J. Agric. Sci. Mansoura Univ., 34 (11): 10619 - 10629, 2009

EFFECT OF DIFFERENT IRRIGATION INTERVALS,APPLIED ANTIOXIDANTS AS WELL AS THEIR INTERACTIONS ON GROWTH AND YIELD OF MAIZE PLANT.

Sakr, M. T. and A. M. A. Gadalla
Agric. Bot.Dept.Agric. Facul.Mans.University.

ABSTRACT

Increasing irrigation intervals (every 14, 16, 18 or 20 days), decreased growth parameters as well as yield and its components of maize plants throughout the hole experimental periods during the two growing seasons (2007& 2008).

Irrigation every 20 days was the most effective treatment in decreasing growth , yield and its component of maize plants.

According to antioxidants, the the results show that applied antioxidants Citric acid, Ascorbic acid or Sea weed extract increased all growth parameters , yield and its components of maize plants.Sea weed extract was the most effective in this respect.

The interaction effect between irrigation intervals and antioxidants substances show that the applied antioxidants enhanced all growth parameter as well as yield and its component of maize under drought stress.

It could be concluded that applied antioxidants could partially counteract the harmful effect of drought stress (irrigation every 16, 18, 20 days) on growth as well as yield and its component of maize plant .

INTRODUCTION

The quantity and quality of plant growth depend on cell devision, enlargement, and differentiation, and all of these events are affected by water stress (Mckersie, *et al.,* 1996).

It could be concluded that the sequence of events in the plant tissue subjected to drought stress as follow : (1-) plant cells accumulate solutes to prevent water loss and to reestablish cell turgor. (2-) Water stress can induce ABA accumulation and oxidative stress in plant cells (Zeevart and Creelman.1988.,Bowler et al., 1992. (3-) increased level of lipid peroxidation and a decrease in the concentration of total soluble protein and thiols was observed in stressed seedlings(Sharma and Dubey (2005). (4-) The activities on superoxide dismutases (SODs) as well as ascorbate peroxidase (APX). (5-) The quantity and quality of plant growth depend on cell devision, enlargement, and differentiation, and all of these events are affected by water stress (Mckersie, *et al.,* 1996). Hsiao (1973), concluded that water stress inhibits cell enlargement more than cell devision. (6-)A loss of turgor may cause a change in the spatial position of transport channels, membrane enzymes, and decrease membrane thickness (Nelson and Orcutt, 1996). (7-) Water stress greatly suppresses cell expansion and plant growth due to the low turgor pressure (Mckersie and Leshem, 1994). (8-) Reactive oxygen species, will be produced and accumulated in the cell (Walker, 1992). (9-)

Water stress resulted in a significant increases in antioxidant _-tocopherol which is a lipid-soluble antioxidant and concentrated in the chloroplasts, especially the thylakoid membranes

Exposure of maize to drought during vegetative phase inhibits shoot growth and endangers the development of reproductive organs. Inaddition, there is a negative response of number of grains/ear,100-grain weight and yield as drought occurred, during grain filling period (During vegetative stage, early drought inhibits the growth of leaves and stems, consequently decreases the florets development, while drought during reproductive periods (late drought) adversely affected fertility, formation and number of spikelets followed by decreased in ear grain number and grain yield/fed of maize plant.

According to Sallah, *et al.,* (2006) drought stress is a major factor limiting the productivity of maize. In the stress environment, grain yields of the varieties ranged from 2.21 to 3.12 t ha^{-1}, while in the favourable environment yields ranged from 4.17 to 5.96 t ha^{-1}.

Zhang and Schmidt, (2000),found that natural products, seaweed extract (SWE) are common sources of plant growth regulators (PGRs) that exhibit multiple functions. These sources of PGRs could not only regulate plant growth and development but also increase plant resistance to various environmental stresses, such as drought, salinity, and low temperature. Seaweed extracts, which possess cytokinin-like and auxin-like properties, can stimulate endogenous cytokinin activities of plants (Crouch, 1990).

Seaweed extracts contain not only most of the major and minor nutrients, amino acids, and vitamins B_1, B_2, C, E, but also cytokinins, auxin, GAs, and ABA-like growth substances (Abetz, 1980). Low rates of seaweed extract could also promote plant growth significantly (Crouch, 1990).

