

**EFFECT OF SOME ANTIOXIDANTS ON GROWTH, YIELD AND
SOME CHEMICAL CONSTITUENTS OF ONION (*ALLIUM CEPA* L.)
PLANTS**

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ABSTRACT

The present investigation was conducted during the two successive seasons 2004/2005 and 2005/2006 on onion (*Allium cepa* L. cv. Giza 20) grown at the experimental station of the Faculty of Agriculture, Fayoum University, Egypt, to study the effect of some antioxidants (ascorbic acid, citric acid, oxalic acid and salicylic acid) foliar spray at the rate of 0,2,5, 5 and 10 mM on the possibility of improving growth, yield and some chemical constituents of onion plants. Significant positive influences of all antioxidants treatments used in this study were observed on growth, yield of bulb and some chemical composition characters in both tested seasons. The obtained results indicated that, the growth characters, i.e. plant height, number of leaves/plant, and fresh and dry weight of leaves/plant were affected positively by the application of all antioxidants used at all studied rates. The maximum increase in this respect was obtained by the treatment of 10 mM followed by 5 mM treatment as compared to the control untreated plants in both seasons. The same treatments increased bulb yield and its components (bulb diameter, as well as fresh and dry weight of bulb). In addition the most effective treatments for enhancing the concentration of chlorophyll a and b, total carotenoids, total free amino acid, total indoles, and total soluble phenols on fresh leaves, and total carbohydrates, total and reducing sugars, anthocyanin concentration, crude protein and some nutrients i.e. N,P and K in dry matter of leaves and the content of bulbs from total soluble solids (T.S.S.%), total soluble carbohydrates and protein was observed at higher concentration (10mM) of all antioxidants used especially Ascorbic acid and Salicylic acid. Thus, the highest application of antioxidants is recommended for improving growth, yield and chemical composition of onion plants.

Key words: Onion (*Allium cepa* L.), antioxidants (Ascorbic acid, Citric acid, Oxalic acid and Salicylic acid), growth, yield, chemical constituents

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important vegetable crops in Egypt, since it is one of the sources for hard currency, due to the early availability of the crop for foreign market as well as its higher quality compared with other onions. Nowadays, there is a widespread use of natural and safety substances such as antioxidants particularly, ascorbic acid, citric acid, oxalic acid and salicylic acid for enhancing or improving growth and productivity of many crops for the aim of reducing health hazards. Since, antioxidants has synergistic effect on growth, yield and chemical composition under favorable and unfavorable environmental conditions. These compounds as non enzymatic material have beneficial effect on catching the free radical or the active oxygen

species namely singlet oxygen, superoxide anion, hydrogen peroxide, hydroxyl radicals and ozone that producing during photosynthesis and respiration process (Zhang and Klessing, 1997). Leaving these free radicals without chelating or catching leads to lipids oxidation and the loss of plasma membrane permeability and the death of cell within plant tissues. They also have an auxinic action (Prusky, 1988; Elade, 1992; Raskin 1992 and Buehala and Schmid, 1997). The beneficial effect of antioxidants on growth and yield of several plant species was reported by several workers (Zaghlool *et al.*, 2001 on dry bean; Ismail and Fawzy, 2001 on pea seedling; Ali 2001 and 2002 on tomato plant; Gad EL-Hak *et al.*, 2003 on potato, Abd El-Magid *et al.*, 2004 and Shalaby, 2006 on onion; Zaghlool *et al.*, 2006 on wheat and Rady, 2006 on sunflower plants).

Accordingly, the present work was planned to study the effect of exogenous application of ascorbic acid, citric acid, oxalic acid or salicylic acid at different rates on growth and yield, as well as some chemical constituents of onion plants during different stages of growth at both 2004/2005 and 2005 /2006 seasons.

MATERIALS AND METHODS

A field experiment was conducted using onion plants (cv. Giza 20) during two successive seasons 2004/2005 and 2005/2006 at experimental area of Faculty of Agriculture, Fayoum University, Egypt. Before planting the most important physical and chemical characters of the selected soil was determined (Table 1) according to Wilde *et al.*, (1985).

