.36	2.76	2.59
AsA 100	3.53	1.46	1.08	2.02	2.54	1.95	2.67	3.50	1.30	2.78	2.49
α-toco 50	3.19	1.59	1.11	1.97	2.88	1.87	2.65	3.51	1.26	2.65	2.42
α-toco 100	3.43	1.52	1.10	2.01	3.24	2.12	2.93	3.39	1.40	2.74	2.56
Yeast 1000	2.95	1.33	0.81	1.70	3.15	1.87	2.66	3.21	1.12	2.43	2.26
Yeast 2000	3.25	1.46	0.92	1.88	3.19	1.90	2.78	3.47	1.23	2.65	2.44
Mean	A	3.28	1.96			2.80			2.68		
	B		2.72	1.44							
	A*B		1.55	1.04		3.15	1.95		3.44	1.31	
LSD at 0.05	A; 0.03	B; 0.03	C; 0.05		A*B; 0.05	A*C; 0.09		B*C; 0.09		A*B*C; 0.16	

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

Pre-soaking seeds in the selected bio-stimulants used at both levels caused a significant increase in the number of sweet pepper fruits and its fresh weight per plant (first 4th pickings and total yield) under non-saline conditions. In addition, pre-soaking seeds in salicylic acid at 75 mg/L or ascorbic acid at 50 mg/L was more effective in this respect.

Regarding the interactions, between salinity and the selected bio-stimulants used (A*C), data in the same tables show that there is a significant increase in fruits number and its fresh weight per plant (first 4th pickings and total yield) as compared to untreated plants under salinity conditions.In addition, means data of (A*B) indicated that the fruit number and its fresh weight per plant (first 4th pickings) were significantly increased under low level of CaCl2 and NaCl+CaCl2, but plants grown under NaCl salinity did not produced yield in the first 4th pickings. 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 the untreated plants under such salinity conditions.

Fruit quality

Ascorbic acid and total carbohydrates concentrations in the fruit

Data presented in Table (6) clearly show that increasing salinity levels from 2000 to 4000 mg/L of all salinity types (NaCl, CaCl2 and its combination 1:1) significantly increased ascorbic acid as well as total carbohydrates concentrations in sweet pepper fruits. The highest value was obtained under high salinity level in all salinity types as compared to the untreated plants. In addition, sweet pepper plants growing under NaCl resulted a greater increase in ascorbic acid and total carbohydrates concentrations followed by NaCl+CaCl2 and CaCl2 as compared to the unstressed plants (control). Furthermore, pre-soaking seeds in SA, AsA, α-tocopherol and yeast extract at both levels increased ascorbic acid and total carbohydrates concentrations under non-saline conditions.

Moreover, AsA at both levels or SA at 75 mg/L was more effective as compared with the other treatments. Regarding the interactions (A*B) the data in the same table show that ascorbic acid as well as total carbohydrates concentrations were significantly increased with increasing salinity level from 2000 to 4000 mg/L in all salinity types. The maximum increase was recorded for plants grown under NaCl followed by NaCl+CaCl2 and CaCl2.

Generally, it could be concluded that, all applied bio-stimulants used enhanced ascorbic acid and total soluble carbohydrates concentrations under high salinity levels. Furthermore, AsA at both levels or SA at 75 mg/L was more effective in this respect.

Total soluble solids percentage (TSS %):

The data presented in Table (7) clearly show that low salinity level (2000 mg/L) of all salinity types NaCl, CaCl2 and its combination (1:1) caused a high significant increase in the TSS %, thereafter decreased with increasing salinity level to 4000 mg/L. In addition, the great reduction in TSS % was occurred under NaCl at high salinity levels as compared with other salinity types. Moreover, pre-soaking seeds in SA, AsA, α-tocopherol and yeast extract at both levels increased TSS % under non-saline conditions. Furthermore, SA at 75 mg/L or AsA at 50 mg/L were more effective as compared with the other treatments. Regarding the interactions (A*B) the data revealed that TSS % was significantly increased under low salinity level (2000 mg/L) and the maximum increase was recorded for plants grown under NaCl+CaCl2 followed by CaCl2 and NaCl. While, increasing salinity level to 4000 mg/L led to a significant decrease in this respect especially under NaCl. Generally, it could be concluded that, all chemicals used enhanced TSS % under high salinity levels. Furthermore, AsA at 50 mg/L as well as SA at 75 mg/L were more effective in this respect. Generally, increasing salinity levels was associated with a reduction in sweet pepper yield.

This reduction in fruit yield may be attributed to a reduction in number of fruits per plant as well as fresh weight per plant (Tables, 4-5) and may be due to low production, expansion, senescence and physiologically less active green foliage (Kumar et al., 1994 and Wahid et al., 1997) and/or to a reduction in fruit set which may be attributed to a decrease in the viability of pollen grains and/or in the receptivity of the stigmatic surface (Khatun and Flowers, 1995) and/or decreasing water potential resulted from increasing salinity stress specially during microsporogenesis causing a significant increase in pollen sterility due to increasing ABA concentration (Saini and Westgate, 2000).

