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EFFECT OF SOME ANTIOXIDANTS AND MICRONUTRIENTS FOLIAR APPLICATION ON YIELD AND QUALITY OF WHEAT GROWN IN SIWA OASIS.

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ABSTRACT: *This study was carried out on sandy loam soil of Tegzerty region, at Siwa Oasis, Egypt. This soil was salinity, had an EC of 4.63dSm^{-1} in the paste extraction and irrigated with water of 1.65dSm^{-1}. A field experiment was done during two successive seasons (2011/2012 & 2012/2013). Wheat (Triticum aesitivum var. Sakha93) was the test plant. Foliar spraying with two antioxidants (ascorbic or citric acids with concentrations of 100, 200 and 400 mgL^{-1} was done) to restrains the harmful effect of salinity. Also application of spraying of micronutrients of Fe, Mn, and Zn at concentration of 100mgL^{-1} of each was done. Application of micronutrients with antioxidants increased yields and nutrients uptake of wheat, and also increased total phenol and total antioxidant activity in straw and grains. The yield parameters of wheat were increased with increasing rates of antioxidants. The ascorbic acid was higher effect on yield than the citric acid. The most effective treatment was (either ascorbic acid or citric acid at 400mgL^{-1} with micronutrients), which scored 18.73 and 9.90Mgha^{-1} of straw and grains of wheat respectively for ascorbic acid, while 17.75 and 9.02 Mgha^{-1} for citric acid. On the other side, the superior treatment (ascorbic acid) achieved (356 and 532mg ascorbic acid/L extract) of total antioxidants activity and (953 and 1590 µmol gallic acid/mL extract) of total phenol for grains and straw respectively, while citric acid recoded (248 and 381mg ascorbic acid/L extract) of total antioxidants activity and (694 and 1285µmol gallic acid/mL extract) of total phenol for grains and straw respectively. Generally, the amendments treatments achieved increase of grain over general control as following; 37.0, 28.3 and 15.4 % for ascorbic acid, citric acid and micronutrients respectively. This fact assures the importance of micronutrients fertilization and antioxidants to improve yield and quality of wheat grown under salinity stress such as Sewa Oasis conditions.*

Key words: *Antioxidants (ascorbic and citric acids), Micronutrients, Maximum yield of Wheat, Sandy loam soil, Siwa Oasis, Egypt*

INTRODUCTION

Salinity is a major problem that negatively impacts agricultural activities in newly reclamation areas of Egypt, especially the soils which higher water table in these soils of Siwa Oasis, Egypt. Soil of current study was irrigated with slightly saline water slightly water (1.65 dSm^{-1}) and the soil was saline (4.63 dSm^{-1}in the paste extraction. Water of EC<0.75 dS/m has no detrimental effect (Gary and Delno 2004). El-Agrodi *et al* (2005) showed that although root dry weight of wheat was decreased with raising soil salinity level up to 0.2%, it decreased when soil salinity level was above 0.2%. Ameer khan *et al* (2006) concluded that foliar spray of ascorbic acid protected photosynthesis from the damaging effects of salt stress. Ahmed and Fawy (2008) reported that the suitable level of NaCl salt in irrigation water for wheat was 5850 to 11700mgL^{-1} and 11.1 to 33.3mgL^{-1} of $CaCl_2$ to achieve economic yield. Farouk (2011) reported that under moderate salinity levels, application of antioxidants alleviated the harmful effects of salinity on leaf senescence related parameter, but under high salinity levels (7.5-11.5 dS/m) all the yield parameter of wheat and nutrients with antioxidants content were reduced.

Foliar application of micronutrients is an effective method for correcting soil deficiencies in them. Ahmad *et al*. (2006) reported that foliar spray with 0.9% solution containing 12, 9, 8, 1, 2, 1.5, 3, 1.4 and 2.3

% of N, P, K, Zn, Fe, Mn, Mg, Cu and S, respectively and 50ppm of B gave the highest wheat yield and N, P and K contents in straw. Seadh *et al* (2009) reported that the foliar micronutrients application at rate 500 ppm produced the highest values of grain yield and its components, chemical composition as well as quality parameters. Muhammad et al (2011) stated that the grain and most of yield parameters of wheat increased with increase micronutrients levels up to1000 ppm, while the increase in straw yield was stop at level of 500ppm) of micronutrients application.