During the experiment, different treatments were arranged in randomized complete design with three replications. The experimental plot was 4x6 m contained 10 rows each was 4 m long and 50 cm width. The outside rows of each plot was considered as boarders. The central two rows of each plot were assigned for plant sampling. Thirty five days old onion transplants were planted 10 cm apart in the two sides of each row on 25th November in both seasons. The plants were sprayed with tap water (as a control) or ascorbic acid or citric acid or oxalic acid or salicylic acid at the rates of (2.5,5 and 10 mM) respectively. Few drops of Tween-20 were added to the spraying solution as a surfactant. The foliar applications were carried out at 40 and 55 days after transplanting. Thus, the experiment involved thirteen treatments as follows:

- | | |
|----------------------------|------------------------------|
| 1- Control | 8-Oxalic acid at 2.5 mM |
| 2- Ascorbic acid at 2.5 mM | 9- Oxalic acid at 5 mM |
| 3- Ascorbic acid at 5 mM | 10- Oxalic acid at 10 mM |
| 4- Ascorbic acid at 10 mM | 11- Salicylic acid at 2.5 mM |
| 5-Citric acid at 2.5 mM | 12- Salicylic acid at 5 mM |
| 6- Citric acid at 5 mM | 13- Salicylic acid at 10 mM |
| 7- Citric acid at 10 mM | |

All antioxidants were applied as foliar application.

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Table (1): The physical and chemical analysis of used soil before planting in both seasons.

Properties	2004/2005	2005/2006	Properties	2004/2005	2005/2006
Physical roperties					
Sand %	26.80	27.00	Silt %	25.80	26.20
Clay %	46.40	46.80	Texture grade	Clay	clay
Chemical properties					
Organic matter %	1.76	1.75	pH (1:2.5)	7.33	7.26
Ec(dsm)	0.61	0.64	CaCO ₃ %	5.60	5.49
Available macro-and micro-elements (ppm)					
N	473.00	479.00	P	418.00	425.00
K	21.00	24.00	Fe	85.00	83.00
Zn	27.90	27.00	Mn	3.40	3.10
Cu	0.79	0.75			

All onion plants including control were fertilized with NPK using the dose recommended by Ministry of Agriculture, Egypt. Phosphorous as triple calcium super phosphate (46% P₂O₅) at the rat of 75 kg/fed., was mixed with soil before sowing. Nitrogen fertilizer was applied in the form of urea (46%N) at the rate of 250 kg/fed., and 50 kg/fed., of potassium sulphate (48% K₂O). The amounts of N and K fertilizers were divided into two equal doses, the first was added after 30 days from transplanting and the second was applied one month later. After 90 days from transplanting a random sample of mature fully expanded leaves of 10 plants was taken from each plot to measure, i.e. plant height (cm), number of leaves/plant, as well as fresh and dry weight of leaves/plant. Onion plants were grown to maturity and they were considered mature when the foliage lodged on 50 % of the plants (**El-Sayed and Attia, 1999**). At this stage of maturity (185 days) from transplanting, diameter of bulb (cm), weight of bulb (g), fresh and dry weight of bulb (g) and total bulbs yield (ton/fed.) were estimated for the remained 2 rows. Samples of bulb were taken at random and dried, then kept for chemical analysis.

Chemical analysis

Fresh and dried leaves and bulbs (90 days of old plants for leaves and maturity stage for bulbs) were used for the determination of the following constituents: In fresh bulbs only total soluble solids (T.S.S.) was estimated using handle refractometer model PZONr. 19877 (**A.O.A.C. 1995**). Photosynthetic pigments: chlorophyll a, b and carotenoids were extracted from fresh leaves by acetone (80%) then, their concentrations were determined µg/g fresh weight according to **Welburn and Lichtenthaler (1984)**, Total carbohydrates mg/g dry weight were determined colorimetrically according to the method described by **Herbert et al., (1971)**. Total and reducing sugars were determined according to **A.O.A.C. (1995)**, and recorded as mg/g dry weight, Anthocyanin concentration mg/100g dry weight was determined according to the method described by **Hoagland (1980)**. Total free amino acids in fresh leaves were determined colorimetrically according to the method described by **Jayarman (1981)** and recorded as mg/g dry weight. Total indoles mg/g fresh weight were determined according to **Larson et al. (1962)**, Total soluble phenols in fresh leaves were determined according to **A.O.A. C. (1995)** and recorded as mg/g dry weight. Nitrogen%, and crude protein percentage was determined according to micro Kjeldahl as described by **A.O.A.C. (1995)**, phosphorus % was determined

according to A.O.A.C. (1995), potassium was determined by Flame Photometer, Parkin–Elmer model 52 according to Page *et al.* (1982).

Statistical analysis:

The experiment was in a complete randomized block design with 13 treatment and 4 replicates for each treatment. Results were statistically analyzed using the L.S.D. at probability level of 5% for comparisons (Gomez and Gomez 1983).

