J. Agric. Sci. Mansoura Univ., 34 (11): 10605 - 10617, 2009

EFFECT OF IRRIGATION INTERVALS AND SOME APPLIED ANTIOXIDANTS AS WELL AS THEIR INTERACTIONS ON BIOCHEMICAL CONSTITUENTS OF MAIZE PLANT.

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

ABSTRACT

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 on mitigate or alleviate the harmful effect of drought stress condition on biochemical constituents of maize plant. Iirrigation intervals (14, 16, 18 and 20 days) decreased photosynthetic chlorophyll a, b, carotenoids in the leaves of maize plants during the two growing seasons, irrigation every 20 days was the most effective treatment in decreasing photosynthetic pigments.

Concerning the applied antioxidants, it could be showed that each of the applied antioxidants (Citric, ASA or SWE) increased photosynthetic pigments content in the leaves of both maize during the growing seasons. Moreover, SWE treatment was the most effective in this respect. AS for the interaction effect, it could be show that all applied antioxidants enhanced the contents of photosynthetic pigments under drought stress levels (irrigation every 16, 18, 20 days) . This is clear when compared with drought stress treatments only but these values were stell under or nearly to control treatment.

As for Endogenous and non-enzymatic antioxidants it could be showed that irrigation intervals treatments and applied antioxidants such as total phenol, proline, ascorbic and glutathione as well as their interactions slightly increased all endogenous enzymatic antioxidants contents as well as SOD, APX and Catalase activities in the shoot of maize plants during the two growing seasons. SWE and irrigation every 20 days were most effective in this respect.

As for N,P ,K contents ,it could be show that drought stress treatments decreased N, P and K contents in leaves and stems of maize plants during the two growing seasons). Moreover high drought stress level (irrigation every 20 days) was the most effective in decreasing N, P, K contents . Contrarily, the data show that applied antioxidants slightly increased N, P , K contents in the different organs of maize plants during the growing seasons. Concerning interaction treatments, it could be show that applied antioxidants enhanced the contents of N, P , K in leaves and stems of maize plants under drought stress treatments (irrigation every 16, 18, 20 days) compared to the drought stress treatments only. But these increases were less or nearly to the control treatment.

INTRODUCTION

Drought stress progressively decreases photosynthetic pigments and CO2 assimilation rates . Drought stress also induces reduction in the contents and activities of photosynthetic carbon reduction cycle enzymes, including the key enzyme, ribulose- 1,5-bisphosphate carboxylase/oxygenase(Reddy, *et al.*, 2004).

ROS plays a crucial role in causing cellular damage under drought stress. The sequence of events in the plant tissue subjected to drought stress are: (1) increased production of ROS and of oxidized target molecules; (2) increases in the expression of genes for antioxidant functions; (3) increases in the levels of antioxidative systems and antioxidants; and (4) increased scavenging capacity for ROS, resulting in tolerance against the drought stress. Secondary products of ROS in plant cells during stress include lipid peroxides and thiol radicals. Although a series of regulatory mechanisms have evolved within the plant cell to limit the production of these toxic molecules . Mechanisms of ROS detoxification exist in all plants and can be categorized as enzymatic [superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APX), peroxidase (POD), glutathione reductase (GR) and monodehydroascorbate reductase (MDAR)] and non-enzymatic (flavanones, anthocyanins, carotenoids and ascorbic acid (AA)).

On the other hand, AA has been implicated in several types of biological activities in plants: (1) as an enzyme co-factor, (2) as an antioxidant, and (3) as a donor/ acceptor in electron transport at the plasma membrane or in the chloroplasts, all of which are related to oxidative stress resistance (Conklin, 2002).

Sharma and Dubey, (2005) reported that tmhe concentration of H2O2 as well as ascorbic acid declined with imposition of drought stress, however glutathione (GSH) concentration declined only under severe drought stress. The activities of total superoxide dismutases (SODs) as well as ascorbate peroxidase (APX) showed consistent increases with increasing levels of drought stress, however catalase activity declined..