Regarding antioxidant foliar application effect, Ameer khan *et al* (2006) concluded that the foliar spray of ascorbic acid protected the photosynthetic process from the damaging effects of salt stress. Amin *et al* (2008) stated that the foliar application with salicylic acid at 100 mgL^{-1} combined with ascorbic acid at 200 or 400 mgL^{-1} for wheat plants were more effective in increasing growth characters, yield and photosynthetic pigments in leaves and total carbohydrates, as well as N, P and K content in wheat grains. Farghal *et al* (2009) reported that foliar spray with solution of ascorbic acid at 1000mgL^{-1} 45 and 75 days after sowing of wheat was the most effective treatment to increase wheat tolerance to different salinity, and achieved highest yield. Farouk (2011) reported that foliar spray with ascorbic acid and α-Tocopherol increased the antioxidants enzyme activities, and enhanced accumulation of ascorbate, phenol, carotenoids, calcium, potassium and magnesium in wheat plants. The objective of the current study is increasing yield of wheat under conditions of saline water irrigation in a sandy loam soil at Siwa Oasis by using the antioxidants and micronutrients as foliar spray at three times during different stages of wheat growth.

MATERIALS AND METHODS

Field experiment was carried out through two successive seasons (2011/2012 and 2012/2013) in Tegzerty region at Siwa Oasis, located at 29º 11' 32" N and 25º 32' 09" E. The soil had been under irrigation with water of 1.65dSm^{-1}. The soil was saline with paste extract of 4.63dSm^{-1}. The experimental plot area was (12.5mx10m) 125m^2. The crop was wheat (*Triticum aesitivum* var. Sakha 93). Analyses of some of chemical and physical properties of the studied soil and used irrigation water are presented in Table 1. Analyses were accomplished according to Page, *et al.* (1982) and Klute (1986).

Table (1). Analyses of some chemical and physical properties of the studied soil and used irrigation water.

Depth cm	pH in soil paste ext.	E.C dSm^{-1} in soil paste ext.	OM	$CaCO_3$	Sand	Silt	Clay	C.E.C $mmolckg^{-1}$ soil	Texture
			gkg^{-1}		%				
0-30	8.31	4.63	25	125	73.95	10.68	15.37	113	S.L
30-60	8.62	5.84	28	147	71.14	11.5	17.36	135	S.L
Soluble cations and anions in soil ($mmolcL^{-1}$) and Total antioxidants and phenol acids									
	Na	K	Ca	Mg	HCO_3^{-1}	Cl^{-1}	SO_4^{-2}	T. phenol	T.A.A
0-30	22.9	2.9	13.6	6.9	2.0	35	9.3	723	175
30-60	27.5	3.8	17.7	9.4	2.7	42	13.7	758	187
Available nutrients in soil ($mgkg^{-1}$)									
	N	P	K	Fe	Mn	Zn	Cu		
0-30	42.8	0.83	38.5	3.18	1.81	0.85	0.41		
30-60	28.4	0.75	49.7	4.72	2.62	1.41	0.56		
Used water irrigation									
pH	EC dSm^{-1}	Soluble cations and anions in ($mmolcL^{-1}$)							
		Na^+	K^+	Ca^{++}	Mg^{++}	HCO_3^-	Cl^-	SO_4^{--}	
7.84	1.65	9.2	0.13	4.4	2.8	0.9	10.9	4.8	

Total phenol antioxidants (µmol of Gallic acid/mL extract) and Total antioxidants activity (Ascorbic acid mgL^{-1} extract.).

The design was a randomized complete block factorial. The three factor of the experiment were as follows; 1- spray with micronutrients; 2 treatments, non and spray, 2- spray with antioxidants; 2 types and 3-rate of antioxidants; 3 rates in addition to non-spray. The nutrients spray solution contained Fe, Mn and Zn at 300mgL^{-1} in spray solution. Soil of the experimental field was supplied with 150kgN, 30kgP and 100kgKha^{-1} (as urea, Ca-superphosphate and potassium sulphate, respectively). Each of N and K fertilizer split into three equal doses and applied after 20, 60, and 90 days from sowing.

A mixture of three solid micronutrients (as chelating form) of Fe: Mn: Zn containing 100mg of each per liter was sprayed on plants. The two types of antioxidants were ascorbic and citric acids at rates 100, 200 and 400 mgL^{-1}. The foliar antioxidants application was after one week following the foliar micronutrients application. The spray rate was 1000Lha^{-1}. Spraying was done in 3 situations; 20, 60 and 90days after sowing.

Plant samples were collected at harvest stage at the end of each experiment. The biological yield, grains, straw, 1000-grains weight, and the number and weight per spikes were recorded in both seasons. Plant samples were analyzed for macro and micronutrients according to Cottenie *et al.* (1982). Total antioxidants and total phenol were carried out in soil and wheat plants according to Rimmer (2009)

Soil and plant Phenol Acids and Total antioxidant

Soil (2g) was extracted with 10 mL of deionized (DI) water for 16h on a reciprocal shaker followed by centrifugation and collection of the supernatant for purification. The soil was then extracted with 10 mL of 50 mM EDTA (pH 7.5) for 16h on a reciprocal shaker. After EDTA extraction, the samples were centrifuged and the supernatant saved for purification.