RESULTS:

A – Growth characters:

Data presented in Table (2) indicate that, growth parameters of onion plants represented as plant height, number of leaves/plant, as well as fresh and dry weight of leaves/plant were greatly improved by antioxidants application at different rates. The highest increase in growth parameters were observed when onion plants were sprayed with the highest rate of antioxidant (10 mM) of either ascorbic acid or salicylic acid. Such increases reached 13.41 and 13.40% respectively on plant height in the first season and 15.62 and 15.18% respectively in the second season in comparison to the control untreated plants. Similar trend was observed on the number of leaves/plant in which the increase reach to 71.24 and 70.91% respectively in the first season and 55.62 and 53.55% respectively in the second season. Also, fresh weight of leaves/plant increased by 16.35 and 15.35% respectively in the first season and 17.98 and 17.86% respectively in the second season. Moreover, dry weight of leaves/plant were increased by 36.81 and 36.26% respectively in the first season and 38.20 and 37.19% respectively in the second season as compared to the control untreated plants.

Table (2): Effect of some antioxidants on growth characters of onion plants during 2004/2005 and 2005/2006 seasons.

Treat.	Conc (mM)	Plant height (cm)		Number of leaves/plant		Fresh weight of leaves/plant		Dry weight of leaves/plant (g)	
		First season	Second season	First season	Second season	First season	Second season	First season	Second season
Control	0.00	74.15	73.21	15.30	16.90	90.33	90.10	9.10	8.90
Ascorbic acid	2.5	77.25	78.00	18.10	19.10	94.90	93.55	10.36	10.40
	5	80.15	80.18	18.90	19.90	96.60	96.10	10.66	10.51
	10	84.10	84.65	26.20	26.30	105.10	106.30	12.45	12.30
Citric acid	2.5	78.90	79.90	19.10	20.20	95.25	95.60	10.30	10.21
	5	79.90	81.12	22.10	23.60	97.71	96.10	10.40	10.42
	10	83.18	82.96	26.10	25.50	103.66	106.10	11.60	11.85
Oxalic acid	2.5	76.90	77.01	19.10	20.60	95.60	94.96	10.51	10.60
	5	79.25	79.66	23.10	23.50	98.60	98.96	10.81	11.01
	10	84.00	83.93	25.30	28.90	104.10	103.66	12.30	11.90
Salicylic acid	2.5	78.18	79.20	20.20	20.40	96.00	95.85	10.65	10.91
	5	80.18	81.15	24.30	23.60	99.10	99.25	10.86	10.79
	10	84.09	84.33	26.15	25.95	104.20	106.20	12.40	12.21
L.S.D. at 5%		2.59	2.73	3.01	2.89	3.50	3.89	0.67	0.69

B- Yield and its components

Result in Table (3) show that foliar application of antioxidants (Ascorbic acid, Citric acid, Oxalic acid and Salicylic acid) at the rates of 2.5, 5 and 10 mM resulted in a great increase in yield and its components of onion plant. The beneficial effect was more pronounced with the highest rate (10

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mM) of all antioxidants used. At these treatments diameter of bulbs, fresh and dry weight of bulb and total yield of bulbs/ fed. were significantly increased by 33.33, 29.24, 28.60 and 29.89% in diameter of bulb and 30.02, 29.18, 28.34 and 29.86% in fresh weight of bulb and 46.99, 46.54, 45.26 and 46.80% in dry weight of bulb and 35.73, 35.27, 31.12 and 35.46 % in total yield of bulb respectively in comparison to the control plants in the first season. Similar trend was observed in the second season.

Table (3): Effect of some antioxidants on yield and its components (diameter of bulb, fresh and dry weight of bulb as well as total yield of bulbs) of onion plants during 2004/2005 and 2005/2006 seasons.

Treat.	Conc (mM)	Diameter of bulb (cm)		Fresh weight of bulb (g)		Dry weight of bulb (g)		Total yield of bulbs (ton/fed.)	
		First season	Second season	First season	Second season	First season	Second season	First season	Second season
Control	0.00	9.30	9.55	141.0	145.50	15.60	15.95	10.83	11.29
Ascorbic acid	2.5	10.60	10.67	160.11	164.25	18.41	18.60	12.32	12.40
	5	10.86	10.95	175.60	169.60	21.50	21.10	14.10	13.90
	10	12.40	12.12	183.33	183.30	22.93	23.66	14.70	14.79
Citric acid	2.5	10.80	10.75	169.01	167.70	19.30	19.10	12.57	12.65
	5	10.80	11.01	178.33	180.00	21.75	21.86	14.10	14.65
	10	12.02	12.10	182.15	182.33	22.86	23.10	14.65	14.73
Oxalic acid	2.5	10.75	10.81	163.25	165.10	18.30	18.10	12.10	12.61
	5	11.01	11.08	173.66	175.50	21.20	21.33	13.90	13.95
	10	11.96	11.90	180.96	179.99	22.66	22.18	14.20	14.73
Salicylic acid	2.5	10.59	10.66	160.60	162.10	18.31	18.40	12.15	12.55
	5	10.95	10.99	175.70	176.60	21.30	21.45	13.65	13.81
	10	12.08	12.11	183.10	182.80	22.90	23.40	14.67	14.76
L.S.D. at 5%		0.67	0.64	10.80	9.73	2.01	1.85	1.60	1.03