Asada et al., (1994) reported that ascorbate has important functions in photosynthesis, such as in protection of photosynthetic apparatus against the oxygen radicals and H_2O_2 that formed during photosynthetic activity, and against photo inactivation since it is a cofactor of carotenoid de-epoxidation (Siefermam and Yamanoto, 1994). Moreover ascorbate enhances ATP synthesis coupled to electron transport in plants grown under salinity stress condition. (Forti and Ehrenheim, 1993). Ascorbate may also be involved in regulation of the cell cycle (Kerk and Feldman 1995). Shalata and Neumann, (2001), found that ascorbic acid acts directly to neutralize superoxide radicals, singlet oxygen or superoxide and as a secondary anti-oxidant during reductive recycling of the oxidized form of α-tocopherol, (Noctor and Foyer, 1998).

MATERIALS AND METHODS

Two field experiments were carried out at Tag-El- Ezz research station in Dakahlia Governorate, Agric.Res.Center, Ministry of Agric during 2007 and 2008 seasons to investigate the role of selected antioxidants in alleviating the harmful effect of drought stress condition on maize plant.

Maize grains(hybrid ,310) kindly supplied by plant breeding section, Field agric.Res. Center, Ministry of Agric .Giza, Egypt) were used in this

expermints. Uniform maize grains were sown in May 10th in the two growing seasons of2007 and 2008 . The expermintal unit was 3.5x3.3 =10.5m2
All the normal cultural practices of the growing maize were applied .

Five irrigaton intervals were applied of each maize plants as follow: Irrigation every 12 days (control), 14 , 16 , 18 or 20 days.

Maize plants were sprayed with some antioxidants at 30 , 45 , and 60 days from sowing. Automatic atomizers were used for spraying the applied antioxidants after adding tween 20 as a wetting agent" (0.05 %).
Antioxidant materials used were: Tap water (control)., Citric acid (300 mg/l)., Ascorbic acid (ASA,300 mg/l).,Sea weed extract(SWE,1000 mg/l)
Three samples were taken at 3 different physiological stages (45, 60 and 75 day from sowing) to study the growth characters. At harvesting stage yield and components of maize (ear length, grain yield / plant, weight of 100 grains, oil content in the grains).

Each treatment replicated 3 times and arranged in a complete randomized block design. The data of experiments were statistically analyzed as technique of the analysis of variance (ANOVA) according to Gomez and Gomez (1984). The treatment means were compared using the least significant differences (LSD).

RESULTS

Growth:

Data presented in tables (1 — 4) show the effect of irrigation intervals and applied antioxidants as well as their interactions on vegetative growth parameters (stem dry weight, leaves dry weight, leaf area, leaves number/plant,) of maize plants throughout the experimental periods (three experimental dates) during the two growing seasons.

Data show that increasing irrigation intervals (every 14, 16, 18, 20 days), decreased growth parameters of maize plants throughout the hole experimental periods during the two growing seasons . Irrigation every 20 days treatment was the most effective in decreasing growth of maize plants.

Data in tables (1 — 4) show that applied antioxidants Citric, ASA or SWE increased all growth parameters of maize plants throughout the experimental periods during the two growing seasons. It could be shown that Sea weed extract was the most effective in this respect.

The interaction treatments of irrigation intervals with antioxidants materials show that the applied antioxidants enhanced all growth parameter of maize under drought stress (irrigation every 16, 18, 20 days) compared with drought stress treatments but these increasing stell less than control.

It could be concluded that applied antioxidants could partially counteract the harmful effect of drought stress on growth of maize plant.

Table (1): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on stem dry weight (gm) of maize plant during the two growing seasons 2007 and 2008.

