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RESPONSE OF FABA BEAN PLANTS TO APPLICATION OF SOME GROWTH PROMOTERS UNDER SALINITY STRESS CONDITIONS

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ABSTRACT

Two pot experiments were carried out during two growing seasons (2010/2011 and 2011/2012) at Seed Technology Research Unit, Seed Technology Research Department , Field Crops Research Institute. The aim of these experiments were to study the response of faba bean namely (Sakha1) growing in saline soil (2000 mg/L, 4000 mg/L, 6000 mg/L and 8000 mg/L) to application of some growth promoters (Salicylic acid 250 mg/L, Ascorbic acid 250 mg/L, α –Tocopherol 100 mg/L, Humic acid 1000 mg/L, Yeast extracts 2000 mg/L) as seed soaking, foliar spraying or seed soaking and foliar spraying together. The effect of these promoters on faba bean yield and it`s components were recorded. Results indicated that salinity stress levels at 8000 mg/L followed by 6000 mg/L, 4000 mg/L and 2000 mg/L respectively, compared with control treatment (320 mg/L) were the most effective in decreasing all yield and it`s parameters (number of pods / plant, pods weight / plant (g), number of seeds / plant, seeds weight / plant (g) and 100- seed weight (g)). While, applied antioxidants promoters ASA 250 mg/L followed by SA 250 mg/L, Yeast extract 2000 mg/L, Humic acid 1000 mg/L and Tocopherol 100 mg/L compared with water as control applied as (seed soaking, foliar spraying or seed soaking and foliar spraying together) were the most effective in increasing all yield and it`s parameters. It could be seen that applied antioxidants as growth promoters hardly decreasing the harmful effects of salinity stress on yield and it`s components of faba bean plants.

INTRODUCTION

Faba bean (*Vicia faba* L.) have a long tradition of cultivation in old world agriculture, being among the most ancient plants in cultivation and also among the easiest to grow. The whole dried seeds of faba bean contain (per 100g) 344 calories, 10.1% moisture, 1.3g fat, 59.4g total carbohydrate, 6.8g fiber, 3.0 g ash, 104mg Ca, 301mg P, 6.7mg Fe, 8mg Na, 1123mg K, 130mg B-carotene equivalent, 0.38 mg thiamine, 0.24mg riboflavin, 2.1mg niacin, and 162mg tryptophane. Flour contains: 340 calories, 12.4, % moisture, 25.5g protein, 1.5g fat, 58.8g total carbohydrate, 1.5g fiber, 1.8g ash, 66mg Ca, 354mg P, 6.3mg Fe, 0.42mg thiamine, 0.28mg riboflavin, and 2.7mg niacin. The fatty acid composition of broad bean oil has been reported as 88.6% unsaturated" (Duke, 1981). The amino acid content except for methionine is reasonably well balanced (Bond *et al*., 1985).

Soil salinity threshold levels depend on a crop species, variety, developmental stage and environmental factors. One of the most important abiotic stress factors is soil salinity. It causes great effect of development of growth, yields of crops (Chaparzadeh, *et al*. 2004, Rahnama and Ebrahimzadeh, 2005) and causes great losses in yield crops (Smirnoff 1998). Seed germination also affected by the excessive content of salt in soil solution, particularly in case of sensitive plants.

Production of reactive oxygen species forms one of the biochemical response of plants to abiotic and biotic stress (Rahnama and Ebrahimzadeh, 2005). ROS also produced during physiological metabolic activity of plants (photosynthesis and respiration). Application of antioxidants as growth promoters is one of the most important ways to increasing salt tolerance of plants. Treatments of [Salicylic acid (SA), Ascorbic acid (ASA), Tochopherol (Toco), Humic acid (HA) and Yeast extract] proved effective in reducing the adverse effect of salinity on growth, yield and chemical composition of faba bean plants.

Because of that, the currant study takes place to investigate the application of some natural antioxidants as (presoaking, spraying or presoaking and spraying) on improving yield and it`s components of faba bean (seeds or plants), as well as reducing the harmful effects induced by salinity stress conditions.

MATERIALS AND METHODS

Pot experiments (seeds presoaking, plant foliar spraying or presoaking and foliar spraying together) were performed twice during the growing seasons of (2010/2011 and 2011/2012).

Seed sowing was carried out on the 20_{th} November in the two growing seasons in pots. Plastic pots of 40 cm diameter were filled with 10 kg of air dried loamy soil. Faba bean seeds were sown at the rate of 8 seeds/pot. The experimental units were fertilized with calcium super phosphate (15.5% P_2O_5), nitrogen in the form of urea (46.5% N) and potassium sulphate (K_2O). Harvesting was in Marsh 1_{st} in the 1_{st} and 2_{nd} seasons, respectively.

Salinity stress levels: Four appropriate amounts of artificial sea water were used by dissolving known weight of natural salt crust, in tap water. The source of salt crust was obtained from the salterns of Rashid, El- Beheira Governorate, Egypt. The appropriate amount of salt for each salinity level was calculated, dissolved in the proper amount of tap water and used for experimental investigation.

Five salinity stress levels were used:1- Tap water (320 mg/L), 2- 2000 (mg/L), 3- 4000 (mg/L), 4- 6000 (mg/L) and 5- 8000 (mg/L).

Growth promoters materials: The sterilized seeds were soaked for 12 hours in any of antioxidant used before sowing, whereas in foliar spraying or seeds soaking and foliar spraying together treatments, plants were sprayed with any of antioxidant used at two physiological stages (25 and 35 days after

sowing). Wetting agent (tween 20) at 0.05% was added to antioxidants before spraying.

The selected antioxidant materials: 1- Tap water, 2- Salicylic acid (250 mg/L), 3- Ascorbic acid (250 mg/L), 4- α –Tocopherol (100 mg/L), 5- Humic acid (1000 mg/L) and 6- Yeast extracts (2000 mg/L).

This experiment contained 5 salinity levels and 6 antioxidant materials. Then the experiment consisted of 30 treatments. Each treatment replicated 3 times. All data were subjected to statistical analysis by the technique of analysis of variance (ANOVA) of randomized complete block design for treatment salinity with treatment antioxidants as a split plot on salinity according to Gomez and Gomez (1984).

Studied Characteristics:-

- Yield and it`s components:

At harvest time, five plants were taken to estimate the following characters: Number of pods/plant, Pods weight / plant (g), Number of seeds / plant, Seeds weight / plant (g) and 100- Seed weight (g).