Hura and Budzioch, (2006) showed that drought stress increased phenolics compound in leaf tissue. Phenolics change optical properties of leaves and have possibility to protect photosynthetic apparatus during drought stress

Proline accumulation caused by drought stress in maize plant does not seem to be an indication of drought stress resistance, but rather a symptom of it.

It can also be inferred that proline acts as a free radical scavenger and may be more important in overcoming stress than in acting as a simple osmolyte. (Levitt, 1980).

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 on mitigation or alleviate the harmful effect of drought stress condition on biochemical constituents of maize plant.

. Uniform grains of maiz were sown on May 10 th in the two growing seasons of2007 and 2008 . Each of the expermintal units were 3.5x3.3 =10.5m2 .

All the normal cultural practices of the growing maize were applied as usual manner followed by the farmers in the district.

Five irrigaton intervals were applied : Irrigation every 12 days (control), 14 , 16 , 18 and 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)

Samples were taken at 75 day from sowing to determinate the biochemical constituents of maize plant. Photosynthetic pigments were determined spectrophotometrically according toMackinny (1941).

Total ascorbate were determined according to *Omaye et al. (1979).* Total glutathione determined by the methods of *De Vos et al (1992).* Total phenols determinated by the methods of Daniel and George (1972). Ascorbate peroxidase activity was assayed ctrophotochemically according to Fielding (1978)..

Super oxide dismutase enzyme activity was determined according to (Dhindsa *et al.*,1981) method. Catalase activity was determined by the methods of Vierling, (1991) and Bettany, (1995). Proline was determined according to the method of Bates *et al.* (1973). Total nitrogsen was determined by the methods described by Jones *et al*(1991)..Phosphorus was determined by the methods described by Jackson (1973)

Potasium was estimated Flamephotometrically using Jenway Flamephotometer(Peterburgski, 1968). Each treatment replicated 3 times and arranged in a complete randomized block design.

RESULTS

photosynthetic pigments:

Data presented in tables (1-3) show that different irrigation intervals (14, 16, 18 and 20 days) decreased photosynthetic chlorophyll a, b, carotenoids in the leaves of maize plants during the two growing seasons, irrigation every 20 days was the most effective treatment in decreasing photosynthetic pigments.

Concerning the applied antioxidants, it could be show from the data in tables (1-3) that, each of applied antioxidants (Citric, ASA or SWE) increased photosynthetic pigments content in the leaves of maize during the two growing seasons. Moreover, SWE treatment was the most effective in this respect.

As for the interaction effects, it could be shown that all applied antioxidants enhanced the contents of photosynthetic pigments under drought stress levels (irrigation every 16, 18, 20 days) . This is clear when compared with drought stress treatments olone but these values were still under or nearly toequal control treatment.

It could be shown that applied antioxidants can partially mitigate the harmful effect of drought stress and SWE was the most effective in this respect.

Table (1): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on leaves chlorophyll a content (mg. chlorophyll/g. fresh weight) 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.)	26.1	27.5	29.2	33.1	29.0	28.3	29.8	31.3	35.2	31.2
14 days	19.3	20.0	23.7	24.6	21.9	21.5	22.3	25.8	26.7	24.1
16 days	14.1	14.8	14.8	18.1	15.4	15.6	16.3	16.9	20.5	17.3
18 days	10.2	11.5	13.4	13.4	12.1	12.3	13.6	15.8	15.6	14.3
20 days	6.6	6.9	7.4	8.5	7.3	8.5	8.9	9.5	10.5	9.3
Mean	15.2	16.1	17.7	19.5		17.2	18.2	19.9	21.7	

Table (2): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on leaves chlorophyll b content (mg. chlorophyll/g. fresh weight) 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.)	7.5	7.7	7.8	9.2	8.0	8.4	8.2	8.3	10.3	8.8
14 days	4.5	5.6	7.1	7.4	6.2	5.4	6.1	7.9	8.2	6.9
16 days	3.4	3.5	3.7	3.9	3.6	4.2	4.3	4.3	5.3	4.5
18 days	2.5	2.6	2.8	3.3	2.8	3.1	3.2	3.4	4.2	3.5
20 days	1.8	1.9	2.3	2.5	2.1	2.3	2.3	2.8	3.2	2.6
Mean	3.9	4.3	4.7	5.2		4.7	4.8	5.3	6.2	