Treatment / Irrigation intervals	Tap water	Critic	ASA	SWE	Mean	Tap water	Critic	ASA	SWE	Mean
	Season 2007					Season 2008				
	1st sample									
12 days(cont.)	156	184	192	198	182	157	185	193	199	183
14 days	132	141	148	154	143	133	142	150	156	145
16 days	90	94	97	104	96	91	95	98	105	9
18 days	84	87	92	95	89	85	88	93	96	90
20 days	68	72	77	86	75	69	73	78	87	76
Mean	106	115	121	127		107	116	122	128	
LSD at 5%	Antioxidant: 1.25 Irrigation: 1.97 Interaction:2.98					Antioxidant: 1.25 Irrigation: 0.88 Interaction: 2.97				
	2nd sample									
12 days(cont.)	195	200	225	260	220	196	201	226	261	221
14 days	155	157	165	185	165	156	158	167	186	166
16 days	105	122	145	150	130	106	123	146	151	131
18 days	95	97	98	103	98	97	98	99	104	99
20 days	78	82	89	95	86	79	83	91	96	87
Mean	125	131	144	158		126	132	145	159	
LSD at 5%	Antioxidant:0.17 Irrigation: 0.47 Interaction: 1.1					Antioxidant: 0.17 Irrigation: 0.47 Interaction: 1.0				
	3rd sample									
12 days(cont.)	290	310	340	345	321	291	311	341	346	322
14 days	220	229	245	280	243	221	230	246	281	244
16 days	180	200	205	212	199	181	201	206	213	200
18 days	150	158	175	178	165	151	160	176	179	166
20 days	80	109	129	143	115	81	110	130	144	116
Mean	184	201	218	231		185	202	220	232	
LSD at 5%	Antioxidant: 0.30 Irrigation: 0.32 Interaction: 0.72					Antioxidant: 0.3 Irrigation: 0.31 Interaction: 0.71				

Table (2): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on leaves dry weight (gm) of maize plant during the two growing seasons 2007 and 2008.

Treatment / Irrigation intervals	Tap water	Critic	ASA	SWE	Mean	Tap water	Critic	ASA	SWE	Mean
	Season 2007					Season 2008				
	1st sample									
12 days(cont.)	115	116	120	137	122	116	117	121	138	123
14 days	96	102	103	105	101	97	103	104	106	102
16 days	86	90	93	94	91	87	91	94	95	91
18 days	80	81	83	86	82	81	82	84	87	83
20 days	59	63	69	75	66	60	64	70	76	67
Mean	87	90	93	99		88	91	94	100	
LSD at 5%	Antioxidant: 0.71 Irrigation: 0.81 Interaction: 1.8					Antioxidant: 0.7 Irrigation: 0.81 Interaction: 1.8				
	2nd sample									
12 days(cont.)	138	140	145	162	146	139	141	146	163	147
14 days	117	124	127	128	124	118	125	128	129	125
16 days	101	104	105	110	105	102	105	106	111	106
18 days	90	92	94	97	93	91	92	95	98	94
20 days	76	79	84	89	82	77	80	85	90	83
Mean	104	107	111	117		105	108	112	118	
LSD at 5%	Antioxidant: 0.22 Irrigation: 0.45 Interaction:1.0					Antioxidant: 0.25 Irrigation:0.45 Interaction: 1.1				
	3rd sample									
12 days(cont.)	221	258	272	282	258	222	259	273	283	259
14 days	182	203	211	216	203	183	204	211	217	203
16 days	148	154	165	173	160	149	155	166	174	161
18 days	129	132	142	146	137	130.5	133	143	147	138
20 days	84	97	115	116	103	85	98	116	117	104
Mean	152	168	181	186		153	169	181	187	
LSD at 5%	Antioxidant: 0.31 Irrigation: 0.23 Interaction: 1.51					Antioxidant: 0.31 Irrigation: 0.32 Interaction: 1.52				

Table (3): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on leaf area of maize plant during the two growing seasons 2007 and 2008.

Treatment / Irrigation intervals	Tap water	Critic	ASA	SWE	Mean	Tap water	Critic	ASA	SWE	Mean
	Season 2007					Season 2008				
	1st sample									
12 days(cont.)	592	610	624	672	624	595	615	630	675	628
14 days	412	522	528	604	516	415	526	532	607	520
16 days	386	462	500	516	466	392	465	505	520	470
18 days	354	402	462	482	425	360	406	465	485	429
20 days	302	386	476	482	411	308	390	476	485	414
Mean	409	476	518	551		414	480	521	554	
LSD at 5%	Antioxidant:3.4 Irrigation: 3.0 Interaction: 6.7					Antioxidant: 3.4 Irrigation: 3.0 Interaction: 6.7				
	2nd sample									
12 days(cont.)	626	618	694	703	660	630	622	696	706	663
14 days	478	545	562	643	557	480	550	565	647	560
16 days	412	504	550	617	520	415	510	556	620	525
18 days	396	425	550	577	487	400	430	554	582	491
20 days	384	419	432	502	434	392	422	435	510	439
Mean	459	502	557	608		463	506	561	613	
LSD at 5%	Antioxidant: 2.8 Irrigation:3.5 Interaction: 7.8					Antioxidant: 2.8 Irrigation: 3.5 Interaction: 7.8				
	3rd sample									
12 days(cont.)	682	695	710	742	707	690	700	715	746	712
14 days	516	572	585	687	590	520	576	595	692	595
16 days	474	546	562	642	556	480	550	570	648	562
18 days	412	494	555	601	515	415	500	562	606	520
20 days	385	432	500	532	462	390	436	508	536	467
Mean	493	547	582	640		499	552	590	645	
LSD at 5%	Antioxidant: 3.8 Irrigation: 3.5 Interaction: 8.0					Antioxidant: 3.8 Irrigation3.5 Interaction: 8.0				