Antioxidant ability assays Total antioxidant activity

The assay was based on the reduction of Mo(VI)-Mo(V) by the extracts and subsequent formation of a green phosphate/Mo(V) complex at acidic pH (Prieto *et al.* 1999). The extract (0.1mL) was mixed with 3 ml of reagent solution (0.6 M sulphuric acid, 28 mM sodium phosphate and 4 mM ammonium molybdate). The tubes were incubated at 95°C for 90 min. The mixture was cooled to room temperature, and then the absorbance of the solution was measured at 695 nm against blank. The total antioxidant activity was expressed as ascorbic acid equivalents (AAE) in milligrams per gram of the extract.

Measurement of total phenol compounds

Total phenolic constituents of plant extracts were performed employing the literature methods involving Folin-Ciocalteu reagent and gallic acid as standard (Slinkard and Singleton, 1977). Extract solution (0.1mL) containing 1000 ug extract was taken in a volumetric flask, 46 mL distilled water and 1mL Folin-Ciocalteu reagent were added and flask was shaken thoroughly. After 3 min, 3 ml of solution 2% Na_2CO_3 was added and the mixture was allowed to stand for 2 h with intermittent shaking. Absorbance was measured at 760nm. The same procedure was repeated to all standard Gallic acid solutions (0-1000 mg, 0.1 ml^{-1}) and standard curve was obtained. The obtained data were statistically analyzed according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of antioxidants and micronutrients on wheat yields

Data in Table 2 and Figs 1 & 2 stated that the yields of wheat increased with increasing the antioxidants rates additions of both ascorbic and citric acids as foliage with or without micronutrients application in studied soil during the two seasons. The most effective compound antioxidants with micronutrients treatments either Cit (Citric acid) or AS (Ascorbic acid) at rate 400 mgL^{-1} with applied micronutrients, achieved 3.79 and 4.16 Mgfed^{-1} of grains respectively, while scored 3.38 and 4.03 Mgfed^{-1} of grains

without micronutrients application. The wheat parameters take the same trend of grains behavior. The AS was higher effect on yield parameters of wheat than Cit. The above results agreed with those obtained by Farghal *et al* (2009) and Farouk (2011).

Table 2: Effect of antioxidants and micronutrients fertilizers applied on wheat yields through the two seasons in the studied soil.

Micro-nutrients foliar spray (M)	Anti-oxidant source (A)	Antioxidant treatment Rate (R), mgL^{-1} in foliar spray				mean	Antioxidant treatment Rate (R) , mgL^{-1} in foliar spray				mean
		0	100	200	400		0	100	200	400	
		Biological yield $Mgfed^{-1}$					Weight 1000 grain (g)				
none	citric	6.37	7.28	8.91	10.27	8.21	29.7	42.9	51.4	58.2	45.6
	ascorbic	6.37	8.12	10.7	11.51	9.18	29.7	49.5	56.3	62.4	49.5
mean		6.37	7.7	9.81	10.89	8.70	29.7	46.2	53.9	60.3	47.6
spray	citric	7.33	8.89	10.54	11.25	9.50	41.5	57.6	65.0	74.1	59.6
	ascorbic	7.33	9.74	11.26	12.03	10.09	41.5	62.4	73.9	81.3	64.8
mean		7.33	9.32	10.9	11.64	9.80	41.5	60.0	69.5	77.7	62.2
Means of R											
	citric	6.85	8.09	9.73	10.76	8.86	35.6	50.3	58.2	66.2	52.6
	ascorbic	6.85	8.93	10.98	11.77	9.63	35.6	56.0	65.1	71.9	57.1
Grand mean		6.85	8.51	10.35	11.27		35.6	53.1	61.7	69.0	
$LSD_{0.05}$		M=0.07 A= 0.07 R=0.10 MA=0.10 MR=0.14 AR=0.14 MAR=0.19					M=0.54 A=0.54 R=0.76 MA=0.76 MR=1.08 AR=1.08 MAR= 1.53				
		Straw yield $Mgfed^{-1}$					Spikes weight kgm^{-2}				
none	citric	4.39	5.02	6.08	6.89	5.6	0.299	0.366	0.452	0.535	0.413
	ascorbic	4.39	5.56	7.29	7.48	6.18	0.299	0.436	0.613	0.692	0.51
mean		4.39	5.29	6.69	7.19	5.89	0.299	0.401	0.533	0.614	0.462
spray	citric	4.99	6.06	7.17	7.46	6.42	0.415	0.515	0.636	0.737	0.576
	ascorbic	4.99	6.59	7.53	7.87	6.75	0.415	0.625	0.728	0.839	0.652
mean		4.99	6.33	7.35	7.67	6.59	0.415	0.57	0.682	0.788	0.614
Means of R											
	citric	4.69	5.54	6.63	7.18	6.01	0.357	0.441	0.544	0.636	0.494
	ascorbic	4.69	6.08	7.41	7.68	6.46	0.357	0.531	0.671	0.766	0.581
Grand mean		4.69	5.81	7.02	7.43		0.357	0.486	0.607	0.701	
$LSD_{0.05}$		M=0.04 A=0.04 R=0.06 MA=0.06 MR=0.09 AR=0.09 MAR=0.12					M=0.006 A=0.006 R=0.008 MA=0.008 MR=0.012 AR=0.012 MAR=0.016				
		Grains yield $Mgfed^{-1}$					Spikes number/m^2				
none	citric	1.98	2.26	2.83	3.38	2.61	204	256	285	315	265
	ascorbic	1.98	2.56	3.41	4.03	3.00	204	289	323	357	293
mean		1.98	2.41	3.12	3.71	2.81	204	273	304	336	279
spray	citric	2.34	2.83	3.37	3.79	3.08	292	353	385	414	361
	ascorbic	2.34	3.15	3.73	4.16	3.35	292	412	440	460	401
mean		2.34	2.99	3.55	3.98	3.22	292	383	413	437	381
Means of R											
	citric	2.16	2.55	3.10	3.59	2.85	248	305	335	365	313
	ascorbic	2.16	2.86	3.57	4.10	3.17	248	351	382	409	347
Grand mean		2.16	2.70	3.34	3.84		248	328	358	387	
$LSD_{0.05}$		M=0.03 A=0.03 R=0.04 MA=0.04 MR=0.05 AR=0.05 MAR=0.07					M=2.8 A=2.8 R=3.9 MA=3.9 MR=5.5 AR=5.5 MAR=7.8				
		Yield in $Mgfed^{-1}$: Biological=3.61 Straw= 2.77 Grains=0.84 Weight 1000 grain=15.9g Spikes weight=0.157kgm^{-2} Spikes number/m^2=118									