RESULTS

Data presented in Tables (1-5) indicated that all salinity stress levels decreased yield and it`s parameters of faba bean plants against untreated plants. High salinity stress level 8000 (mg/L) was the most effective in this respect.

Moreover that, applied antioxidants as growth promoters (Salicylic acid 250 mg/L, Ascorbic acid 250 mg/L, α –Tocopherol 100 mg/L, Humic acid 1000 mg/L, Yeast extracts 2000 mg/L) in pot experiments (presoaking, foliar spraying or presoaking and foliar spraying together) alleviated the harmful effects of salinity stress which enhanced yield and it`s components.

Yield and it`s components of faba bean plant:-

1- Number of pods / plant.

Data presents in Table (1) showed that stressed plants grown under salinity stress levels recorded lowest values of number of pods/plant when compared with control treatment (320 mg/L). In this respect, salinity stress level at 8000 mg/L recorded the lowest value. All antioxidants promoters were applied recorded the highest values as compared with tap water as control.

Table (1): No. of pods / plant as affected by salinity stress levels, applied antioxidants as (Presoaking, Foliar spraying or Presoaking and Foliar spraying together) and their interactions during the two growing seasons (2010/2011 and 2011/2012).

Treat. / Anti.	320	2000	4000	6000	8000	Mean	320	2000	4000	6000	8000	Mean
	Season 2010/2011						Season 2011/2012					
(Presoaking)												
Tap water	11.51	10.07	8.65	7.03	5.41	8.53	10.67	9.02	7.34	5.71	4.56	7.46
SA (250 mg/L)	15.58	14.09	12.66	10.93	8.47	12.35	15.09	13.55	11.23	9.60	7.25	11.34
ASA (250mg/L)	17.25	15.61	13.38	11.59	9.10	13.39	17.17	15.05	12.42	10.11	7.97	12.54
TOCO (100 mg/L)	13.37	12.64	11.06	9.55	7.48	10.82	12.86	11.58	9.94	8.14	6.42	9.79
HA (1000 mg/L)	14.51	13.07	11.54	9.97	7.71	11.36	13.42	12.30	10.69	9.04	6.84	10.46
Yeast (2000 mg/L)	15.05	13.89	12.22	10.66	8.12	11.99	14.73	13.26	11.05	9.36	7.15	11.11
Mean	14.55	13.23	11.59	9.96	7.72		13.99	12.46	10.45	8.66	6.70	
New LSD 5%	Salinity: 0.24 Anti.: 0.12 Inter.: 0.32						Salinity: 0.25 Anti.: 0.10 Inter.: 0.24					
(Foliar spraying)												
Tap water	11.49	10.26	8.61	7.06	5.51	8.59	10.34	9.08	7.35	5.22	4.59	7.32
SA (250 mg/L)	15.02	13.95	12.56	10.73	8.76	12.20	13.66	12.41	10.44	9.18	6.93	10.52
ASA (250 mg/L)	16.75	15.39	13.61	11.92	9.40	13.41	16.01	13.41	11.20	9.56	7.44	11.52
TOCO (100 mg/L)	13.59	12.48	10.94	9.66	7.15	10.76	11.84	10.68	9.18	7.70	6.29	9.14
HA (1000 mg/L)	13.95	12.92	11.50	10.06	7.49	11.18	12.46	10.96	9.53	8.39	6.54	9.58
Yeast (2000 mg/L)	14.83	13.61	12.42	10.58	8.47	11.98	13.38	11.60	10.08	9.22	6.74	10.20
Mean	14.27	13.10	11.61	10.00	7.80		12.95	11.36	9.63	8.21	6.42	
New LSD 5%	Salinity: 0.2 Anti.: 0.12 Inter.: 0.35						Salinity: 0.09 Anti.: 0.09 Inter.: 0.23					
(Presoaking and Foliar spraying)												
Tap water	11.75	10.36	8.58	7.26	5.78	8.75	10.32	9.09	7.60	6.17	5.02	7.64
SA (250mg/L)	17.43	15.84	13.71	11.77	9.79	13.71	15.87	14.89	12.58	10.50	8.44	12.46
ASA (250 mg/L)	19.03	17.23	14.67	12.98	10.33	14.85	18.43	16.63	13.58	11.82	9.06	13.90
TOCO (100 mg/L)	15.22	13.56	11.65	9.83	7.81	11.61	13.61	12.55	10.64	8.52	6.48	10.36
HA (1000 mg/L)	15.73	13.98	12.31	10.64	8.65	12.26	14.27	13.39	11.50	9.36	7.37	11.18
Yeast (2000 mg/L)	17.24	15.46	13.68	11.74	9.33	13.49	15.50	14.55	12.40	10.56	8.18	12.24
Mean	16.07	14.41	12.43	10.70	8.62		14.67	13.52	11.38	9.49	7.43	
New LSD 5%	Salinity: 0.38 Anti.: 0.20 Inter.: 0.67						Salinity: 0.09 Anti.: 0.08 Inter.: 0.18					

SA: Salicylic acid ASA: Ascorbic acid TOCO: Tocopherol HA: Humic acid Yeast: Yeast extract

2- Pods weight / plant (g).

Data presents in Table (2) showed that stressed plants grown under salinity stress treatments recorded lowest values of pods weight/plant (g) against control treatment (320 mg/L). All antioxidants which applied as growth promoters recorded the highest values of pods weight/plant (g) in presoaking, foliar spraying and presoaking and foliar spraying together experiments, while compared with tap water (control) at all salinity stress levels.

Table (2): Pods weight / plant (g) as affected by salinity stress levels, applied antioxidants as (Presoaking, Foliar spraying or Presoaking and Foliar spraying together) and their interactions during the two growing seasons (2010/2011 and 2011/2012).