Table (4): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on leaves number of maize plant during the two growing seasons 2007 and 2008.

Treatment / Irrigation intervals	Tap water	Critic	ASA	SWE	Mean	Tap water	Critic	ASA	SWE	Mean
	Season 2007					Season 2008				
	1st sample									
12 days(cont.)	14	14	15	15	14.5	15	15	16	16	15.5
14 days	14	15	14	15	14.5	15	16	15	16	15.5
16 days	12	13	12	14	12.7	13	13	12	15	13.2
18 days	10	10	12	12	11.0	11	11	12	13	11.7
20 days	10	10	11	12	10.7	11	10	11	12	11.0
Mean	12	12.4	12.8	13.6		13	13	13.2	14.4	
LSD at 5%	Antioxidant: 0.67 Irrigation: 0.54 Interaction: 1.21					Antioxidant: 0.65 Irrigation: 0.54 Interaction: 1.21				
	2nd sample									
12 days(cont.)	17	17	17	18	17.2	18	18	18	19	18.2
14 days	17	17	17	17	17.0	18	18	18	18	18.0
16 days	16	17	18	18	17.2	17	18	19	19	18.2
18 days	17	18	17	18	17.5	17	18	18	18	17.7
20 days	16	16	17	17	16.5	16	17	17	17	16.7
Mean	16.6	17.0	17.2	17.6		17.2	17.8	18.0	18.2	
LSD at 5%	Antioxidant:0.53 Irrigation: 0.62 Interaction: 1.38					Antioxidant:0.3 Irrigation: 0.621 Interaction: 1.38				
	3rd sample									
12 days(cont.)	17	17	18	18	17.5	18	18	19	19	18.5
14 days	16	17	17	17	16.7	17	18	18	18	17.7
16 days	17	17	18	18	17.5	18	18	18	19	18.2
18 days	16	17	17	17	16.7	17	18	18	18	17.7
20 days	16	16	16	17	16.2	17	17	17	17	17.0
Mean	16.4	16.8	17.2	17.4		17.4	17.8	18.0	18.2	
LSD at 5%	Antioxidant: 0.59 Irrigation:0.62 Interaction: 0.60					Antioxidant: 0.59 Irrigation: 0.62 Interaction: 0.60				

Yield and its components:

Data presented in tables (5– 8) show the effect of drought stress levels (irrigation every 14, 16, 18, 20 days) and applied antioxidants (Citric, ASA, SWE) as well as their interactions on the yield and yield components of maize (ear length, grain yield / plant, weight of 100 grains, oil content in the grains) during the two growing seasons 2007 and 2008.

Data show that drought stress the yield and its component of maize plants during the two growing seasons. The highest drought stress level (irrigation every 20 days) was the most effective in decreasing the yield of plants.

Applied antioxidants increased yield and its components of maize plants during the two growing seasons. SWE was found to be the most effective in this respect.

As for the interactions treatments, the data show that each of applied antioxidants enhanced the yield and its components of maiz plants as compared with the drought stress treatments but the values were nearly or still less than unstressed plants. SWE combined with irrigation every 14 days was the most effective treatment in this respect.

It could be concluded that antioxidants could counteract the harmful effect of drought stress levels on the yield of maize during the two growing seasons. Moreover, SWE was found to be the most effective antioxidant in this respect.

Table(5): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on ear length (cm) of maize plant during the two growing seasons 2007 and 2008.