C- Chemical constituents:-

1- Leaf pigments:

Data recorded in Table (4) clearly show in two growing seasons that, foliar application of all antioxidants had a stimulating effect on chemical constituents of onion plants. The best results were obtained with the highest rate (10 mM) of ascorbic acid and salicylic acid. In the first season, the increments over the control treatment reached to 43.16 and 43.08% respectively for chlorophyll a; 39.36 and 39.32% respectively for chlorophyll b, 52.68 and 52.28% respectively for carotenoids as well as 21.99 and 19.99% respectively for anthocyanin compared to the control untreated plants. Similar trend was observed in the second season (Table 4).

Table (4): Effect of some antioxidants on leaf pigments (chlorophyll a and b as well as total carotenoids and anthocyanin) of onion plants during 2004/2005 and 2005/2006 seasons.

Treat.	Conc (mM)	Chlorophyll a (ug/g F.W.)		Chlorophyll b (ug/g F.W.)		Total carotenoids (ug/g F.W.)		Anthocyanin (mg/100 g D.W.)	
		First season	Second season	First season	Second season	First season	Second season	First season	Second season
Control	0.00	266.08	283.50	225.30	226.30	29.80	27.39	50.91	51.18
Ascorbic acid	2.5	278.80	339.00	233.04	245.15	32.79	30.50	56.0	58.33
	5	326.60	353.00	246.95	251.13	42.90	33.30	59.06	59.11
	10	380.93	417.25	314.00	319.15	45.50	44.70	62.11	61.63
Citric acid	2.5	269.33	338.23	229.33	233.25	31.1	29.99	54.10	53.25
	5	276.80	339.20	248.80	251.18	42.25	32.96	55.70	58.18
	10	378.75	409.33	278.80	290.25	43.42	36.18	60.15	59.10
Oxalic acid	2.5	270.00	301.60	235.66	233.33	35.32	34.43	56.15	55.21
	5	278.80	334.28	248.26	265.00	37.18	37.70	58.06	59.18
	10	380.23	394.28	313.78	306.18	43.79	39.32	59.04	59.60
Salicylic acid	2.5	304.28	320.18	268.26	253.15	37.42	31.99	53.60	54.26
	5	31.18	353.73	301.60	282.66	42.27	33.32	54.25	54.66
	10	380.73	413.23	313.88	309.60	45.38	43.55	61.09	60.17
L.S.D. at 5%		38.55	34.66	28.42	30.28	10.27	3.67	3.55	3.72

2- Carbohydrates and Sugars:-

Data recorded in Tables (5 and 6) clearly show that antioxidant application had positive effect on the chemical constituents of onion leaves and bulbs. It is clear that, carbohydrates represented as total carbohydrates, total sugars and reducing sugars increased with increasing the rate of all antioxidants used. The best results were obtained with the highest rate (10 mM) of Ascorbic acid followed by the same rate of Salicylic acid. In the first season, the increments were recorded 16.99 and 16.94% for total carbohydrates; 27.47 and 25.42% for total sugars; 24.94 and 24.92% for reducing sugars in leaves as well as 20.61 and 19.84% for total soluble solids and 17.92 and 17.45% for total soluble carbohydrates in bulbs over the control, respectively. Similar trend was observed in the second season. The obtained results in this study showed clearly that chemical constituents of leaves and bulbs of onion plants were greatly improved by antioxidants application especially Ascorbic acid and Salicylic acid.

3-Crude protein %

Data recorded in Tables (5 and 6) show that foliar application of all used antioxidants had a stimulating effect on crude protein of onion leaves and bulbs. The concentration of crude protein were gradually increased with increasing the rate of antioxidants concentration. The best results were obtained with the highest rate at 10mM of ascorbic acid followed by salicylic acid. In the first season, the increases recorded were 62.99 and 62.13% for crude protein, in leaves and 22.63 and 22.10 % respectively for crude protein in bulbs over the control. Similar trend was observed in the second season.