Treat. / Anti.	Salinity Levels (mg/L)											
	320	2000	4000	6000	8000	Mean	320	2000	4000	6000	8000	Mean
	Season 2010/2011						Season 2011/2012					
(Presoaking)												
Tap water	24.23	21.76	17.82	15.69	14.44	18.79	19.27	16.17	14.35	11.28	9.09	14.03
SA (250 mg/L)	31.30	29.22	26.71	23.58	19.71	26.10	28.31	25.17	20.32	18.08	14.03	21.18
ASA (250mg/L)	34.80	31.32	28.79	25.79	21.80	28.50	32.68	28.29	24.12	19.99	15.81	24.18
TOCO (100 mg/L)	29.10	25.40	23.65	20.86	16.93	23.19	22.94	21.48	17.95	15.63	12.30	18.06
HA (1000 mg/L)	29.86	26.69	24.72	21.58	17.70	24.11	24.98	23.01	18.89	16.34	13.20	19.28
Yeast (2000 mg/L)	30.73	28.48	26.14	23.15	19.01	25.50	27.34	24.65	20.53	18.76	14.10	21.08
Mean	30.00	27.15	24.64	21.78	18.27		25.92	23.13	19.36	16.68	13.09	
New LSD 5%	Salinity: 0.57 Anti.: 0.27 Inter.: 0.74						Salinity: 0.42 Anti.: 0.30 Inter.: 0.75					
(Foliar spraying)												
Tap water	24.39	22.68	19.28	16.17	13.75	19.25	19.14	16.25	13.64	10.82	9.23	13.82
SA (250 mg/L)	31.17	28.85	26.04	22.80	19.21	25.61	27.01	23.40	20.50	18.05	13.31	20.45
ASA (250 mg/L)	33.76	31.37	27.85	24.76	20.99	27.75	29.45	25.43	22.32	20.00	14.67	22.37
TOCO (100 mg/L)	27.44	25.80	23.03	19.74	16.28	22.46	21.76	20.36	16.50	14.51	11.55	16.94
HA (1000 mg/L)	28.64	26.97	24.10	20.52	17.54	23.55	22.97	21.72	18.10	15.81	12.56	18.23
Yeast (2000 mg/L)	30.54	28.55	25.22	22.21	18.53	25.01	26.22	22.89	20.24	18.21	13.13	20.14
Mean	29.32	27.37	24.25	21.03	17.72		24.43	21.68	18.55	16.23	12.41	
New LSD 5%	Salinity:0.76 Anti.: 0.3 Inter.: 1.22						Salinity: 0.29 Anti.: 0.21 Inter.: 0.51					
(Presoaking and Foliar spraying)												
Tap water	25.18	22.87	19.00	16.61	14.35	19.60	17.96	15.99	13.72	12.19	11.05	14.18
SA (250mg/L)	36.54	33.91	29.91	26.70	21.59	29.73	32.15	29.40	24.71	20.69	17.32	24.85
ASA (250 mg/L)	39.33	36.70	33.10	29.58	23.84	32.51	36.20	31.99	26.27	23.68	18.40	27.31
TOCO (100 mg/L)	31.57	27.91	25.23	21.94	18.43	25.02	27.52	24.90	20.23	16.88	13.35	20.58
HA (1000 mg/L)	33.21	30.43	26.82	23.20	19.43	26.62	29.47	26.16	21.22	17.92	14.52	21.86
Yeast (2000 mg/L)	35.24	32.68	28.90	25.90	20.71	28.69	31.34	28.09	23.62	20.01	16.84	23.98
Mean	33.51	30.75	27.16	23.99	19.73		29.11	26.09	21.63	18.56	15.25	
New LSD 5%	Salinity: 0.38 Anti.: 0.32 Inter.: 0.91						Salinity: 0.38 Anti.: 0.15 Inter.: 0.34					

SA: Salicylic acid ASA: Ascorbic acid TOCO: Tocopherol HA: Humic acid Yeast: Yeast extract

3- Number of seeds / plant.

Data presents in Tables (3) showed that salinity stress levels decreased values of number of seeds/plant of stressed plants against control treatment. In this regard, the most effective salinity level was 8000 mg/L followed by 6000 mg/L, 4000 mg/L and 2000 mg/L respectively. Applied ASA (250 mg/L) followed by SA (250 mg/L), yeast (2000 mg/L), HA (1000 mg/L) and Toco (100 mg/L), respectively, recorded the highest values in all pot experiments when compared with Tap water (control).

Table (3): No. of Seeds / plant as affected by salinity stress levels, applied antioxidants as (Presoaking, Foliar spraying or Presoaking and Foliar spraying together) and their interactions during the two growing seasons (2010/2011 and 2011/2012).

(Presoaking)												
Treat. / Anti.	Salinity Levels (mg/L)											
	320	2000	4000	6000	8000	Mean	320	2000	4000	6000	8000	Mean
	Season 2010/2011						Season 2011/2012					
Tap water	20.57	18.76	16.48	14.49	12.49	16.56	18.07	16.68	14.80	12.51	10.71	14.55
SA (250 mg/L)	28.98	26.84	23.51	21.58	18.25	23.83	25.30	22.25	20.65	18.70	15.42	20.46
ASA (250mg/L)	32.25	29.11	26.24	23.49	20.06	26.23	28.18	24.77	21.79	19.92	17.39	22.41
TOCO (100 mg/L)	25.14	22.88	20.41	18.41	15.83	20.53	22.17	19.33	16.85	15.60	13.60	17.51
HA (1000 mg/L)	27.20	24.76	21.71	19.84	16.71	22.04	22.97	20.30	18.09	16.28	14.56	18.44
Yeast (2000 mg/L)	28.07	25.71	22.50	21.28	17.30	22.97	24.20	21.93	19.67	17.18	15.31	19.66
Mean	27.04	24.68	21.81	19.85	16.77		23.48	20.88	18.64	16.70	14.50	
New LSD 5%	Salinity:0.57 Anti.: 0.31 Inter.: 1.02						Salinity: 0.28 Anti.: 0.22 Inter.:0.62					
(Foliar spraying)												
Tap water	21.46	19.35	16.98	14.37	12.91	17.01	17.79	16.52	14.42	11.75	10.76	14.25
SA (250 mg/L)	29.60	26.13	24.17	21.37	18.65	23.98	25.13	22.79	20.33	18.17	15.57	20.40
ASA (250 mg/L)	31.64	28.07	25.21	23.30	19.50	25.54	27.63	24.74	21.20	19.70	16.94	22.04
TOCO (100 mg/L)	25.43	23.05	20.92	18.98	16.18	20.91	21.52	19.72	17.63	15.70	13.30	17.57
HA (1000 mg/L)	27.77	24.02	21.73	19.96	16.83	22.06	22.74	20.42	18.18	16.73	13.99	18.41
Yeast (2000 mg/L)	28.84	25.17	23.26	20.90	17.67	23.17	24.33	21.84	19.62	17.27	15.14	19.64
Mean	27.46	24.30	22.05	19.81	16.96		23.19	21.01	18.56	16.55	14.28	
New LSD 5%	Salinity: 0.59 Anti.: 0.27 Inter.: 0.59						Salinity: 0.50 Anti.: 0.17 Inter.: 0.45					
(Presoaking and Foliar spraying)												
Tap water	22.57	20.08	17.86	15.81	13.69	18.00	19.90	17.08	14.13	12.26	10.77	14.83
SA (250mg/L)	33.42	30.74	27.27	24.60	21.62	27.53	29.99	28.20	24.51	20.85	17.71	24.25
ASA (250 mg/L)	35.60	32.33	29.33	26.83	23.51	29.52	32.94	30.00	26.97	22.75	19.39	26.41
TOCO (100 mg/L)	29.03	26.16	23.67	20.87	17.73	23.49	25.93	24.16	20.67	17.69	13.98	20.49
HA (1000 mg/L)	29.84	27.57	24.94	22.58	18.60	24.71	27.68	25.57	21.95	18.93	15.52	21.93
Yeast (2000 mg/L)	32.47	29.56	26.03	23.56	19.74	26.27	29.27	27.37	22.99	20.02	16.21	23.17
Mean	30.49	27.74	24.85	22.38	19.15		27.62	25.40	21.87	18.75	15.60	
New LSD 5%	Salinity: 0.64 Anti.: 0.25 Inter.: 0.70						Salinity: 0.59 Anti.: 0.26 Inter.: 0.68					