Table (3): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on leaves carotenoids content (mg. /gm.fresh weight) 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.)	6.4	6.5	7.7	7.7	7.1	7.2	7.1	8.2	8.2	7.7
14 days	5.7	4.1	5.9	6.4	5.5	6.5	5.2	6.5	6.9	6.3
16 days	3.8	3.4	3.1	4.2	3.6	4.3	4.0	3.7	4.7	4.2
18 days	3.0	2.5	2.6	2.9	2.7	3.2	3.2	3.5	3.4	3.3
20 days	2.1	1.8	1.9	2.1	1.9	2.5	2.4	2.5	2.6	2.5
Mean	4.2	3.7	4.2	4.6		4.7	4.4	4.9	5.2	

Endogenous non-enzymatic Antioxidants content:

The data in tables (4----7)show that irrigation intervals treatments and applied antioxidants as well as their interactions slightly increased all endogenous non-enzymatic antioxidants contents such as total phenol, proline, ascorbic and glutathione in the shoot of maize plants during the two growing seasons. It could be shown that applied antioxidants (Citric, ASA, SWE) promoted the synthesis and accumulation of endogenous non-enzymatic antioxidants under drought stress levels treatments (irrigation every 16, 18, 20 days). SWE and irrigation every 20 days were most effective in this respect.

Table (4): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on phenol content(total phenols: mg/gm f.wt) 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.)	362	375	384	394	379	361	376	383	394	378
14 days	412	429	445	454	435	413	430	445	454	435
16 days	468	492	521	545	506	468	492	522	545	507
18 days	576	589	618	637	605	577	590	619	638	606
20 days	683	713	721	757	718	684	714	721.5	758	719
Mean	500	520	538	557		501	520	538	558	

Table (5): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on content of proline(mg/gm. D. wt) 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.)	319	328	342	357	336	320	330	343	358	338
14 days	371	381	395	428	394	371	382	396	429	394
16 days	456	475	508	528	492	456	475	509	530	492
18 days	542	554	567	585	562	543	555	569	589	564
20 days	592	625	651	664	633	593	626	652	665	634
Mean	456	473	493	512		457	474	494	514	

Table (6): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on ascorbic acid content (mg/gm.f.wt) 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.)	106	118	123	131	119	106	120	125	132	121.
14 days	145	153	162	174	158	146	152	161	175	158
16 days	182	193	201	212	197	184	194	200	210	197
18 days	225	239	251	273	247	226	238	253	275	248.0
20 days	285	306	321	334	311	286	307	322	335	312
Mean	188	202	211	225		189	202	212	225	

Table (7): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on glutathione content(Red.Glutathion ;µ mol/gm. f.wt;)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.)	166	181	191	223	190	165	184	192	221	190
14 days	239	248	262	293	260	240	245	263	292	260
16 days	314	333	345	362	338	315	334	346	363	339
18 days	374	385	392	408	389	375	386	393	409	391
20 days	414	451	475	477	449	416	452	458	478	451
Mean	301	319	329	353		302	320	330	353	

Enzymatic Antioxidants activity:

Data in tables (8-----10) show that SOD, APX and Catalase activities increased gradually with increasing drought stress . Moreover applied antioxidants gave similar response in enzymatic antioxidant. In addition it could show that exogenous applied antioxidants (Citric, ASA, Catalase) promoted the enzymatic activity under drought stress levels in maize plants during the two growing seasons. Exogenous applied SWE was the most effective treatment in this respect.