Table (6) Effect of pre-soaking seeds in SA, AsA, α-tocopherol or Yeast extract on concentration of **ascorbic acid (mg/100g FW) and total carbohydrates (mg/g DW)** in sweet pepper fruits grown under non-saline and saline conditions 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 (A*C)	Conc. (B)		Mean (A*C)	Conc. (B)		Mean (A*C)	
		2000	4000		2000	4000		2000	4000		
Ascorbic acid											
Water	16.31	29.43	38.88	28.21	22.66	33.31	24.09	24.93	36.30	25.85	26.05
SA 75	21.15	31.57	42.37	31.70	23.90	34.67	26.57	27.19	38.37	28.90	29.06

SA 150	20.98	32.18	43.19	32.12	23.77	35.06	26.60	27.69	37.82	28.83	29.18
AsA 50	22.02	32.78	44.41	33.07	24.23	35.82	27.35	28.02	38.27	29.44	29.95
AsA 100	22.47	33.04	48.02	34.51	24.43	36.09	27.66	28.31	38.50	29.76	30.64
α-toco 50	21.40	31.77	42.73	31.97	24.06	34.92	26.79	27.35	37.65	28.80	29.18
α-toco 100	21.69	32.59	44.08	32.79	24.15	35.36	27.07	27.77	38.08	29.18	29.68
Yeast 1000	18.93	29.17	39.48	29.19	22.77	33.64	25.12	25.89	36.55	27.12	27.14
Yeast 2000	19.90	30.48	40.80	30.39	23.50	34.41	25.94	26.76	37.46	28.04	28.12
Mean A	20.54	31.55			26.35			28.44			
Mean B		27.42	38.38								
Mean A*B		31.45	42.66		23.72	34.81		27.10	37.67		
LSD at 0.05	A; 0.18	B; 0.18		C; 0.31	A*B; 0.31		A*C; 0.53	B*C; 0.53		A*B*C; 0.92	
Total soluble carbohydrates											
Water	45.52	67.31	80.45	64.43	58.80	70.89	58.41	63.96	74.53	61.34	61.39
SA 75	58.67	70.78	113.05	80.83	63.66	74.34	65.56	66.91	80.01	68.53	71.64
SA 150	55.71	69.76	84.88	70.12	61.88	72.79	63.46	65.55	76.84	66.03	66.54
AsA 50	58.41	70.54	98.98	75.97	63.39	73.83	65.21	66.58	79.31	68.10	69.76
AsA 100	57.30	70.11	90.05	72.49	62.76	73.24	64.43	66.17	77.86	67.11	68.01
α-toco 50	56.42	69.91	87.15	71.16	62.37	73.07	63.95	65.86	77.41	66.56	67.22
α-toco 100	57.91	70.27	91.47	73.21	63.17	73.47	64.85	66.44	78.58	67.64	68.57
Yeast 1000	51.85	68.52	81.32	67.23	59.65	71.21	60.90	64.10	74.89	63.61	63.92
Yeast 2000	54.10	69.00	82.95	68.68	60.75	72.03	62.29	64.96	75.90	64.99	65.32
Mean A	55.10	71.57			63.23			65.99			
Mean B		65.67	80.02								
Mean A*B		69.58	90.03		61.83	72.76		65.61	77.26		
LSD at 0.05	A; 0.27	B; 0.27		C; 0.48	A*B; 0.48		A*C; 0.82	B*C; 0.82		A*B*C; 1.42	

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-tocopherol or Yeast extract on **total soluble solids (TSS) %** in sweet pepper fruits grown under non-saline and saline conditions 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 (A*C)	Conc. (B)		Mean (A*C)	Conc. (B)		Mean (A*C)	
		2000	4000		2000	4000		2000	4000		
Total soluble solids %											
Water	4.95	5.19	3.38	4.51	5.52	4.69	5.06	5.98	4.38	5.10	4.89
SA 75	5.18	5.51	4.37	5.02	5.91	4.95	5.35	7.75	4.65	5.86	5.41
SA 150	5.08	5.39	4.21	4.89	5.77	4.87	5.24	6.70	4.58	5.45	5.20
AsA 50	5.17	5.49	4.34	5.00	5.88	4.94	5.33	7.38	4.65	5.73	5.35
AsA 100	5.10	5.42	4.27	4.93	5.81	4.91	5.28	6.92	4.60	5.54	5.25