SA: Salicylic acid ASA: Ascorbic acid TOCO: Tocopherol HA: Humic acid Yeast: Yeast extract

4- Seed weight / plant (g).

Data presents in Tables (4) indicated that salinity stress levels decreased values of seeds weight/plant (g) of stressed plants against control treatment (320 mg/L). More, applied growth promoters (antioxidants) recorded the highest values in all pot experiments against tap water as control.

Table (4): Seeds weight / plant (g) as affected by salinity stress levels, applied antioxidants as (Presoaking, Foliar spraying or Presoaking and Foliar spraying together) and their interactions during the two growing seasons (2010/2011 and 2011/2012).

Treat. / Anti.	Salinity Levels (mg/L)											
	320	2000	4000	6000	8000	Mean	320	2000	4000	6000	8000	Mean
	Season 2010/2011						Season 2011/2012					
(Presoaking)												
Tap water	14.73	13.80	11.83	10.12	8.66	11.83	12.03	10.15	8.64	6.27	5.18	8.45
SA (250 mg/L)	23.18	20.93	18.23	16.12	13.00	18.29	19.36	16.53	13.84	11.27	9.04	14.01
ASA (250mg/L)	25.60	22.90	19.86	17.74	14.87	20.19	21.85	18.48	15.64	12.64	10.01	15.72
TOCO (100 mg/L)	19.57	17.33	15.00	13.44	10.97	15.26	15.11	12.81	10.95	9.46	8.09	11.28
HA (1000 mg/L)	21.29	18.37	15.85	14.76	11.62	16.38	16.47	14.40	11.95	10.56	8.50	12.38
Yeast (2000 mg/L)	21.94	19.54	17.39	15.44	12.37	17.34	18.47	15.37	13.24	11.17	8.83	13.42
Mean	21.05	18.81	16.36	14.60	11.92		17.22	14.62	12.38	10.23	8.28	
New LSD 5%	Salinity: 0.27 Anti.: 0.23 Inter.: 0.63						Salinity: 0.37 Anti.: 0.22 Inter.: 0.56					
(Foliar spraying)												
Tap water	15.38	13.78	12.34	10.19	8.47	12.03	11.47	10.31	8.14	6.12	5.05	8.22
SA (250 mg/L)	23.11	20.72	18.31	16.03	13.29	18.29	18.34	15.60	13.15	11.69	9.12	13.58
ASA (250 mg/L)	25.31	22.81	20.12	17.41	14.36	20.00	20.69	17.64	14.43	12.90	9.81	15.09
TOCO (100 mg/L)	19.85	17.75	15.40	13.49	10.86	15.47	15.20	13.35	11.27	9.51	7.96	11.46
HA (1000 mg/L)	20.98	18.82	16.72	14.17	11.95	16.53	16.36	13.82	11.78	10.23	8.47	12.13
Yeast (2000 mg/L)	22.47	20.49	17.59	15.35	12.79	17.74	17.69	14.87	12.82	11.17	8.82	13.07
Mean	21.18	19.06	16.75	14.44	11.95		16.63	14.27	11.93	10.27	8.21	
New LSD 5%	Salinity:0.67 Anti.: 0.21 Inter.: 0.56						Salinity: 0.26 Anti.: 0.14 Inter.: 0.35					
(Presoaking and Foliar spraying)												
Tap water	14.99	14.06	12.39	10.40	8.81	12.13	12.07	10.32	8.35	7.01	6.14	8.78
SA (250mg/L)	25.38	23.62	20.59	18.37	15.30	20.65	22.43	20.77	17.03	13.37	11.08	16.94
ASA (250 mg/L)	27.37	26.27	23.42	20.02	16.92	22.80	25.06	22.04	18.35	15.47	11.84	18.55
TOCO (100 mg/L)	22.54	19.17	17.61	14.85	11.90	17.21	19.08	17.33	13.84	11.16	8.48	13.98
HA (1000 mg/L)	23.57	20.22	18.36	16.33	12.83	18.26	20.25	18.54	14.81	11.54	9.44	14.92
Yeast (2000 mg/L)	25.26	23.21	20.22	17.33	13.95	19.99	21.43	20.14	15.68	12.51	10.27	16.01
Mean	23.19	21.09	18.77	16.22	13.29		20.05	18.19	14.68	11.84	9.54	
New LSD 5%	Salinity: 0.33 Anti.:0.25 Inter.: 0.66						Salinity: 0.28 Anti.: 0.20 Inter.: 0.50					

SA: Salicylic acid ASA: Ascorbic acid TOCO: Tocopherol HA: Humic acid Yeast: Yeast extract

5- 100- Seed weight (g).

Data presents in Table (5) showed that stressed plants grown under all salinity stress treatments recorded lowest values of 100-seed weight (g) against control treatment (320 mg/L). All antioxidants which applied as growth promoters recorded highest values of 100-seed weight (g) in presoaking, foliar spraying and the presoaking and foliar spraying together experiments, when compared with tap water (control) at all salinity stress levels.

Table (5): Hundred Seed weight / plant (g) as affected by salinity stress levels, applied antioxidants as (Presoaking, Foliar spraying or Presoaking and Foliar spraying together) and their interactions during the two growing seasons (2010/2011 and 2011/2012).