Table(8):Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on super oxide dismutase activity (SOD, mg protein/min)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.)	208	213	216	228	216	209	214	218	229	217
14 days	236	241	248	253	244	237	242	249	254	245
16 days	287	270	279	282	279	288	272	280	282	280
18 days	277	305	324	344	312	279	307	325	345	314
20 days	271	360	371	380	345	273	362	372	382	347
Mean	255	277	287	297		257	279	289	298	

Table (9): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on ascorbic peroxidase activity (APX ; unit/gm fat), 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.)	161	168	179	184	173	162	170	180	185	174
14 days	198	204	219	236	214	200	205	220	238	215
16 days	246	262	281	295	271	247	262	282	296	272
18 days	308	317	328	349	325	310	318	329	350	326
20 days	361	382	414	432	397	363	384	415	433	398
Mean	254	266	284	299		256	268	285	300	

Table (10): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on catalase activity(μ Mol H_2O_2 red/mg protein /min) 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.)	1.51	1.53	1.55	1.57	1.54	1.58	1.62	1.65	1.65	1.63
14 days	1.58	1.61	1.62	1.64	1.61	1.64	1.68	1.72	1.74	1.69
16 days	1.66	1.68	1.71	1.74	1.69	1.75	1.72	1.85	1.85	1.79
18 days	1.78	1.88	1.94	2.09	1.92	1.8	1.95	2.1	2.15	2.0
20 days	2.18	2.29	2.35	2.42	2.31	2.2	2.4	2.45	2.52	2.39
Mean	1.74	1.79	1.83	1.89		1.79	1.87	1.95	1.98	

N, P and K contents:

The data in tables (11 – 16) show that drought stress treatments (irrigation every 16, 18, 20 days) decreased N, P and K contents in leaves and stems of maize plants during the two growing seasons (2007& 2008). Moreover, high drought stress level (irrigation every 20 days) was the most effective in decreasing N, P, K contents in both plant organs of maize plants.

Contrarily, the data show that applied antioxidants slightly increased N, P , K contents in the different organs of maize plants during the growing seasons.

According to interaction treatments, it could be show that applied antioxidants enhanced the contents of N, P , K in leaves and stems of maize plants under drought stress treatments (irrigation every 16, 18, 20 days) compared to the drought stress treatments only. But these increases were less or nearly to the control treatment.

It could be mentioned that applied antioxidants could partially counteract the harmful effect of drought stress levels on the contents of N, P, K in leaves and stems of maize plants during the two growing seasons. Antioxidants SWE was the most effective in this respect.

Table (11): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on nitrogen leaves content (mg/gm D.wt) 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.)	2.48	2.68	2.83	2.92	2.72	2.55	2.789	2.942	2.987	2.81
14 days	2.25	2.32	2.35	2.36	2.32	2.36	2.42	2.46	2.46	2.43
16 days	2.33	2.69	2.10	2.18	2.32	2.32	2.78	2.25	2.28	2.40
18 days	1.88	1.92	1.96	1.98	1.93	1.96	1.98	2.02	2.03	1.99
20 days	1.69	1.85	1.85	1.85	1.81	1.75	1.95	1.95	1.95	1.90
Mean	2.12	2.29	2.21	2.25		2.18	2.38	2.32	2.34	

Table (12): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on phosphorus leaves content (mg/gm D.wt) of maize plant during the two growing seasons 2007 and 2008.

Irrigation intervals \ Treatment	Tap water	Critic	ASA	SWE	Mean	Tap water	Critic	ASA	SWE	Mean
	2007					2008				
12 days(cont.)	1.16	1.21	1.23	1.27	1.21	1.25	1.32	1.32	1.35	1.31
14 days	1.12	1.13	1.14	1.15	1.13	1.25	1.23	1.24	1.25	1.24
16 days	0.90	0.93	1.09	1.11	1.00	0.95	0.96	1.15	1.22	1.07
18 days	0.78	0.79	0.82	0.85	0.81	0.87	0.85	0.95	0.95	0.90
20 days	0.52	0.59	0.64	0.67	0.60	0.62	0.65	0.65	0.76	0.67
Mean	0.89	0.93	0.98	1.01		0.98	1.00	1.06	1.10	

Table (13): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on potassium leaves content (mg/gm D.wt) of maize plant during the two growing seasons 2007 and 2008.