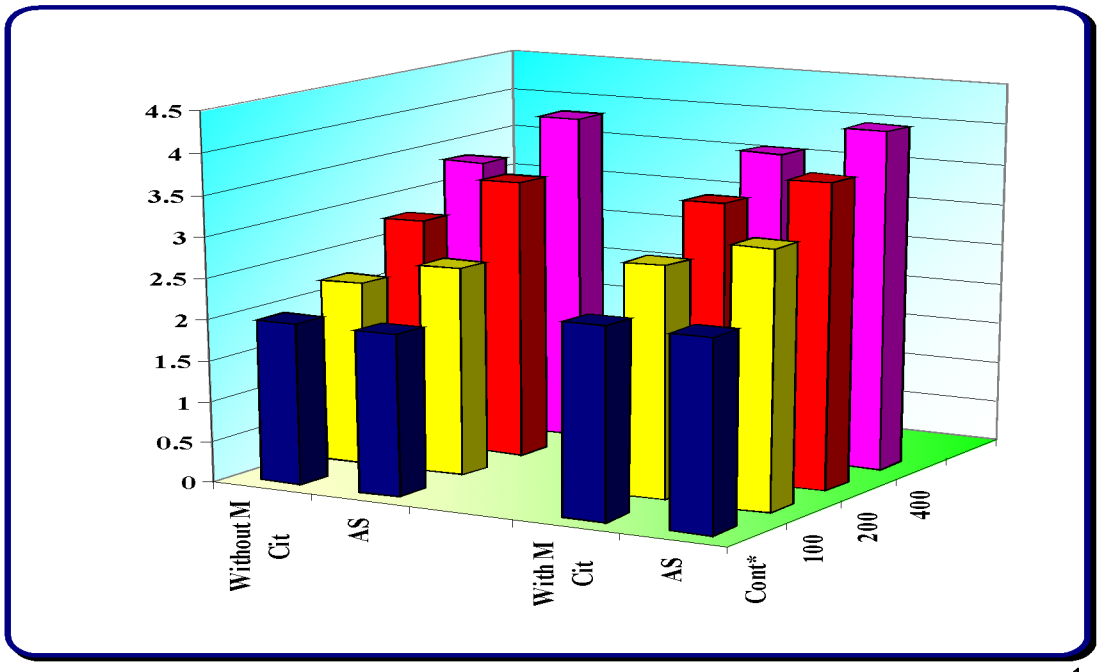

Fig.1: Effect of soil antioxidants and micronutrients application on straw yield (Mgfed^{-1}).