Treat. / Anti.	Salinity Levels (mg/L)											
	320	2000	4000	6000	8000	Mean	320	2000	4000	6000	8000	Mean
	Season 2010/2011						Season 2011/2012					
(Presoaking)												
Tap water	64.47	60.92	57.27	54.38	51.43	57.69	67.49	63.47	60.76	59.06	54.30	61.02
SA (250 mg/L)	74.26	71.61	68.21	64.27	60.30	67.73	74.62	72.57	71.04	67.15	63.20	69.72
ASA (250mg/L)	75.81	74.16	69.86	66.44	62.22	69.70	76.27	73.86	71.83	68.79	65.05	71.16
TOCO (100 mg/L)	69.82	68.43	65.28	61.92	57.66	64.62	72.12	68.33	66.10	63.59	61.05	66.24
HA (1000 mg/L)	71.62	69.00	66.65	63.06	58.83	65.83	73.44	69.80	67.18	65.28	61.69	67.48
Yeast (2000 mg/L)	73.23	70.26	67.57	63.26	59.64	66.79	74.59	71.48	69.33	66.07	62.54	68.80
Mean	71.54	69.06	65.81	62.22	58.35		73.09	69.92	67.71	64.99	61.31	
New LSD 5%	Salinity: 0.74 Anti.: 0.32 Inter.: 1.48						Salinity: 0.65 Anti.: 0.31 Inter.: 1.01					
(Foliar spraying)												
Tap water	63.35	60.41	56.40	52.94	49.91	56.60	65.10	61.83	59.88	57.20	55.32	59.87
SA (250 mg/L)	72.40	70.28	67.21	62.93	58.43	66.25	73.75	70.20	67.75	65.03	63.02	67.95
ASA (250 mg/L)	74.18	71.46	68.58	65.02	60.61	67.97	75.50	72.22	69.21	66.41	63.77	69.42
TOCO (100 mg/L)	68.91	65.93	62.34	59.72	55.53	62.49	70.63	67.40	64.39	61.58	60.46	64.89
HA (1000 mg/L)	70.12	67.44	62.89	64.15	56.29	64.18	72.20	68.26	65.55	63.41	61.54	66.19
Yeast (2000 mg/L)	71.12	69.44	65.23	61.84	57.42	65.01	73.60	69.45	67.08	64.02	62.53	67.34
Mean	70.01	67.49	63.78	61.10	56.37		71.80	68.23	65.64	62.94	61.11	
New LSD 5%	Salinity: 0.9 Anti.: 0.6 Inter.: 2.42						Salinity: 1.04 Anti.: 0.25 Inter.: 1.05					
(Presoaking and Foliar spraying)												
Tap water	66.16	62.90	59.42	56.05	52.36	59.38	64.39	61.93	59.28	56.88	54.69	59.43
SA (250mg/L)	76.42	74.12	70.44	66.04	62.47	69.90	76.30	73.95	71.08	68.58	63.79	70.74
ASA (250 mg/L)	80.39	78.88	72.92	69.66	64.36	73.24	78.13	75.35	72.48	69.97	66.73	72.53
TOCO (100 mg/L)	72.38	70.35	66.48	62.88	58.80	66.18	73.59	70.48	66.73	63.72	61.44	67.19
HA (1000 mg/L)	73.56	71.45	67.24	64.13	60.31	67.34	74.27	71.88	68.32	64.86	61.87	68.24
Yeast (2000 mg/L)	75.37	72.66	69.78	65.27	61.58	68.93	75.60	72.89	70.04	68.87	63.79	70.24
Mean	74.05	71.73	67.71	64.01	59.98		73.71	71.08	67.99	65.48	62.05	
New LSD 5%	Salinity: 0.47 Anti.: 0.35 Inter.: 1.25						Salinity: 0.19 Anti.: 0.33 Inter.: 1.01					

SA: Salicylic acid ASA: Ascorbic acid TOCO: Tocopherol HA: Humic acid Yeast: Yeast extract

DISCUSSION

Effect of salinity stress on:
Yield and it`s components.

Water salinity caused by soil salinity is an environmental stress factor that inhibits growth and yield of glycophytic crop plants in many regions of the world, agreement with (Epstein, 1985).

The salinity effect on leaf are and dry matter and finally caused a decreased of about 15%. The decrease in yield of grains was about 28%. The yield depression confirms the low salt tolerance of broad bean. So the reduction in yield is mainly caused by a difference in the weight of grains corresponds with the observation that the water stress was significantly affected before the stage of flowering and fruit setting.

More, Salinity stress does not even necessarily have to occur during reproductive growth stages in order to exert its effects on plant reproduction and thas seed yield. The effects of the different stress conditions may be attributed to physiological and metabolic changes, which affect yield development (Hameda, 2011).

Salinity stress may led to competes between Na^+ and K^+ for binding sites essential for cellular function. The latter implication of these two macronutrients in salinity is thought be to one of the factors responsible for reduction in the biomass and yield components (Tester and Davenport, 2003).

The yield depression confirms the low salt tolerance of broad beans. The observation that the decrease in yield is mainly caused by a difference in the weight of the grains corresponds with the observation that the water stress was not significantly affected before the stage of flowering and fruit setting (Katerji *et al*., 1992).

More, The reduction in seed yield is largely due to a decrease in seed set, which may be attributed to a decrease in the viability of pollen or in the receptivity of the stigmatic surface or both as pointed by (Sakr *et al*., 2004). The depression effects of salinity on grain yield may be due to decreasing the leaf area and number per plant, resulting reduction in the supply of carbon assimilate due to decreasing the net photosynthetic rate and biomass accumulation (Sakr and El-Metwally, 2009).

Role of non-enzymatic antioxidants on alleviating and mitigation the harmful effects of salinity stress:-

1- Salicylic acid:

During the relationship between SA, NaCl stress and oxidative stress, the expression of the genes RD29A, PR1, and GPX have been reported to increase after NaCl, SA and oxidative stress, respectively. RD29A gene expression is induced by NaCl and osmotic stresses and encodes a protein with potential protective function during desiccation (Yamaguchi-Shinozaki and Shinozaki, 1993a).

SA antioxidant mediated effect of NaCl on the oxidized state in the glutathione pool that may explain the observed phenotype. Elevated levels of GSH are associated with increased oxidative stress tolerance. Moreover, transgenic plants over-expressing glutathione reductase had both elevated levels of GSH and increased tolerance to oxidative stress in leaves (Broadbent *et al*., 1995).