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Table (5): Effect of some antioxidants on total soluble carbohydrates, total sugars, reducing sugars and crude protein of onion leaves during 2004/2005 and 2005/2006 seasons.

Treat.	Conc (mM)	Total soluble carbohydrates (mg/g D.W.)		Total sugars (mg/g D.W.)		Reducing sugars (mg/g D.W.)		Crude protein (g/100 g D.W.)	
		First season	Second season	First season	Second season	First season	Second season	First season	Second season
Control	0.00	111.21	116.60	79.99	75.12	47.39	45.12	13.97	14.08
Ascorbic acid	2.5	121.55	122.22	86.73	84.18	53.20	56.16	20.35	19.09
	5	126.60	125.14	87.49	89.99	59.15	58.28	21.39	20.18
	10	130.11	132.22	101.97	101.11	59.21	60.99	22.77	22.99
Citric acid	2.5	118.33	121.13	81.25	81.25	50.10	48.13	14.26	14.66
	5	123.36	124.20	83.33	84.16	52.15	50.51	16.27	17.13
	10	129.18	127.16	100.24	99.01	59.18	60.16	22.08	22.08
Oxalic Acid	2.5	117.27	120.16	83.67	86.28	56.44	54.14	19.20	17.07
	5	123.18	122.20	95.83	93.28	56.56	56.56	20.36	20.64
	10	129.99	126.98	97.91	100.61	59.12	60.61	22.42	22.54
Salicylic Acid	2.5	126.18	126.98	81.16	83.33	51.18	52.20	14.26	15.18
	5	128.20	126.15	85.41	89.26	51.21	54.12	16.27	16.96
	10	130.05	131.31	100.33	100.99	59.20	60.70	22.65	22.59
L.S.D. at 5%		5.59	3.74	7.73	7.62	3.64	4.16	2.74	2.58

Table (6): Effect of some antioxidants on total soluble solids (T.S.S.)%, total soluble carbohydrates % and crude protein % of onion bulbs during 2004/2005 and 2005/2006 seasons.

Treat.	Conc (mM)	Total soluble solids (T.S.S.) %		Total soluble carbohydrates % (D.W. of bulb)		Crude protein % (D.W. of bulb)	
		First season	Second season	First season	Second season	First season	Second season
Control	0.00	13.10	13.20	10.60	10.40	9.50	8.45
Ascorbic acid	2.5	13.60	13.80	11.90	12.10	10.20	10.30
	5	14.60	14.70	11.95	12.15	11.05	11.16
	10	15.80	15.41	12.50	12.70	11.65	11.66
Citric acid	2.5	13.80	13.80	11.85	11.73	10.40	10.35
	5	14.50	14.50	12.01	12.31	11.15	11.25
	10	15.10	15.60	12.41	12.56	11.35	11.41
Oxalic acid	2.5	13.70	13.80	11.95	12.01	10.35	10.46
	5	14.90	14.70	11.99	12.23	11.25	11.31
	10	15.60	15.50	12.30	12.51	11.55	11.59
Salicylic acid	2.5	13.80	13.60	11.75	11.91	10.25	10.38
	5	14.00	14.20	11.95	12.03	11.25	11.29
	10	15.70	15.65	12.45	12.66	11.60	11.62
L.S.D. at 5%		0.69	0.74	0.40	0.49	0.56	0.57

4-Total free amino acids and total indoles concentration:-

Data in both two seasons presented in Table (7) indicate that, leaves of onion plants contained a high concentration of total free amino acids and total indoles under antioxidants applications comparing to control plants. Moreover,

the total free amino acids and total indoles were significantly increased with increasing antioxidants rates. The highest rate gave the best results especially ascorbic acid and salicylic acid at the rate (10mM); the maximum increase was 51.27 and 47.87 % in the first season and 42.76 and 42.46% in the second seasons for total free amino acids, respectively and 58.42 and 52.80% in the first season and 53.33 and 51.11% in the second seasons for total indoles respectively over the control plants.

5- Total soluble phenols:-

Data recorded in Table (7) clearly show total soluble phenols of leaves were greatly affected by the different kinds and levels of antioxidants application. Moreover, the total soluble phenols were significantly increased with increasing antioxidants rates. The maximum increase in total phenols concentration reached 51.27 and 45.20% for ascorbic acid and salicylic acid treatments at the rate (10mM) in the first seasons and 45.43 and 44.16 in the second seasons respectively over the control.