Treatment / Irrigation intervals	Tap water	Critic	ASA	SWE	Mean	Tap water	Critic	ASA	SWE	Mean
	2007					2008				
12 days(cont.)	22	22	22	23	22	23	23	23	23	23
14 days	19	21	21	21	20	20	22	22	22	22
16 days	19	21	20	21	20	20	21	21	21	21
18 days	19	20	20	20	20	19	21	20	21	20
20 days	17	19	18	19	18	17	20	18	20	19
Mean	19	20	20	21		20	21	21	21	
LSD at 5%	Antioxidant: 0.42 Irrigation: 0.25 Interaction: 0.56					Antioxidant:0.73 Irrigation: 0.34 Interaction: 0.77				

Table (6): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on grain yield (gm)/plant of maize plant during the two growing seasons 2007 and 2008.

Treatment / Irrigation intervals	Tap water	Critic	ASA	SWE	Mean	Tap water	Critic	ASA	SWE	Mean
	2007					2008				
12 days(cont.)	88	95	97	99	94.7	85	92	95	97	92.2
14 days	83	90	92	94	89.7	80	88	90	92	87.5
16 days	75	82	84	86	81.7	71	79	82	84	79.0
18 days	66	72	74	76	72.0	62	69	72	75	69.5
20 days	55	62	64	66	61.7	51	60	63	65	59.7
Mean	73.4	80.2	82.2	84.2		69.8	77.6	80.4	82.6	
LSD at 5%	Antioxidant:2.13 Irrigation:1.45 Interaction: 3.24					Antioxidant: 0.80 Irrigation: 0.47 Interaction: 1.05				

Table (7): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on weight of 100 grain (gm) of maize plant during the two growing seasons 2007 and 2008.

Treatment / Irrigation intervals	Tap water	Critic	ASA	SWE	Mean	Tap water	Critic	ASA	SWE	Mean
	2007					2008				
12 days(cont.)	21	24	26	28	24.7	22	24	26	28	25.0
14 days	20	21	22	23	21.5	21	22	23	25	22.7
16 days	16	17	19	21	18.2	17	18	20	22	19.2
18 days	16	16	16	18	16.5	16	17	17	19	17.2
20 days	12	14	14	14	13.5	12	15	15	15	14.2
Mean	17.0	18.4	19.4	20.8		17.6	19.2	20.2	21.8	
LSD at 5%	Antioxidant: 0.39 Irrigation: 0.28 Interaction: 0.63					Antioxidant:1.179 Irrigation: 0.12 Interaction: 0.28				

Table (8): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on seeds oil content (gm/100 gm grains) of maize plant during the two growing seasons 2007 and 2008.

Treatment / Irrigation intervals	Tap water	Critic	ASA	SWE	Mean	Tap water	Critic	ASA	SWE	Mean
	2007					2008				
12 days(cont.)	2.67	2.67	2.78	2.87	2.70	2.78	2.77	2.87	2.92	2.83
14 days	2.66	2.64	2.65	2.67	2.65	2.75	2.76	2.75	2.84	2.77
16 days	2.63	2.62	2.65	2.66	2.64	2.68	2.67	2.68	2.68	2.67
18 days	2.61	2.53	2.62	2.63	2.59	2.65	2.65	2.67	2.67	2.66
20 days	2.49	2.62	2.58	2.60	2.57	2.52	2.64	2.65	2.65	2.61
Mean	2.61	2.62	2.65	2.68		2.67		2.72	2.75	
LSD at 5%	Antioxidant:0.3 Irrigation:0.3 Interaction: 0.5					Antioxidant:0.3 Irrigation:0.3 Interaction: 0.6				

DISCUSSION

water stress reduces plant growth through inhibition of various physiological and biochemical precesses, such as photosynthesis, respiration, translocation, ion uptake, carbohydrates, nutrient metabolism, and hormones (Kramer,1983). As a result, plant size, leaf area, extensive root systems and productivity are reduced. Cell growth (expansion) is one of the most drought sensitive physiological processes due to the reduction of turgor pressure. Water stress inhibits cell enlargement more than cell devision so water stress greatly suppresses cell expansion and plant growth due to the low turgor pressure

In accordance with the results of the present investigation,drought stress reduces yield of maize (*Zea mays* L.) and other grain crops by (i) reducing canopy absorption of incident photosynthetically active radiation (PAR), (ii) reducing radiation use efficiency (RUE), and (iii) reducing harvest index Earl and Davis, ((2003).