The osmotic stress can induce the activation of a SA induced protein kinase. Also, in Arabidopsis SA has been proposed to have a dual role, SA is very important for the induction of antioxidant defenses and maintaining the redox state of the glutathione pool (Sharma *et al*., 1996 and Mikolajczk *et al*., 2000).

SA greatly potentiates the effects of salt and osmotic stresses by enhancing ROS generation during photosynthesis and germination of Arabidopsis. High NaCl enhanced the production of ROS and that somehow SA could be involved in the increased ROS. This role of SA in the generation of ROS could explain the increased tolerance of seedlings to NaCl. The increase in fresh weight of faba bean in response to SA could be attributed to the role of those growth regulators in decreasing the rate of water loss caused by salinity stress (El-Hakem, 2008).

SA might alleviate the imposed salt stress, either via osmotic adjustment or by conferring desiccation resistance to plant cells as reported by other investigators (Hussein *et al*,. 2007 and Gunes *et al*., 2007).

The increase in dry weight of salt stressed faba bean in response to SA treatment may be related to the induction of antioxidant response and protective role of membranes that increase the tolerance of plant to damage. The stimulation effect of SA on the endogens ascorbic acid might play an important role as an antioxidant and protect the faba bean plants from the oxidative damage by scavenging ROS that are generated during salt stress conditions (Arrigoni and De Tullio, 2000; Gunes *et al*., 2007 and Athar *et al*., 2008).

SA as foliar treatment or seed soaking and their interaction alleviated the harmful effect of salt stress on Vicia faba growth and yield by decreasing the water loss induced by stress and/or increasing the water and ions uptake (Khafaga *et al*., 2009).

2- Ascorbic acid:

Ascorbic acid (ASA) is small water soluble antioxidants molecule which acts as primary substrate in the cyclic pathway for enzymatic detoxification and neutralization of singlet oxygen, hydrogen and peroxide superoxide radicals generated by stress (Noctor and Foyer, 1998 and Shalata and Neumann, 2001).

Also, pre-treatment with vitamin C led to a significant increase in betaine levels in vitamin C, such an increase may be attributed to the fact that the addition of this precursor (vitamin C) promotes betaine formation by stimulating its biosynthesis as discussed by (Hitz *et al*., 1982). The significant increase of this osmolyte (proline and petaine) in plant tissue from seeds pre-treatment with vitamin C would help to explain the increase in tolerance to

salinity. Although, increases in osmolyte during germination because its biosynthetic precursor, vitamin C could activate BADH, the accumulation of these osmolyte seems to correlate with greater tolerance against stress (Fahad, 2007).

More, vit. C can play an inductive role in alleviating the adverse effect of salinity on plant growth and metabolism in many plants. Ascorbic acid has been suggested as a bio-regulator of plant growth and development, as studied by (Gupta and Datta, 2003).

3- Tocopherol:

Proportional antioxidant activity of the tocopherol is due to the methylation modality and the quantities of methy I groups attached to the phenolic ring of the polar head structure. Chloroplast membranes of higher plants consist of α- tocopherol as the dominant tocopherol isomer, and are hence well protected against photooxidative damage (Fryer, 1992). There is also evidence that α-tocopherol quinone, existing solely in chloroplast membranes.

Vitamin E is a chain-breaking antioxidant, i.e. it is able to repair oxidizing radicals directly, preventing the chain propagation step during lipid autoxidation (Serbinova and Packer, 1994). It reacts with alkoxy radicals (LO'), lipid peroxyl radicals (LOO') and with alkyl radicals (L'), derived from PUPA oxidation (Kamal-Eldin and Appelqvist, 1996). The reaction between vitamin E and lipid radical occurs in the membrane-water interphase where vitamin E donates a hydrogen ion to lipid radical with consequent tocopheroxyl radical (TOH') formation (Buettner, 1993). Regeneration of the TOH' back to its reduced form can be achieved by vitamin C (ascorbate), reduced glutathione. In addition, tocopherols act as chemical scavengers of oxygen radicals, especially singlet oxygen and as physical deactivators of singlet oxygen by charge transfer mechanism (Fryer, 1992). At high concentration tocopherols act as prooxidant synergists with transition metal ions, lipid peroxides or other oxidizing agents (Kamal-Eldin and Appelqvist, 1996). In addition to antioxidant functions vitamin E has several non-antioxidant functions in membranes. Tocopherols have been suggested to stabilize membrane structures.

There is recent correlation between PS II with α-tocopherol and α-tocopherol quinone (Kruk, 2000). Complexation of tocopherol with free fatty acids and lysophospholipids protects membrane structures against their damages effects. It seems to be a great physiological relevance, since phospholipid hydrolysis products are characteristics of pathological events, ischemia or stress damage In addition, more functions of non-antioxidant a-tocopherol have been cleared such as protein kinase C inhibition, inhibition of cell proliferation (Azzi and Stocker, 2000). More, α-tocopherols, play an essential role in preventing damages to chloroplastic membranes from the deleterious effects of singlet oxygen and lipid peroxy radicals (Fryer, 1992). The α-tocopherols are usually regenrated back by ascorbic acid or reduced glutathione following oxidation by lipid peroxy radicals. This compound may

serve to protect symbiosome membranes and other nodule membranes against lipid peroxidation.

4- Humic acid:

HA contributes significantly to water retention and metal/solute binding and release, and they are necessary for safe plant nutrition (Stevenson, 1994). In addition, HA can be used as a growth regulator by regulate endogenous hormone levels (Frgbenro and Agboola, 1993).

Increasing alleviation salinity or drought stress by humic acid may be through stimulates plant growth observation by accelerating cell division, increasing the rate of development in root systems, and enhancing the yield of dry matter (Clapp *et al*., 2006).

Treated plants with humic acid let to enhancing K+ in faba bean roots, which stimulates the permeability of cell membranes. As a factor contributing to salinity, Na+ has an essential negative effect on salt sensitive plant such as broad bean (Akinci *et al*., 2009).

Humic substances will improve the effective use of residual plant nutrients, reduce fertilizer costs, and help release those plant nutrients presently bound is minerals and salts. Amino acids are primary components in the process of protein synthesis. About 20 important amino acids are involved in the process of each function. Studies have proved that amino acid can directly or indirectly influence the physiological activates of the plant. Because of the amino acid pool is only a small portion of the total dissolved organic nitrogen pool, which generally contains less than 10% free amino acids in temperate ecosystems (Yu *et al*., 2002 and Ayman *et al*., 2009).