Irrigation intervals \ Treatment	Tap water	Critic	ASA	SWE	Mean	Tap water	Critic	ASA	SWE	Mean
	2007					2008				
12 days(cont.)	1.35	1.36	1.40	1.41	1.38	1.45	1.46	1.52	1.52	1.48
14 days	0.90	0.91	0.94	0.97	0.93	0.95	0.95	0.96	0.98	0.96
16 days	0.84	0.85	0.85	0.86	0.85	0.86	0.87	0.86	0.88	0.86
18 days	0.74	0.75	0.78	0.79	0.76	0.78	0.76	0.79	0.85	0.79
20 days	0.50	0.51	0.52	0.54	0.51	0.56	0.55	0.55	0.56	0.55
Mean	0.86	0.87	0.89	0.91		0.92	0.92	0.94	0.96	

Table (14): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on nitrogen stem content (mg/gm D.wt) of maize plant during the two growing seasons 2007 and 2008.

Irrigation Intervals \ Treatment	Tap water	Critic	ASA	SWE	Mean	Tap water	Critic	ASA	SWE	Mean
	2007					2008				
12 days(cont.)	1.37	1.59	1.64	1.81	1.60	1.45	1.687	1.742	1.92	1.70
14 days	1.08	1.16	1.19	1.23	1.16	1.19	1.26	1.28	1.32	1.26
16 days	0.89	0.94	0.95	0.87	0.91	0.97	0.98	0.96	0.98	0.97
18 days	0.76	0.79	0.83	0.87	0.81	0.86	0.87	0.85	0.88	0.87
20 days	0.58	0.61	0.68	0.71	0.64	0.67	0.65	0.69	0.75	0.69
Mean	0.94	1.02	1.06	1.09		1.03	1.09	1.10	1.17	

Table (15): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on phosphorus stem content(mg/gm D.wt) of maize plant during the two growing seasons 2007 and 2008.

Irrigation Intervals \ Treatment	Tap water	Critic	ASA	SWE	Mean	Tap water	Critic	ASA	SWE	Mean
	2007					2008				
12 days(cont.)	0.78	0.81	0.86	0.88	0.83	0.87	0.85	0.92	0.92	0.89
14 days	0.62	0.67	0.73	0.75	0.69	0.72	0.75	0.78	0.78	0.75
16 days	0.52	0.55	0.57	0.58	0.55	0.64	0.58	0.59	0.62	0.60
18 days	0.38	0.44	0.45	0.48	0.44	0.48	0.54	0.51	0.51	0.51
20 days	0.16	0.21	0.27	0.32	0.24	0.25	0.26	0.32	0.38	0.30
Mean	0.49	0.53	0.57	0.60		0.59	0.59	0.62	0.64	

Table (16): Effect of water irrigation intervals and plant antioxidant materials as well as their interactions on potassium stem content (mg/gm D.wt) of maize plant during the two growing seasons 2007 and 2008.

Irrigation Intervals \ Treatment	Tap water	Critic	ASA	SWE	Mean	Tap water	Critic	ASA	SWE	Mean
	2007					2008				
12 days(cont.)	0.85	0.93	1.05	1.09	0.98	0.86	0.95	1.152	1.124	1.02
14 days	0.63	0.66	0.74	0.79	0.70	0.64	0.68	0.98	0.84	0.79
16 days	0.52	0.57	0.58	0.59	0.56	0.54	0.62	0.65	0.63	0.61
18 days	0.40	0.44	0.48	0.50	0.45	0.52	0.48	0.53	0.58	0.53
20 days	0.31	0.33	0.37	0.39	0.35	0.34	0.39	0.42	0.42	0.39
Mean	0.54	0.58	0.64	0.67		0.58	0.62	0.75	0.72	

DISCUSSION

Photosynthetic pigments:

Water availability is thought to be the most critical limiting factor for photosynthesis, and hence for agriculture. A lack of water has deleterious effects on numerous plant processes which can impinge on photosynthetic pigments with productivity reduction, however, the reverse is true for plants best supplied with water (Opik *et al.,* 2005) .