According to Kazemi, *et al.*, (2001). droughe reduced grain filling period and, thus yield of maize decreases significantly.

Role of antioxidants on alleviating the harmful effect of drought stress:

Ascorbic and citric acid can alleviate the harmfull effect of ROS which generated by drought stress levels may be through several ways such as : (1) inhibits the lipid photoperoxidation (Michalski and Kaniuga, 1981). (2) is involved in both electron transport of PS II and antioxidizing system of chloroplasts. (McKersie et al, 1996). (3)), as membrane stabilisers and multifaceted antioxidants, that scavenge oxygen free radicals, lipid peroxy radicals, and singlet oxygen (Diplock, *et al.*, 1989). (4) react with peroxyl radicals formed in the bilayer as they diffuse to the aqueous phase. (Hess, 1993). (5) . scavenge cytotoxic H_2O_2, and reacts non-enzymatically with other ROS: singlet oxygen, superoxide radical and hydroxyl radical (Larson, 1988). (6) stabilize membrane structures (Blokhina, 2002). (7) modulates membrane fluidity in a similar manner to cholesterol, and also membrane permeability to small ions and molecules (Fryer, 1992). (8) to decrease the permeability of digalactosyldiacylglycerol vesicles for glucose and protons (Berglund, *et al.*, 1999).

The enzymes ascorbate peroxidase, glutathione reductase, superoxide dismutase and monodehydroascrbate reductase, among others, are involved in the regeneration of glutathione and ascorbate that are important in detoxification of ROS (Foyer and Mullineaux, 1994). Ascorbate ,reduced gluthione (GSH), APX,GR,SOD and MDHAR are involved in several contexts in antioxidant regeneration throughout the .the plant cell Ascorbate also acts as a reductant in the regeneration of *a* –tochopherol and in zeaxanthin cycle (Foyer, 1993).

Seaweed extract may enhance hydrophobic and hydrophilic antioxidant activity and thus promote growth and leaf water status. It may be concluded that antioxidant status could be manipulated with exogenous application of plant growth biostimulants (SWE) (Schmidt, 2005).

Bostimulants (SWE) can alleviate the harmfull effect of drought stress through: I)- activate root cells at the same time stimulate biosynthesis of endogenous Cytokinins from roots (Schmidt, 2005). II)- enhancing leaf water status, some plant nutrients uptake, shoot growth ,(Demir, *et al.*, 2004). III)- altering hormonal balances and favor Cytokinins and auxins production (Schmidt, 2005). IV)- enhancement of antioxidant enzymes (SOD,GR,ASP) for protection against adverse environmental conditions (Schmidt, 2005). V)- stimulation the biosynthesis of Tocopherol, ascorbic acid and carotenoids in chloroplast which protect photosynthetic apparatus of PSII (Zhang and Schmidt, 2000).VI)- protection of plant cells from lipid peroxidation and inactivation of enzymes that occur under stress (Smirnoff, 1995). VII)- stimulation stem elongation and exhibits auxin-like activity. (Crouch and VanStaden,1993). VIII)- reduced uptake of NaCl (Nabati, *et al.*,1994) while increased K and Ca content in the leaves (Demir, *et al.*, 2004). IX)- stimulation of chlorophyls biosynthesis (Garbay and Churin,1996) and regulation cell membrane components under drought stress. (Yan and Schmidt,1993). X)- inhibits activity of free radical groups which are major elements for chlorophyll degradation (Fletcher, *et al.*,1988). XI)- stimulation the uptake of N,P,K,Mg,Ca,Zn,Fe and Cu by the plants that alleviate the inhibitory effect of Na toxicity and restored growth (Van Staden,(1984). XII)-

promoted the accumulation of reducing sugars which increased wilting resistance through enhancing osmotic pressure inside plant and stimulate nucleic acids. (O,Donnell,1973). XIII)- Stimulation of chloroplast development and enhancing phloem loading and delay senescenc (Demir, *et al.*,2004).

REFERENCES

Asada, K., Takahashi, M., and Hayahawa, T. (1983). In "Oxy radicals and their scavenger systems," Vol. I. Molecular aspects, ed by G. Cohen and R.A. Greenwald, Elsevier, Amsterdam. pp. 240-245.