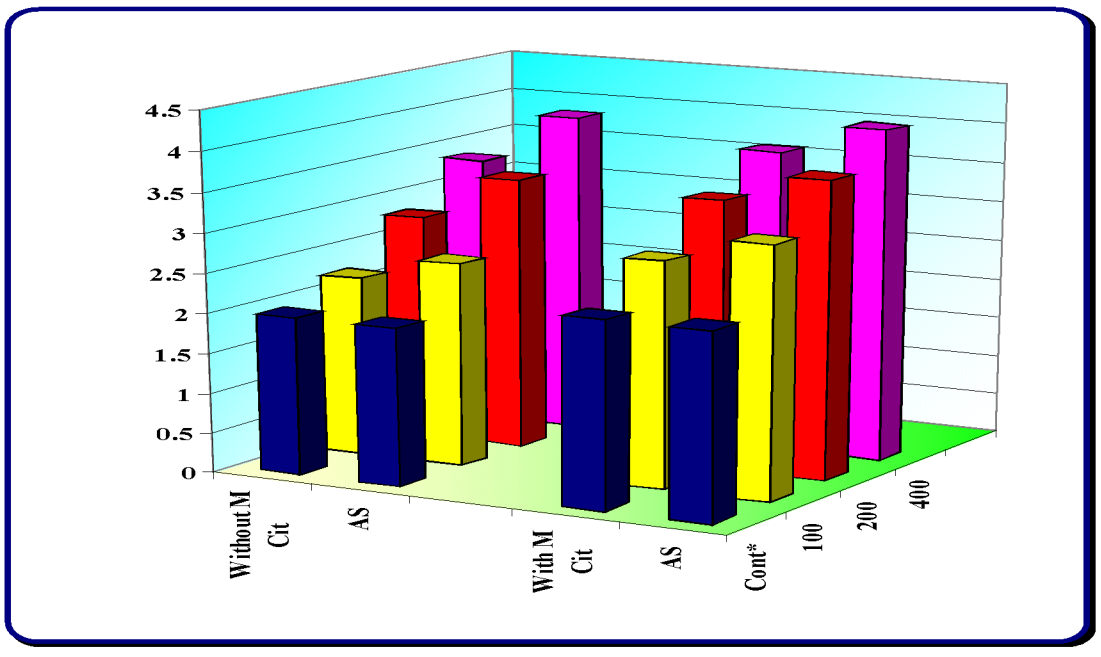

Fig. 2: Effect of soil antioxidants and micronutrients application on grain yield (Mgfed^{-1}).

Micronutrients increased yield of wheat. The effect on yield was lower than that of the antioxidants. Antioxidants plus micronutrients applications achieved higher yields of wheat for straw and grains wheat by 12.7 % and 16.3% respectively (Fig1 and Fig 2).

Other parameters took the same trend at that of the yield. This reflects the importance of micronutrients to improve the antioxidants effect. The above results agree with those obtained by Seadh *et al* (2009) and. Muhammad *et al* (2011).

Concerning to effect on yields of wheat, the amended treatment achieved increases in grain yield by 37.0, 28.3 and 15.4 % for micronutrient spray, ascorbic acid spray and citric acid spray, respectively. Thus fertilization and antioxidants improve quantity and quality of wheat yield. The above results agree with those obtained by Ameer khan *et a*l (2006), Ahmed and Fawy (2008) and Farouk (2011).

Effect of fertilizers and antioxidants on nutrients uptake by wheat:

Concerning the effect of fertilizers and antioxidants on the uptake of nutrients by wheat, (Tables 3 and 4), spray with micronutrients or antioxidants increased the nutrients uptake by wheat.

The effect of ascorbic acid spray on nutrients uptake by wheat was higher than citric acid spray. The most efficient treatment was either ascorbic acid spray or citric acid spray at rate 400mgL^{-1} combined with micronutrients spray at 300mgL^{-1}.

Regarding micronutrients effect with antioxidants, data of Table 4, show that micronutrients uptake (i.e. Fe, Mn, Zn and Cu) by wheat was increased by spraying of micronutrients or antioxidants or both. The above results agree with those obtained by Farouk (2011) and Muhammad *et al* (2011).

Effect of fertilizers and antioxidants on total phenol and antioxidants:

Data in Table 5 show that application of micronutrients increased total phenol and total antioxidant activity in straw and grain of wheat. Total phenol and total antioxidant activity in straw were higher than in grains. Application both antioxidants increased total phenol and total antioxidant activity. The most effective treatment was either ascorbic or citric acid at a concentration of 400mgL^{-1} combined with micronutrients spray. The above results agree with those obtained by Farghal *et al*. (2009), Muhammad *et al*. (2011) and Farouk (2011).

CONCLUSION

Therefore, spraying wheat with micronutrients or ascorbic acid or citric acid increased wheat yield and nutrient uptake. Also, their application increased total antioxidants activity and total phenol in straw and grain of wheat. The most effective treatment was that of either ascorbic acid or citric acid at 400mgL^{-1} with micronutrients.

Generally, the amendments treatments achieved increase of grain over general control as following; 37, 28.3 and 15.4% AS, Cit and micronutrients respectively. This shows the importance of micronutrients fertilization and antioxidants to improve yield and quality of wheat grown under salinity stress.

Table 3: Effect of fertilizers and antioxidants treatments on the nutrients uptake (kg/fed) of wheat grown through the two seasons.