Table (7): Effect of some antioxidants on total free amino acids, total indoles and total soluble phenols of onion leaves during 2004/2005 and 2005/2006 seasons.

Treat.	Conc (mM)	Total free amino acids (mg/g D.W.)		Total indoles (mg/g F.W.)		Total soluble phenols (mg/g D.W.)	
		First season	Second Season	First season	Second season	First season	Second season
Control	0.00	14.46	16.39	0.89	0.90	5.11	4.71
Ascorbic acid	2.5	18.42	18.21	1.10	1.22	6.44	4.92
	5	19.40	19.21	1.19	1.24	6.44	5.68
	10	24.90	23.40	1.41	1.38	7.73	6.85
Citric acid	2.5	19.40	18.10	0.91	0.93	5.11	5.01
	5	19.60	19.10	1.19	1.22	6.11	5.77
	10	23.43	23.20	1.20	1.26	7.33	6.68
Oxalic acid	2.5	20.46	21.80	0.91	0.95	5.33	4.44
	5	21.34	21.9	1.10	1.08	6.89	5.70
	10	24.33	22.90	1.31	1.26	7.33	5.83
Salicylic acid	2.5	19.94	20.90	0.85	0.94	5.78	4.78
	5	21.37	21.13	0.89	0.94	5.79	5.79
	10	24.34	23.35	1.36	1.36	7.42	6.79
L.S.D. at 5 %		4.81	4.78	0.164	0.143	0.73	0.72

6- Nitrogen, phosphorus and potassium concentrations:-

Data in both two seasons presented in Table (8) indicate that, leaves of onion plants contained a high concentration of nitrogen, phosphorus and potassium under antioxidants applications condition comparing to control untreated plants. Moreover, the concentration of these elements were significantly increased with increasing antioxidants rates. The maximum increase which obtained from ascorbic acid and salicylic acid treatments at the rate of (10mM) were 62.96 and 62.14% for nitrogen concentration; 51.85 and 48.15% for phosphorus concentration and 51.85 and 46.03% for potassium concentration in the first season respectively over the control plants. Similar trend was observed in the second season, Table (8).

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Table (8): Effect of some antioxidants on total nitrogen, phosphorus and potassium of onion leaves during 2004/2005 and 2005/2006 seasons.

Treat.	Conc (mM)	Total nitrogen (%)		Total phosphorus (%)		Total potassium (%)	
		First season	Second season	First season	Second season	First season	Second season
Control	0.00	2.43	2.45	0.27	0.25	1.89	1.91
Ascorbic acid	2.5	3.54	3.32	0.29	0.29	2.51	2.46
	5	3.72	3.51	0.38	0.36	2.56	2.61
	10	3.96	3.99	0.41	0.39	2.87	2.91
Citric acid	2.5	2.48	2.55	0.30	0.31	2.43	2.45
	5	2.83	2.98	0.35	0.36	2.55	2.57
	10	3.84	3.84	0.39	0.37	2.71	2.75
Oxalic acid	2.5	3.34	2.97	0.29	0.30	2.36	2.41
	5	3.54	3.59	0.31	0.33	2.58	2.60
	10	3.90	3.92	0.37	0.37	2.66	2.70
Salicylic acid	2.5	2.48	2.64	0.32	0.31	2.31	2.29
	5	2.83	2.95	0.36	0.36	2.65	2.68
	10	3.94	3.93	0.40	0.38	2.76	2.79
L.S.D. at 5%		0.53	0.41	0.038	0.035	0.20	0.21

DISCUSSION

It is clear from the results of the present study that, foliar spray of antioxidants; i.e. (ascorbic acid, citric acid, oxalic acid and salicylic acid) recorded the highest value on all of the studied growth characters (plant height etc.....), yield and its components and chemical constituents of leaves and bulbs (chlorophyll a, b, carotenoids, sugars, anthocyanin, total free amino acid, crude protein, total soluble phenols, total indoles, and macro elements (N, P and K concentration). The beneficial effect of antioxidants on growth characters may be attributed to their positive effect on enhancing cell division and counteracting drought, salinity and diseases stresses and protecting plant cells against free radicals that responsible for plant senescence as well as to their auxinic action (**Prusky, 1988; Elade, 1992 and Raskin, 1992**). In addition, ascorbic acid maybe regulate cell wall expansion, cell division and cell elongation through its action in cell vacuolarization (**Gonzalez-Reyes et al., 1994; Navas and Gomez-Diaz, 1995 and Cordoba-Pedregosa et al., 1996**), that might improve the nutritional status and absorbing phenolic compounds which lead to save the growing tissues from toxic effects of the oxidized phenols (**Gupta et al., 1980**) and/or enhances the biosynthesis of carbohydrates and translocation of sugars (**Ahmed, 2001**) which could explain the results of this study. In this respect, **Shahda, (2000)** reported that ascorbic acid, benzoic acid, or salicylic acid exhibited growth promoting effect and subsequently increased the shoot and root growth as well as fresh and dry weight. These findings are in coincidence with those obtained by **Ahmed et al. (1998), Tarraf et al. (1999), Mostafa (2004) and Rady (2006)**. Also the improving effect of antioxidant on onion yield and its components may be mainly attributed to its positive action on enhancing growth parameters (Table 3), photosynthetic pigments of plants leaves, cellular solutes, i.e. total sugars, total free amino acid, total indoles, to sustenance of cell turgor leading to maintenance of metabolic activities in plants and plant nutritional status. In