Berglund, A.H., Nilsson, R. and Liljenberg, C. (1999). Permeability of large unilamellar digalactosyldiacylglycerol vesicles for protons and glucose—influence of a-tocopherol, ß-carotene, zeaxanthin and cholesterol. Plant Physiology and Biochemistry 37: 179–186.

Blokhina, O., Eija Virolainen, E. and Fagerstedt, K. V. (2002). Antioxidants, Oxidative Damage and Oxygen Deprivation Stress: a Review. Annals of Botany 91: 179-194.

Bowler, C., Van Montagu, M., and Inzé, D. (1992). Superoxide dismutase and stress tolerance. Annual Review of Plant Physiology and Plant Molecular Biology, 43, 83–116.

Crouch, I . J., and Van-Staden, J. (1993). Evidence for the presence of plant growth regulators in commercial seaweed products. Plant Growth Regul. 13: 2129.

Crouch, I. J. (1990). The effect of seaweed concentrate on plant growth. Dissertation for doctor of philosophy. Dept. Botany. Univ. Natal, Pietermaritzburg. South Africa.

Demir, D., Günes, A., Inal, A. and Alpaslan, M. (2004). Effects of humic acids on the yield and mineral nutrition of cucumber (*cucumis sativus* l.) grown with different salinity levels.ishs acta horticulturae 492(2004).

Diplock, A.T., Machlin, L. J. , Packer, L. , and Pryor, W.A. (1989). Eds., Vitamin E: Biochemistry and Health Implications. Ann. N.Y. Acad. Sci. Vol. 570 p.555.

Fletcher, R.A., Hofstra, G. and Gao, J. (1988). Comparative fungitoxic and plant growth regulating properties of triazole derivatives. Plant Cell Physiology 27:367-371.

Foyer, C.H. (1993). Ascorbic acid. In: R.G. Alscher and J.L. Hess, Editors, Antioxidants in higher plants, CRC Press, Boca Raton, FL, pp. 51–58.

Foyer, C.H. and Mullineaux, P. (1994). Causes of Photooxidative Stress and Amelioration of Defense Systems in Plants. CRC Press. Boca Raton. FL. ISBN 0-8493-5443-9.

Francki, R.I.B. (1960). Manurial value of seaweeds: I. Effects of pachymenia himantophora and durvillea antartica meals on plant growth. Plant and Soil 12:297-310.

Froti, G. and Ehrenheim, A. M. (1993). The role of oscorbic acid in photosynthetic electron transport. Biochim. Biophys. Acta. 1183: 408-412.

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

Garbaye, J., and Churin, J.L. (1996). Effect of ectomycorrhizal inoculation at planting on growth and foliage quality of *Tilia tomentosa*. J.Arboric. 22(1):29–33.

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

Hess, J.L. (1993). Vitamin E, a - tocopherol. In: R.G.Alscher and J.L. Hess (eds.) antioxidants in higher plants. pp 111-134. CRC Press, Inc. Boca Rarton, Florida.

Hsiao, T. C. (1973). Plant resposes to water stress. Annu. Rev. Plant Physiol, 4: 519-570.

Huber, S.C., Rogers, H.H. and Mowry, F.L. (1984). Effects of water stress on photosynthesis and carbon partitioning in soybean (*Glycine max* [L.] Merr.) plants grown in the field at different CO2 levels. Plant Physiol. 76, 244–249.

Kerk, N. M. and Feldman, L. J. (1995). A biochemical model for initiation and maintenance of the quiescent center: implications for organisation of root meristems. Plant Development 121:2825-33.

Kramer, P. J. (1983). plant water relation. Acad-preaa New york.

Larson, R. A. (1988). The antioxidants of higher plants. Phytochemistry 27(4): 969-978.

Lawlor, D.W. (1995). The effects of water deficit on photosynthesis. In: N. Smirnoff (eds.) environment and plant metabolism: flexibility and acclimation. BIOS Scientific Publishers Limited. Oxford, UK.

Mckersie, B.D., and Leshem, Y.Y. (1994). Stress and stress coping in cultivated plants. Klumer Academic Publishers, Netherland

Mckersie, B.D., Bowley .S.R., Harjanto, E. and leprince, O. (1996). Water deficit tolerance and field performance of trans genic alfalfa overexpressing superozide dismutase .-plant physiol .111: 1177-1181 .