Micro-nutrients foliar spray (M)	Anti-oxidant source (A)	Straw					Grains				
		Antioxidant treatment Rate (R), mgL-1 in foliar spray					Antioxidant treatment Rate (R), mgL-1 in foliar spray				
		0	100	200	400	mean	0	100	200	400	mean
		N uptake kgfed^{-1}									
none	citric	19.0	22.6	29.2	38.0	27.2	14.8	18.1	23.5	28.7	21.3
	ascorbic	19.0	26.2	38.0	44.1	31.8	14.8	21.0	29.0	35.1	25.0
Mean		19.0	24.4	33.6	41.1	29.5	14.8	19.6	26.3	31.9	23.1
spray	citric	22.0	25.4	31.6	39.7	29.7	16.8	20.6	25.4	31.0	23.4
	ascorbic	22.0	29.6	38.6	44.4	33.6	16.8	24.1	30.2	36.5	26.9
Mean		22.0	27.5	35.1	42.1	31.7	16.8	22.3	27.8	33.7	25.2
Means of R											
	citric	20.5	24.0	30.4	38.9	28.4	15.8	19.4	24.5	29.8	22.4
	ascorbic	20.5	27.9	38.3	44.3	32.7	15.8	22.5	29.6	35.8	25.9
Grand mean		20.5	26.0	34.3	41.6		15.8	20.9	27.0	32.8	
LSD0.05		M=0.30 A=0.30 R=0.43 MA=0.43 MR=0.61 AR=0.61 MAR=0.86					M=0.25 A=0.25 R=0.36 MA=0.36 MR=0.51 AR=0.51 MAR=0.72				
		P uptake kgfed^{-1}									
none	citric	2.78	3.49	5.13	6.89	4.57	1.93	2.44	3.51	4.43	3.08
	ascorbic	2.78	4.03	6.52	7.39	5.18	1.93	3.10	4.47	5.49	3.75
mean		2.78	3.76	5.83	7.14	4.88	1.93	2.77	3.99	4.96	3.41
spray	citric	3.50	4.36	6.17	7.57	5.40	2.52	3.32	4.27	5.44	3.89
	ascorbic	3.50	5.30	7.44	8.46	6.17	2.52	4.04	5.44	6.94	4.73
Mean		3.50	4.83	6.80	8.01	5.78	2.52	3.68	4.86	6.19	4.31
Means of R											
	citric	3.14	3.93	5.65	7.23	4.98	2.22	2.88	3.89	4.94	3.48
	ascorbic	3.14	4.66	6.98	7.92	5.68	2.22	3.57	4.96	6.22	4.24
Grand mean		3.14	4.29	6.31	7.58		2.22	3.22	4.42	5.58	
LSD0.05		M=0.07 A=0.07 R=0.10 MA=0.10 MR=0.15 AR=0.15 MAR=0.21					M=0.06 A=0.06 R=0.09 MA=0.09 MR=0.13 AR=0.13 MAR=0.18				
		K uptake kgfed-^{1}									
none	citric	18.5	22.1	27.5	33.0	25.3	5.72	6.83	8.47	10.99	8.00
	ascorbic	18.5	26.6	31.4	37.1	28.4	5.72	8.39	9.82	12.33	9.07
Mean		18.5	24.4	29.5	35.1	26.8	5.72	7.61	9.15	11.66	8.53
spray	citric	15.9	18.9	23.5	29.1	21.8	4.86	5.75	7.51	9.75	6.96
	ascorbic	15.9	22.5	28.9	33.8	25.3	4.86	7.14	9.17	11.68	8.21
Mean		15.9	20.7	26.2	31.4	23.5	4.86	6.44	8.34	10.72	7.59
Means of R											
	citric	17.2	20.5	25.5	31.0	23.5	5.29	6.29	7.99	10.37	7.48
	ascorbic	17.2	24.6	30.2	35.5	26.8	5.29	7.77	9.50	12.01	8.64
Grand mean		17.2	22.5	27.8	33.2		5.29	7.03	8.74	11.19	
LSD0.05		M=0.26 A=0.26 R=0.36 MA=0.36 MR=0.51 AR=0.51 MAR=0.73					M=0.09 A=0.09 R=0.13 MA=0.13 MR=0.18 AR=0.18 MAR=0.26				
General control		Macronutrients in straw (kgfed^{-1})					N= 7.2		P= 0.92		K= 5.26
		Macronutrients in grains (kgfed^{-1})					N= 5.80		P= 0.38		K= 1.15

Table (4). Effect of fertilizers and antioxidants treatments on the nutrients uptake (g/fed) of wheat grown through the two seasons.