Enzymatic and Non Enzymatic Antioxidants:

ROS plays a crucial role in causing cellular damage under drought stress. The sequence of events in the plant tissue subjected to drought stress are: (1) increased production of ROS and of oxidized target molecules; (2) increases in the expression of genes for antioxidant functions; (3) increases in the levels of antioxidative systems and antioxidants; and (4) increased scavenging capacity for ROS, resulting in tolerance against the drought stress. Secondary products of ROS in plant cells during stress include lipid peroxides and thiol radicals. Mechanisms of ROS detoxification exist in all plants and can be categorized as enzymatic [superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APX), peroxidase (POD), glutathione reductase (GR) and monodehydroascorbate reductase (MDAR)] and non-enzymatic (flavanones, anthocyanins, carotenoids and ascorbic acid (AA)).

On the other hand, AA has been implicated in several types of biological activities in plants: (1) as an enzyme co-factor, (2) as an antioxidant, and (3) as a donor/ acceptor in electron transport at the plasma membrane or in the chloroplasts, all of which are related to oxidative stress resistance (Conklin, 2002).

Effect of Drought Stress on Proline:

It can also be inferred that proline acts as a free radical scavenger and may be more important in overcoming stress than in acting as a simple osmolyte. Proline accumulation caused by drought stress in maize plant does not seem to be an indication of drought stress resistance, but rather a symptom of it.

It can also be inferred that proline acts as a free radical scavenger and may be more important in overcoming stress than in acting as a simple osmolyte.

Role of antioxidants ascorbic and citric on alleviating the harmful effect of drought stress:

Ascorbic and glutathione and citric 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) involved in both electron transport of PS II and antioxidizing system of chloroplasts. (McKersie, 1996). (3)), as membrane stabilisers and multifaceted antioxidants, that scavenge oxygen free radicals, lipid peroxy radicals, and singlet oxygen (Diplock, *et al.*, 1989). (4) can react with peroxyl radicals formed in the bilayer as they diffuse to the aqueous phase. (Hess, 1993). (5) . It scavenges cytotoxic H_2O_2, and reacts non-enzymatically with other ROS: singlet oxygen, superoxide radical and hydroxyl radical (Larson, 1988). (6) regenerate another powerful water-soluble antioxidant, ascorbic acid, via the ascorbate–glutathione cycle. (Blokhina, *et al.*, 2002). (7) stabilize membrane structures (Blokhina, 2002). (8) modulates membrane fluidity in a similar manner to cholesterol, and also membrane permeability to small ions and molecules (Fryer, 1992). (9) 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).

Role of antioxidant Sea Weed Extract (SWE) on alleviating the harmful effects of drought stress:

Bostimulants (SWE) can alleviate the harmful effect of drought or 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 and root pull strength (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 protectphotosynthetic 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 (Dimir, *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..Inaddition nucleic acids metabolism was stimulated (O,Donnell,1973). XIII)- Stimulation of chloroplast development and enhancing phloem loading and delay senescenc (Dimir, *et al.*,2004).

REFERENCES

Bates, S.,Waldern, R .P. and Teare, D. (1973). Rapid determination of free prolin for water stress studies .Plant and soil .39, 205-207.

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.

Bettany, A.J.E., (1995). Stress responses in cell cultures of Lolium temulentum. I. Transcriptional and post-transcriptional changes in gene expression during heat shock and recovery. J Plant physiol 146: 162-168.

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.

Conklin, P.I. (2002). Recent advances in the role and biosynthesis of ascorbic acid in plants. Plant Cell Environ , 24: 383–94.

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.

De Vos, C. H., Vonk, M. J .,Vooijs, . R. and Hek, S. (1992). Glutathione depletion due to copper-induced phytochelation synthesis causes oxidative stress in *silene cucblus*. Plant physiology. 98: 858-859.

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.

Dhindsa, R. S., Plumb-Dhindsa, P. and Throne, T.A. (1981). Leaf senescence: correlated with increased levels of membrane permeability and lipid peroxidation and decreased levels of superoxide dismutase and catalase. J.Exp.Bot 32, pp. 93-101.

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.