α-toco 50	5.09	5.40	4.25	4.92	5.79	4.84	5.24	6.82	4.60	5.51	5.22
α-toco 100	5.12	5.46	4.31	4.96	5.85	4.93	5.30	7.21	4.63	5.65	5.30
Yeast 1000	4.96	5.24	3.87	4.69	5.56	4.72	5.08	6.10	4.43	5.16	4.98
Yeast 2000	5.01	5.38	4.16	4.85	5.71	4.78	5.17	6.43	4.48	5.31	5.11
Mean A	5.07	4.86			5.23			5.48			
Mean B		5.98	4.51								
Mean A*B		5.39	4.13		5.75	4.85		6.81	4.56		
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; 0.06	

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

Moreover, poor seed setting characterized by sterile fruits is believed to be due to a reduction in fruit number (Tables, 4 -5) referred to substantial abscission of flowers or young fruit due to ethylene induction (Bishnoi et al., 1990). This factor affecting cell division and cell expansion, such as tissue water status and the concentration of certain plant hormones, i.e. ABA is involved in the regulation of fruit set under stress (Saini and Westgate, 2000) .

In the present investigation, presoaking seeds in phytohoromnes, vitamins and yeast extract has a beneficial effect on yield of pepper grown under saline conditions by enhancing growth and nutritional status of plant (Faissal and Hassan, 2004). These results are in agreement with El-lithy and El-Greadly (2001) who pointed out that AsA gave earliness of melon flowering and yield and increased weight of total yield but the number of fruits was not affected. In addition, Faissal and Hassan (2004) reported that AsA caused promotion on number of clusters/vine, yield/vine and cluster and berry weights in grapevines. The obtained results might be attributed to the increment in the amounts of metabolites synthesized by the plant, which, in turn, accelerated plant growth and dry weight, resulting in favorable effects on flowering and fruiting as well as finally improved the total yield.

Concerning ascorbic acid and its role in increasing carbohydrates and protein, it could be concluded that ascorbic acid play a role as activator or intermediate in the formation of carbohydrates during photosynthesis. It may be the transformative product of the sugar first found in photosynthesis (Ghourab and Wahdan, 2000). Moreover, Ahmed (2001) reported that ascorbic acid enhances the biosynthesis of carbohydrates and translocation of sugars.

Salicylic acid might be increase enzyme activity as α-amylase, nitrate reductase which accelerates the sugar translocation from the leaves to developing fruit (Sharma et al., 1986). In addition, Haroun et al. (1998) found that low dose of salicylic acid (2.5 mM) significantly increased total carbohydrate content in seed lupine. While, higher doses (5 and 10 mM) significantly decreased total carbohydrate content in maize grains (Abdel-Wahed et al., 2006). Moreover, Amin et al. (2008) stated that enhancement effect of total carbohydrates as well as nitrogen, phosphorus and potassium contents in wheat grains was obtained by 100 or 200 mg L-1 of salicylic acid.

The stimulating effect of α-tocopherol on yield and its quality on sweet pepper may be due to the role of α-tocopherol in preventing the propagation of lipid peroxidation by scavenging lipid peroxyl radicals in thylakoid membranes. Sattler et al. (2004) mentioned that the only well defined tocochromanol function in plants to date is the protection of seed storage lipids from oxidation during dormancy and germination.

The positive effects of applying yeast could be attributed to its active role in hydrolysis of pectic substances, vitamins, enzymes and coenzymes that are important components of the yeast. Moreover, yeast has three basic functions, i.e. carbon dioxide production, formation of alcohol, acids, esters (Martinez-Anoya et al., 1990 and Nadia, 1995) and it contains after decomposition a wide group from amino acids and vitamins (FAO, 2008). In addition, yeast contains different nutrients especially nitrogen, phosphorus and potassium as well as some common amino acids (Abou-Zaid, 1984) and/or its capability to produce ethylene followed accumulation of phytoalexin, 6-methoxyeelein (Guo and Ohta, 1994). Thus, mechanism of yeast functions may be due to one or more of yeast components or the bio-products of reactions by yeast with other bio-organism compounds.

Dealing with the various positive effects of applying active dry yeast to plants, Idso et al. (1995) reported that these effects are attributed to their own contents of different nutrients, high protein, larger amount of vitamin B and natural plant growth regulators such as cytokinins which play a role in orientation and translocation of metabolites from leaves into the reproductive organs. Moreover, it might be play a role in the synthesis of protein degradation which might lead to the improvement of yield and its quality (El-Ghamriny et al., 1999). In addition, soluble phosphate combination with cation in soil solution to form low solubility substances called phosphate fixation which improve net photosynthesis. Moreover, Naguib and Khalil (2002) found that the enhancing effect of yeast on the growth and yield of black cumin plants could be attributed to its great content of minerals particularly N, P and K as well as certain natural hormones, beside high amount of vitamins especially B which plays an important role in improving growth.

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