Micro-nutrients foliar spray (M)	Anti-oxidant source (A)	Straw: Antioxidant treatment Rate (R), mgL-1 in foliar spray 0	100	200	400	mean	Grains: Antioxidant treatment Rate (R), mgL-1 in foliar spray 0	100	200	400	mean
		Fe gfed^{-1}									
none	citric	156	193	259	316	231	139	172	232	287	208
	ascorbic	156	237	357	404	289	139	215	312	398	266
mean		156	215	308	360	260	139	194	272	343	237
spray	citric	364	530	688	817	600	248	317	422	536	381
	ascorbic	364	686	850	1002	726	248	413	563	692	479
mean		364	608	769	910	663	248	365	493	614	430
Means of R											
	citric	338	458	603	725	531	263	331	443	555	398
	ascorbic	338	580	782	905	651	263	422	594	744	506
Grand mean		338	519	693	815		263	376	518	650	
LSD0.05		M=9.5 A=9.5 R=13.5 MA=13.5 MR=19.0 AR=19.0 MAR=26.9					M=5.7 A=5.7 R=8.0 MA=8.0 MR=11.4 AR=11.4 MAR=16.1				
		Mn gfed^{-1}									
none	citric	81	105	148	195	132	67	84	114	152	104
	ascorbic	81	129	214	249	168	67	107	162	210	137
mean		81	117	181	222	150	67	96	138	181	120
spray	citric	210	324	458	527	380	157	224	290	361	258
	ascorbic	210	419	565	647	460	157	268	358	467	313
mean		210	372	512	587	420	157	246	324	414	285
Means of R											
	citric	186	267	377	459	322	146	196	259	333	233
	ascorbic	186	339	497	573	398	146	241	341	444	293
Grand mean		186	303	437	516		146	219	300	388	
LSD0.05		M=6.5 A=6.5 R=9.2 MA=9.2 MR=13.0 AR=13.0 MAR=18.4					M=4.2 A=4.2 R=5.9 MA=5.9 MR=8.3 AR=8.3 MAR=11.8				
		Zn gfed^{-1}									
none	citric	33	43	60	72	52	30	39	57	74	50
	ascorbic	33	52	87	92	66	30	49	81	103	66
mean		33	48	74	82	59	30	44	69	89	58
spray	citric	113	157	209	254	183	73	98	131	158	115
	ascorbic	113	195	258	312	220	73	131	175	204	146
mean		113	176	234	283	201	73	115	153	181	130
Means of R											
	citric	90	122	165	199	144	67	88	123	153	108
	ascorbic	90	150	216	248	176	67	115	169	205	139
Grand mean		90	136	190	224		67	101	146	179	
LSD0.05		M=3.2 A=3.2 R=4.5 MA=4.5 MR=6.4 AR=6.4 MAR=9.0					M=1.9 A=1.9 R=2.6 MA=2.6 MR=3.7 AR=3.7 MAR=5.3				
		Cu gfed^{-1}									
none	citric	20	27	35	52	34	17	22	33	41	28
	ascorbic	20	37	51	66	44	17	30	46	57	38
mean		20	32	43	59	39	17	26	40	49	33
spray	citric	41	63	90	103	74	38	52	66	78	59
	ascorbic	41	82	112	126	90	38	72	88	100	75
mean		41	73	101	115	82	38	62	77	89	67
Means of R											
	citric	41	59	80	104	71	36	48	66	80	58
	ascorbic	41	78	107	129	89	36	66	90	107	75
Grand mean		41	68	94	116		36	57	78	94	
LSD0.05		M=1.2 A=1.2 R=1.7 MA=1.7 MR=2.4 AR=2.4 MAR=3.4					M=0.9 A=0.9 R=1.3 MA=1.3 MR=1.8 AR=1.8 MAR=2.5				
General control		Micronutrients in straw (gfed^{-1})				Fe= 89	Mn= 43		Zn= 14	Cu=10	
		Micronutrients in grains (gfed^{-1})				Fe= 47	Mn= 21		Zn= 8	Cu=5	

Table (5). Effect of fertilizers and antioxidants on total antioxidants activity and total phenol in wheat during two seasons.