5- Yeast extract:

Appling yeast as bio-fertilization on faba bean plants led to decreasing leaves content of proline, regardless of salinity level in comparison with the non-biofertilized treatments. Although, plants under high salinity level revealed proline accumulation in their leaves more than the low salinity levels. Further, proline seemed to have additional function other than osmoregulation because of its poor ability to resist the toxic effect of salinity. Furthermore, the proline may play a role as enzyme stabilizing agent under NaCl salinity (Hathout, 1996 and Demir and Kacacaliskan, 2001).

Overexpression of HAL1 gene in yeast confers a high salt tolerance level by reducing K^+ loss and decreasing intracellular Na+ from the cells upon salt stress. The expression of HAL1 gene promotes a moderate level of salt tolerance both In vitro and in vivo in transgenic (Rı´os *et al*., 1997).

The yeast extract contain high amount of macro and micro elements, important plant hormones like Auxins, Gibberellins and Cytokinin which increase cell division and cell enlargement and lead to balance of physiological and biological processes and enhancing photosynthesis processes and improving growth characters (Jensen, 2004).

REFERENCES

Akinci, S., Buyukkeskin, T. Eroglu, A. and Erdogan, B.E. (2009). The effect of humic acid on nutrient composition in broad bean (*Vicia faba* L.) roots. Not. Sci. Biol., 1: 81-87.

Arrigoni, O. and De Tullio, M.C. (2000). The role of ascorbic acid in cell metabolism: Between gene directed functions and unpredictable chemical reactions. J. Plant Physiol., 157: 481-488.

Athar, H., Khan, A. and Ashraf, M. (2008). Exogenously applied ascorbic acid alleviates salt-induced oxidative stress in wheat. Environ. Exp. Bot., 63: 224-231.

Ayman, M., Kamar, M. and Khalid, M. (2009). Amino and humic acids promote growth, yield and disease resistance of faba bean cultivated in clayey soil. Australian J. of Basic and Applied Sci., 3(2): 731-739.

Azzi, A. and Stocker, A. (2000). Vitamin E: Non-antioxidant Roles. Progress in Lipid Research, 39, 231-255.

Bond, D.A.; Lawes, D.A.; Hawtin, G.C.; Saxena, M.C. and Stephens, J.S. (1985). Faba Bean (Vicia faba, L.). p. 199-265. In: R.J. Summerfield and E.H. Roberts (eds.), Grain Legume Crops. William Collins Sons Co. Ltd. 8 Grafton Street, London, WIX 3LA, UK.

Broadbent, P., Creissen, G.P, Kular, B., Wellburn, A.R. and Mullineaux, P. (1995). Oxidative stress response in transgenic tobacco containing altered levels of glutathione reductase activity. Plant J. 8: 247-255.

Buettner, G. R. (1993). The pecking order of free radicals and antioxidants: lipid peroxidation, α-tocopherol, and ascorbate. Archives of Biochemistry and Biophysics, 300, 535-543.

Chaparzadeh, N., D`amico, M.L., Khavari-Nejad, R.A. and Izzo, F. (2004). Antioxidative response of *Calandula* officinalis under salinity conditions. Plant Physiol. Biochem., 42: 695-701.

Clapp, C.E., Cline, V.W., Hayes, M., Palazzo, A.J. and Chen, Y. (2006). Plant growth promoting activity of humic substances. Bouyoucos Conference Proceedings. p. 37.

Demir, Y. and Kocacaliskan, I. (2001). Effects of NaCl and proline on polyphenol oxidase activity in bean seedlings. Biol. Plant, 44: 607-609.

Duke, J.A. (1981). Handbook of legumes of world economic importance. Plenum Press, New York. p. 199-265.

El-Hakem, A.H.M. (2008). Control of growth and productivity of droughted wheat cultivars by glycine betaine and salicylic acid. Ph.D. Thesis. Fac Sci. Mansoura Univ., Egypt.

Epstein, E. (1985). Salt tolerance crops origin, development and prospect of the concept. Plant and Soil., 89: 187-198.

Fahad, A. (2007). Responses of faba bean and pea to vitamin C under salinity stress. R. J. of Agric. And Biological Sci., 3(6): 714-722.

Frgbenro, J.A. and Agboola, A.A. (1993). Effect of different levels of humic acid on growth and nutrient uptake of teak seedlings. J. Plant Nutrition, 16(8): 1465-1483.

Fryer, M. J. (1992). The antioxidant effects of thylakoid vitamin E (α-tocopherol). Plant Cell and Environment, 15, 381-392.

Gomez, K. A. and Gomez, A. A. (1984). Statistical procedures for agricultural research .2nd Ed., Sons Willy and Sons, New York. U.S.A.

Gupta, S.D. and Datta, S. (2003). Antioxidant enzyme activities during In vitro morphogenesis of gladiolus and the effect of application of antioxidants on plant regeneration. Biol. Plant. 2: 179-183.

Gunes, Y., Inal, A., Alpaslan, M., Eraslam, F., Bagci, E.G. and Cicek, G.N. (2007). Salicylic acid induced changes on some physiological parameters symptomatic for oxidative stress and mineral nutrition in maize (*Zea mays* L.) grown under salinity. J. Plant Physiol. 164(6): 728-36.

Hameda, E.A. (2011). Influence of salinity (NaCl and Na2SO4) treatments on growth development of broad bean (*Vicia faba* L.) plant. American Eurasian J. Agric. & Environ. Sci., 10 (4): 600-610.

Hathout, T.A. (1996). Salinity stress and its concentration by the growth regulator in wheat plant. Egyptian J. Physiological Sci., 20: 127-152.

Hitz, W.D., Ladyman, J.A.R. and Hanson, A.D. (1982). Betaine synthesis and accumulation in barley during field water stress. Crop Sci., 22: 47-54.

Hussein, M.M., Balbaa, L.K. and Gaballah, M.S. (2007). Salicylic acid and salinity effects on growth of maize plants. Res. J. Agric. Biol. Sci., 3: 321-328.

Jensen, E. (2004). Seaweed; fact or fancy. Published by Moses the Midwest Organic and Sustainable Education. From the broad Caster. 12(3): 164- 170.

Kamal-Eldin, A. and Appelqvist, L. (1996). The chemistry and antioxidant properties of tocopherols and tocotrienols. Lipids, 31, 671-701.