this respect, **Datta and Nanda (1985)** reported that the effect of salicylic acid may be brought about through an increase in mobilization of reserve food materials. Also, **Al-Qubaie (2002)** stated that ascorbic acid as an antioxidant compound has an auxinic action and also synergistic effect on the biosynthesis of carbohydrates and controlling the incidence of most fungi on plants makes them in vigorous states and reflects on seed yield and production. Besides, the induced effect of ascorbic acid as one of vitamins on oil content may be due to that vitamins are recognized to be coenzymes involved in specific biochemical reactions in plants such as oxidative and nonoxidative decarboxylations (**Robinson, 1973**). Furthermore, **Shalaby (2006)** reported an increase in yield bulbs of onion plant as a result of the foliar application with some antioxidants. Their results regarding the beneficial effect of ascorbic acid on yield are confirmed with those reported by **Ahmed *et al.* (2002)**, **Mostafa (2004)** and **Rady (2006)**. The results also showed that high concentrations of chemical constituents estimated in the leaves and bulbs of the above mentioned treated plants. This finding could be an indication to the high rate of synthesis of these products as indication to the high level of absorption of the essential nutrients for the various growth processes such as chlorophyll formation, photosynthetic activity as well as the utilization of carbohydrates. In this connection, **Foyer *et al.* (1990)** stated that, the antioxidant prevent enzymes inactivation, the generation of more dangerous radicals and allow flexibility in the production of photosynthetic assimilatory power. The role of antioxidant, which directly involved in the regulation and protection of photosynthetic processes, could be led to the enhancing effect of antioxidants on photosynthetic pigment. The results obtained in this study are in agreement with those obtained by **Farago and Brunhold (1994)**. In additions **Elade (1992)** and **Abdou *et al.*, (2001)** proved that most antioxidants were responsible for accelerating the biosynthesis of various pigments and consequently the photosynthetic rates.. The positive effects of ascorbic acid on photosynthetic pigments obtained by **Tarraf *et al.* (1999)**, **Ali (2002)** and **Al-Qubaie (2002)** were in agreement with findings of the present study. Concerning the effect of the tested antioxidants on total carbohydrates, total soluble sugars, total soluble solid and anthocyanin data showed that the used antioxidants significantly increased these components. In this respect, **Farag (1996)** pointed out that most antioxidants were responsible for accelerating the biosynthesis of various pigments leading to the increase in biosynthesis of sugars. Moreover, **Al-Qubaie (2002)** reported that ascorbic acid as an antioxidant compound has an auxinic action and also synergistic effect on biosynthesis of carbohydrates. Also **Omer (1999)** reported that, antioxidant increased photosynthesis, leading to an enhancement of the syntheses and accumulation of sugars so, increased T.S.S. Moreover, **Tsuda *et al.* (1994)** show that anthocyanins may play an important role in the prevention of lipid peroxidation of cell membranes induced by active oxygen radicals. The increase in the total free amino acid and protein concentration in the treated onion plants with the antioxidants in the present study agreed with those obtained by **Abd El-Magid *et al.*, (2004)** and **Zaghlool *et al.*, (2006)**. In this respect, **Doares *et al.*, (1995)** reported that salicylic acid inhibits synthesis of proteinase inhibitors in tomato leaves induced by systemin and jasmonic acid. Also **Reda *et al.*, (1977)** reported the involvement of ascorbic acid in many physiological and biochemical processes such as synthesis of enzyme, nucleic acid and protein as well as it also acted as co-enzyme. Moreover, many