Micro-nutrients foliar spray (M)	Anti-oxidant source (A)	Straw					Grains				
		Antioxidant treatment Rate (R), mgL-1 in foliar spray				mean	Antioxidant treatment Rate (R), mgL-1 in foliar spray				mean
		0	100	200	400		0	100	200	400	
		Total antioxidants µg of Ascorbic acid/mL extract									
none	citric	157	228	303	382	268	101	147	198	253	175
	ascorbic	157	305	353	413	307	101	201	221	273	199
mean		157	267	328	398	287	101	174	210	263	187
spray	citric	199	321	358	466	336	127	208	238	293	217
	ascorbic	199	381	463	532	394	127	248	305	356	259
mean		199	351	411	499	365	127	228	272	325	238
Means of R											
	citric	257	389	482	615	436	165	251	317	400	283
	ascorbic	257	496	585	679	504	165	325	374	451	329
Grand mean		257	442	533	647		165	288	345	425	
LSD0.05		M=4.1 A=4.1 R=5.7 MA=5.7 MR=8.1 AR=8.1 MAR=11.5					M=2.7 A=2.7 R=3.8 MA=3.8 MR=5.4 AR=5.4 MAR=7.6				
		Total phenols µmol of Gallic acid/mL extract									
none	citric	753	1057	1247	1385	1111	375	485	597	775	558
	ascorbic	753	1170	1350	1430	1176	375	550	690	840	614
mean		753	1114	1299	1408	1143	375	518	644	808	586
spray	citric	811	1161	1320	1485	1194	453	581	705	861	650
	ascorbic	811	1285	1497	1590	1296	453	694	786	953	722
mean		811	1223	1409	1538	1245	453	638	746	907	686
Means of R											
	citric	1159	1638	1907	2128	1708	602	776	950	1206	883
	ascorbic	1159	1813	2099	2225	1824	602	897	1083	1317	975
Grand mean		1159	1725	2003	2176		602	836	1016	1261	
LSD0.05		M=9.9 A=9.9 R=14.1 MA=14.1 MR=19.9 AR=19.9 MAR=28.1					M=6.4 A=6.4 R=9.0 MA=9.0 MR=12.7 AR=12.7 MAR=18.0				
General control		Total antioxidants µg of Ascorbic acid/mL extract in straw= 98 in grain = 65									
		Total phenols µmol of Gallic acid/mL extract in straw= 432 in grain = 211									

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تأثير الاضافة رشا لبعض مضادات الاكسدة والعناصر الغذائية الصغرى على محصول وجودة القمح النامى فى اراضى واحة سيوة

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الملخص العربي

اقيمت هذة الدراسة فى ارض رملية طمية بمنطقة تجزرتى فى واحة سيوة مصر. ملوحة مستخلص عجينة هذة التربة هى (4.63ديسى/م) تروى بمياة ملوحتها (1.65ديسى/م). التجربة الحقلية تمت خلال موسمين متعاقبين (2012/2011 ، 2013/2012) . النبات المختبر هو القمح صنف سخا 93 بتصميم قطاعات كاملة العشوائية فى ثلاث عوامل العامل الأول نوعين من مضادات الاكسدة هما الإسكوربيك أسيد والسيتريك أسيد والعامل الثانى أربع معدلات لكل نوع من مضادات الأكسدة هى (0 ، 100 ، 200 ، 400ملجم/لتر) ، والعامل الثالث هو معدلين من العناصر الغذائية الصغرى (الحديد ، المنجنيز ، الزنك) هما (0 300ملجم/لتر) بواقع 100ملحم/لتر لكل عنصر ، وكل هذه المعاملات اضيفت رشا خلال مراحل النمو المختلفة للقمح (أى بعد 20 ، 60 ، 90 يوم من الزراعة).

النتائج المتحصل عليها تؤكد ان اضافة اسمدة العناصر الصغرى مع مضادات الاكسدة زادت من محصول القمح والمغذيات الممتصة ، وايضا زادت من الفيتولات الكلية ومضادات الاكسدة النشطة الكلية فى القش والحبوب. القياسات المحصولية للقمح تزداد مع زيادة معدلات مضادات الاكسدة. حامض الاسكوربيك كان الاعلى تاثيرا على المحصول بالمقارنة بحامض الستريك. المعاملة الاكثر تأثيرا على إنتاجية القمح كانت لحامض الاسكوربيك او لحامض الستريك عند المعدل (400ملجم/لتر) مع اضافة العناصر الغذائية الصغرى، والتى سجلت لحامض الاسكوربيك (7.87 ، 4.16ميجاجرام/فدان) للقش والحبوب على التوالى بينما لحامض الستريك كانت (7.46 ، 3.79ميجاجرام/فدان) للقش والحبوب على التوالى. وأيضاً حققت المعاملة المثلى لحامض الاسكوربيك (365 ، 532ميكروجرام اسكوربيك أسيد/ ملليلتر مستخلص) من مضادات الاكسدة النشطة الكلية و(953 ، 1590ميكرومول جاليك أسيد/ملليلتر مستخلص) من الفينولات الكلية للحبوب والقش على التوالى. وقد سجل حامض الستريك (248 ، 381ميكروجرام اسكوربيك أسيد/ ملليلتر مستخلص) من مضادات الاكسدة النشطة الكلية و(694 ، 1285ميكرومول جاليك أسيد/ملليلتر مستخلص)من الفينولات الكلية. وبصفة عامة حققت معاملات الإضافة زيادة فى الحبوب اعلى معاملة المزارع (الكنترول العام) كألاتى: 15.4 ، 28.3 ، 37.3% للمغذيات الصغرى ، وحامض الستريك ، وحامض الاسكوربيك على التوالى. هذة الحقيقة تؤكد اهمية التسميد بالعناصر الصغرى ومضادت الاكسدة فى تحسين إنتاجية ونوعية نبات القمح المنزرع تحت ظروف الإجهاد الملحى (كما فى واحة سيوة).