Katerji, N.; Van Hoorn, J.W.; Hamdy, A. and Bouzid, N. (1992). Effect of salinity on water stress, growth and yield of broadbeans. Agr. Water Management, 21:107-117.

Khafaga, H. S., Raeefa, A. H., Hala, M. M. and Ala, S. A. (2009). Response of two faba bean cultivars to application of certain growth regulators under salinity stress condition at siwa oasis. 1- Growth traits, yield and yield components. 4th Conference on Recent Tech. in Agric.

Kruk, J., Schmid, G. H., and Strzalka, K. (2000). Interaction of α-tocopherol quinone, α- tocopherol and other prenyllipids with photosystem. 11. Plant Physiology and Biochemistry, 38, 271-277.

Mikolajczyk, M., Awotunde, O.S., Muszynska, G., Klessig, D.F. and Dobrowolska, G. (2000). Osmotic stress induces rapid activation of a salicylic acid induced protein kinase and a homolog of protein kinase ASK1 in tobacco cells. Plant Cell 12: 165-178.

Noctor, G. and Foyer, C.H. (1998). Ascorbate and glutathione: Keeping active oxygen under control. Ann. Rev. Plant Physiol. Mol. Biol., 49: 249-279.

Rahnama, H. and Ebrahimzadeh, H. (2005). The effect of NaCl on antioxidant enzyme in potato seedlings. Biol. Plant., 49(1): 93-97.

Rı´os, G., Ferrando, A. and Serrano, R. (1997). Mechanism of salt tolerance conferred by overexpression of the *HAL1* Gene in *Saccharomyces cerevisiae*. Yeast 13: 515–528.

Sakr, M.T.; El-Hadidy, M.A. and Farouk, S. (2004). Physiological studies of some osmo-regulator on kanulla. International conversation microbiology and biotechnology in Africa and Arab Reagan 27th to 29th. Pp. 295- 321.

Sakr, M.T. and EL-Metwally, M.A. (2009). Alleviation of the harmful effects of soil salt stress on growth, wield and endogenous antioxidant content of wheat plant by application of antioxidants. Pakistan J. of Biological Sciences 12 (8): 624-630.

Serbinova, E. A. and Packer, L. (1994). Antioxidant properties of α-tocopherol and α- tocotrienol. Methods in Enzymology, 234, 354-366.

Sharma, Y.K., Leon, J., Raskin, I. and Davis, K.R. (1996). Ozone-induced response in *Arabidopsis thaliana*: the role of salicylic acid in the accumulation of defense-related transcripts and induced resistance. Proc. Natl. Acad. Sci. USA 93: 5099-5104.

Shalata, A. and Neumann, P.M. (2001). Exogenous ascorbic acid (vitamin C) increases resistance to stress and reduces lipid peroxidation. J. Exp. Bot., 52: 2207-2211.

Stevenson, F.J. (1994). Humus Chemistry: Genesis, Composition, Reaction (Second ed.), Wiley, New York.

Tester, M. and Davenport, R. (2003). Na tolerance and Na transportation in higher plants. Ann. Bot. 91:503-527.

Yamaguchi-Shinozaki, K. and Shinozaki, K. (1993a). Arabidopsis DNA encoding two desiccation-responsive *rd*29 genes. Plant Physiol. 101: 1119-1120.

Yu Z., Zhang, Q. and Kraus, T.E.C. (2002). Contribution of amino compounds to dissolved organic nitrogen in forest soils. Biogeochemistry, 61: 173-198.

دراسة مدي استجابة نباتات الفول البلدي للمعاملة ببعض منشطات النمو تحت ظروف الإجهاد الملحي

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**** وحدة بحوث تكنولوجيا البذور – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية**

أجريت تجربة أصص في وحدة تكنولوجيا البذور بالمنصورة التابعة لمعهد بحوث المحاصيل الحقلية في الموسمين الشتويين ٢٠١٠/٢٠١١ و ٢٠١١/٢٠١٢، وذلك بغرض دراسة دور بعض المواد المنشطة للنمو والمضادة للأكسدة (حمض السالسليك ٢٥٠ مليجرام/لتر، حمض الاسكوربيك ٢٥٠ مليجرام/لتر، ألفا توكوفيرول ١٠٠ مليجرام/لتر، حمض الهيوميك ١٠٠٠ مليجرام/لتر ومستخلص الخميرة الجافة ٢٠٠٠ مليجرام/لتر) تحت بعض مستويات الإجهاد الملحي (صفر مليجرام/لتر، ٢٠٠٠مليجرام/لتر، ٤٠٠٠ مليجرام/لتر، ٦٠٠٠ مليجرام/لتر و ٨٠٠٠ مليجرام/لتر) على محصول الفول البلدي ومكوناته (عدد القرون/ النبات، وزن القرون/ النبات، عدد البذور/ النبات، وزن البذور/ نبات و محصول ١٠٠ بذرة) وذلك من خلال ثلاث تجارب (نقع بذور الفول البلدي في مضادات الأكسدة قبل الزراعة، رش نباتات الفول البلدي بمضادات الأكسدة وفي التجربة الثالثة نقع البذور ثم رش نباتات الفول البلدي بالمواد المضادة للأكسدة).

مستوى الملوحة ٨٠٠٠ مليجرام/لتر ثم ٦٠٠٠ مليجرام/لتر ، ٤٠٠٠ مليجرام/لتر و ٢٠٠٠ مليجرام/ لتر على التوالي مقارنة بمعاملة الكنترول (٣٢٠ مليجرام/لتر) كان الأكثر تأثيراً في حدوث نقص واضح في محصول الفول البلدي ومكوناته.

المعاملة بمضاد الأكسدة (حمض الاسكوربيك ٢٥٠ مليجرام/لتر ثم حمض السالسليك ٢٥٠ مليجرام/لتر، مستخلص الخميرة ٢٠٠٠ مليجرام/لتر، حمض الهيوميك ١٠٠٠ مليجرام/لتر والتوكوفيرول ١٠٠ مليجرام/لتر) على التوالي في الثلاث تجارب تحت الدراسة (نقع، رش أو نقع البذور ثم رش النباتات) كان الأكثر تأثيرا في زيادة صفات المحصول ومكوناته (سخا ١) تحت الدراسة.

والخلاصة من هذه الدراسة، أن المواد المنشطة للنمو (مضادات الأكسدة) أدت إلي التغلب ولو جزئيا على الآثار الضارة للإجهاد الملحي على نباتات الفول البلدي

قام بتحكيم البحث

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