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investigation mentioned that the hormonal balance between the promoters and inhibitors which regulate the different physiological processes in the plants appear to be highly affected by the antioxidant kind and rates. In this connection, **Wafaa *et al.* (1996)** concluded that applied salicylic acid induced great changes in endogenous phytohormones of tomato plants and other plants. Also, **Shehata *et al.* (2000)** reported that salicylic acid application increased auxin, cytokinin and gibberellin in cotton leaves. In this respect, cytokinin retarded leaves senescence and increased chlorophyll pigments (**Zayed, 1986**). Moreover, the increase in phenolic compounds of plants (Table, 4) resulted from an increase in antioxidants thus, a linear relationship between total antioxidants and total phenolic content in plants was found (**Campeau and Proctor, 2003**). Phenolic antioxidants play an important roles as free radical terminators and sometimes, as metal chelators (**Shahidi and Wanasundara, 1992**). The results obtained in this study are in harmony with those reported by **Ali (2001) and (2002)**, **Al-Qubaie (2002) and Ahmed *et al.* (2003)**. Concerning the effect of antioxidants on leaf macronutrients concentration, the data show that all of the tested antioxidants increased significantly leaf mineral concentration. In this respect, **Ahmed and Abd El-Hameed (2004)** reported that the effect of antioxidants on producing healthy plants leads to enhancement of the uptake of mineral elements. Moreover, **Gonzalez-Reyes *et al.* (1994)** concluded that ascorbate free radical caused hyperpolarization of plasma membranes, and this energization could then facilitate transport processes across such membranes. Most of the previous results are consistent with those of **Ali (2001)**, **Ahmed (2001)**, **Ahmed *et al.* (2002) and Mostafa (2004)**.

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**تأثير بعض مضادات الأكسدة على النمو والمحصول
وبعض المكونات الكيماوية لنباتات البصل**

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أجرى هذا البحث لمدة موسمين متتاليين هما ٢٠٠٤/٢٠٠٥ و ٢٠٠٥/٢٠٠٦م على نباتات البصل (صنف جيزة ٢٠) وذلك بمحطة التجارب التابعة لكلية الزراعة بالفيوم- جامعة الفيوم- مصر. تمت هذه الدراسة بغرض دراسة تأثير الرش الورقي ببعض مضادات الأكسدة (حامض الأسكوربيك - حامض الستريك - حامض الأوكساليك - حامض السلسيليك بمعدلات صفر و ٢.٥ و ٥ و ١٠ مللي مول على إمكانية تحسين النمو والمحصول والمكونات الكيماوية لنباتات البصل.

* لوحظ تأثير معنوي لجميع معاملات مضادات الأكسدة المستخدمة في هذه الدراسة على كل من صفات النمو الخضري ومحصول الأبصال وكذلك على بعض المكونات الكيماوية محل الدراسة في كلا الموسمين.

* أوضحت النتائج المتحصل عليها أن صفات النمو مثل (ارتفاع النبات - عدد الأوراق للنبات - الوزن الطازج والجاف لأوراق النبات) قد حدث لها تأثير ايجابي بواسطة استخدام جميع معاملات مضادات الأكسدة وجميع المعدلات المستخدمة في هذه الدراسة.

* أدت معاملات مضادات الأكسدة بمعدل ١٠ مللي مول إلى حدوث أعلى زيادة في صفات النمو السابقة ثم يليها المعاملات بتركيز ٥ مللي مول وذلك مقارنة بالكنترول في كلا الموسمين.

* أدت نفس المعاملات إلى حدوث زيادة في المحصول وصفاته (قطر البصلة- الوزن الطازج والجاف للبصلة) بالإضافة إلى ذلك فإن أكثر المعاملات تأثيراً في زيادة تركيز الأوراق من الكلوروفيل أ و ب والكاروتينويدات الكلية وكذلك تركيز الأوراق من الفينولات والأحماض الأمينية الحرة الكلية والانذولات الكلية في الأوراق الطازجة وأيضاً الكربوهيدرات الكلية والسكريات الذائبة الكلية والمختزلة والأنثوسيانين والبروتين الخام وبعض العناصر محل الدراسة (نتروجين - فسفور - بوتاسيوم) في الأوراق الجافة بالإضافة لتركيز الأبصال من المادة الصلبة الذائبة الكلية والكربوهيدرات الذائبة الكلية والبروتين قد تم الحصول عليها من خلال استخدام المعدل العالي (١٠ مللي مول) من جميع معاملات الأكسدة المستخدمة وبالأخص حامض الأسكوربيك وحامض السلسيليك.

* وهكذا نوصى باستخدام مضادات الأكسدة المستخدمة لتحسين النمو والمحصول والمكونات الكيماوية لنباتات البصل.