Fielding, J. (1978). A biochemical and cytochemical study of peroxidase activity in root of *Pisum sativum*. J. of Experimental Botany. 29: 969-981

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. 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.

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.

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., Jone 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.

Jackson, M.L. (1973).Soil chemical Analysis .Brintica –Hall of Indian private New Delhi,pp:144-197.

Jones, J. , Bonten ,B., Wolf, B. and Mills, H. (1991). Plant analysis hand book .Method of plant analysis. Publishing ink ,USA .pp. 30-34 .

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

Levitt, J. (1980). Responses of plants to environmental stress: chilling, freezing and high temperature stresses, 2nd ed.. New York: Academic Press.

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.;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.

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

Omaye, S. T., Turnbm, J. D. and Saubermch, H. E. (1979). Selected methods for the determination of ascorbic acid in animal cells, tissues and fluids. Methods in Enzymologyi. Vol. 62. Academic Press. New York. Pp 1.

Peterburgski , A .V. (1968). Handbook of Agronomic chemistry Klop publishing House Moscad .pp:29-86.

Reddy, A. R., Chaitanya, K.V. and Vivekanandan, M. (2004). Drought-induced responses of photosynthesis and antioxidant metabolism in higher plants. Journal of Plant Physiology, V161 :1189-1202.

Schmidt, R.E. (2005). biostimulants function in turfgrass nutrition. Phd emeritus virginia tech.

Sharma, P., and Dubey, S. R. (2005). Drought induces oxidative stress and enhances the activities of antioxidant enzymes in growing rice seedlings. Plant Growth Regulation,46:209–221.

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.

Vierling, E. (1991). The roles of heat shock proteins in plants.

wheat seedlings growing in drying soil. Australian Journal of Annu Rev.Plant *Physiology* 17, 149–157.

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 التفاعل بينهم على المحتويـــات البيوكيماوية فى نبات الذرة

محب طه صقر و أحمد محمد عبده جاد الله

قسم النبات الزراعى – كلية الزراعة – جامعة المنصورة

أجريت تجربتى حقل فى محطة بحوث تاج العز التابعة لمركز البحوث الزراعية – وزارة الزراعة فى موسمى ٢٠٠٧& ٢٠٠٨ لدراسة دور بعض مضادات الأكسدة للتغلب على الآثار الضارة الناجمة عــن ظروف التعطيش وخاصة على المحتويات البيوكيماوية لنبات الذرة.

وجد أن الرى على فترات ١٤، ١٦، ١٨، ٢٠ يوم أدى الى نقص المحتوى مــن صـــفات البنـــاء الضوئى فى أوراق نبات الذرة خلال موسمى الزراعة وقد كانت معاملة الرى كل ٢٠يوم هى الأكثر فاعلية فى هذا الشأن.

كان لتأثير مضادات الأكسدة دور ايجابى فى زيادة المحتوى من صبغات البناء الضوئى وكذلك أدت مضادات الأكسدة الى تحسين الزيادة فى صفات البناء الضوئى تحت ظروف الإجهاد بالتعطيش ولكــن تلـــك الزيادة ظلت أقل من الكنترول .

أوضحت النتائج زيادة المحتوى من مضادات الأكسدة غير الأنزيميـــة (الفينـــولات – البـــرولين – الأسكوربيك – الجلوتاثيون) ونشاط انزيمات مضادات الأكسدة (SOD& APX& Catalase) وذلـــك تحت تأثير التعطيش أو مضادات الأكسدة أو معاملات التفاعل بينهم وكان معاملات الرى بعد ٢٠ يـــوم و SWE هما الأكثر تأثيرا.

أدت معاملات التعطيش الى نقص المحتوى من N, P, K وذلك على العكس من معاملات مضادات الأكسدة . كما أدت معاملات مضادات الأكسدة الى تحسين المحتوى منN, P, K تحت ظروف التعطـــيش ولكن ظل المحتوى أقل من الكنترول.

قام بتحكيم البحث

أ.د / عرفه احمد عرفه	كلية الزراعه – جامعة المنصوره
أ.د / محمد خليل خليل الدعدع	كلية الزراعه – جامعة القاهره