Michalski, W. P. and Kaniuga, Z. (1981). Photosynthetic apparatus of chilling-sensitive plants. IX. The involvement of alpha-tocopherol in the electron transport chain and the anti-oxidizing system in chloroplasts of tomato leaves. Biochim Biophys Acta. 1981 Mar 12;635(1):25-37.

Nabati, D.A., Schmidt, R.E. and Parrish, D. J. (1994). Alleviation of salinity stress in Kentucky bluegrass by plant growth regulators and iron. Crop Sci., 34: 198-202

Nelson, E. T., and. Orcutt, D.M(1996). Physiology of plants under stress: abiotic factors. John Wiley & Sons., New York.

Noctor, G. and Foyer, C.H. (1998). Ascorbate and glutathione: keeping active oxygen under control. Annual Review of Plant Physiology and Plant Molecular Biology, v.49, p.249-279.

O'Donnell, R.W. (1973). The auxin-like effects of humic preparations from leonardite. Soil Science, v.116, p.106-112, 1973.

Opik, H. Stephen, A.R. and Arthur, J.W. (2005). Water Relations. The physiology of Flowering Plants,4th Ed,06-100. Cambridge Univ. Press.

Sallah, P., Antui, K. and Ewool, M. (2006). Potential of elite maize composites for drought tolerance in stress and non-drought stress environments . African Crop Science Journal.
Schmidt, R.E. (2005). biostimulants function in turfgrass nutrition. phd emeritus virginia tech.
Shalata, A. and Neumann, P.M . (2001). Exogenous ascorbic acid (vitamin c)increases resistans to salt stress and reduces lipid peroxidation . Journal of Experimental Botany.
Siefermann, D. and Yamamoto, H. Y. (1994). Light induced de-epoxidation of violaxanthin in lettuce chloroplast. Bioch. Biophys. Acta. 357: 144-150.
Smirnoff, N. (1995). Antioxidant systems and plant response to the environment. In N. Smirnoff (ed.) environment and plant metabolism: Flexibility and acclimation. BIOS Sci. Publ., Oxford, UK.
Van Staden, J. (1993). Evidence for the presence of plant growth regulators in commercial seaweed products. Plant Growth Regul. 13:21–29
Walker, D.A. (1992). Excited leaves. New Phytologist, 121:325-345.
Winston, G. W. (1990). Physiochemical basis for free radical formation in cells: production and defenses, p. 57-86. In:R.G. Alscher and J.R. Cummings (eds.). Stress responses in plants. Adaptation and acclimation mechanisms. Wiley-Liss, New York.
Yan, J. (1993). Influence of plant growth regulators on turfgrass polar lipid composition, tolerance to drought and saline stresses, and nutrient efficiency. Ph.D.. Dissertation. CSES, Virginia Tech.
Zeevart, J., and Creelman, R. (1988). Metabolism and physiology of ABA. Ann. Rev. Plant physiol. &Plant Mol.Biol, 39:439-473.
Zhang, X. and Schmidt, R.E. (2000). Hormone-containing products' impact on antioxidant status of tall fescue and creeping bentgrass subjected to drought. Crop Science, v.40, p.1344-1349.

تأثير فترات الرى وبعض مضادات الأكسدة وكذلك معاملات التفاعل بينهم على النمو و المحصول لنبات الذرة

محب طه صقر و أحمد محمد عبده جاد الله
قسم النبات الزراعى – كلية الزراعة – جامعة المنصورة

أدت معاملات التعطيش إلى نقص صفات النمو و المحصول لنبات الذرة وكانت المعاملة الرى بعد ٢٠ يوم هى الأكثر تأثيرا فى هذا الشأن. بينما أدت معاملات مضادات الأكسدة الى زيادة النمو و المحصول وكان SWE هو الأكثر فاعلية.
معاملات التداخل أدت الى تحسين صفات النمو و المحصول إذا ماقورنت بمعاملات التعطيش ولكن هذه الزيادة ظلت أقل من الكنترول.
يمكن ملاحظة أن مضادات الأكسدة المستخدمة أدت الى التغلب جزئيا على الأثار الضارة على النمو والمحصول والناجمة عن التعطيش.

قام بتحكيم البحث

أ.د / زين العابدين عبد الحميد محمد كلية الزراعه – جامعة المنصوره
أ.د / سعيد عواد محمد شحاته كلية الزراعه – جامعة عين شمس