Response of Sunflowers Cultivar Giza- 102 (*Helianthus annuus*, L) Plants to Spraying Some Antioxidants

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Abstract: During 2009 and 2010 seasons, plants of sunflower cv. Giza 102 were sprayed thrice with three antioxidants namely vitamin E at 50 ppm, citric acid at 500 ppm and amino acids (tryptophan, methionene and cystein) at 500 ppm either singly/ or in all possible combinations. Growth characters yield and its components, as well as plant pigments (chlorophylls a & b, total chlorophylls and carotenoids) in response to the present antioxidant treatments were investigated. Results showed that single and combined applications of the three antioxidants (vitamin E, citric acid and the three amino acids) were very effective in improving growth characters namely plant height, stem diameter, number of leaves per plant and total leaves area per plant, diameter and fresh weight of head, seed yield/ plant, straw yield/ plant, oil yield/ fed , oil % biomass/ plant, seed index; number of seeds/ head, percentages of proteins and plant pigments in relative to the check treatment. This promotion was associated with using E vitamin, citric acid and amino acids, in ascending order. Combined application of these antioxidants was favourable than using each antioxidant alone. In general, the maximum yield per fed. (seed and oil) of sunflower cv. Giza 102 was recorded by spraying the plants thrice with a mixture of antioxidants contains citric acid at 500 ppm, vitamin E at 50 ppm and the three amino acids (tryptophan, methionene and cystein) at 500 ppm.
[Al- Qubaie, A. I. **Response of Sunflowers Cultivar Giza- 102 (*Helianthus annuus*, L) Plants to Spraying Some Antioxidants**] *Nat Sci* 2012; 10(11):1-6]. (ISSN: 1545-0740).. http://www.sciencepub.net. 1

Key words: Sunflower; Cultivar Giza-102 (*Helianthus annuus*, L); Plant; Antioxidant

1. Introduction

Sunflower (*Helianthus annuus*, L.) is considered as one of the four important annual crops in the world for edible oil. Sunflower seeds contain 24 – 49 % of oil and the cake contains 25 – 35 % of protein which is mostly feeded to livestock because of its high biological value. Furthermore, sunflower seeds are eaten as salted whole seeds as roasted nut meats. Moreover, oil is characterized by its high content of unsaturated fatty acids such as oleic and lenoleic which represent 90 % of total fatty acids **(Saleh *et al*., 2004).**

Recently, a great attention has been focused on the possibility of using natural and safety substances in order to improve plant growth. In this concern, antioxidants have synergistic effects on growth, yield and yield quality of many plant species. These compounds have beneficial effects on catching the free radicals or the active oxygen that producing during photosynthesis and respiration processes **(Foyer *et al*., 1991).** 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. Antioxidants have also an auxinic action. One of the most familiar antioxidants is citric acid which being synthesized in higher plants and affects plant growth and development. It is a product of D- glucose metabolism which affects some nutritional cycles activity in higher plants and play an important role in the electron transport system **(Elad, 1992).**

Antioxidants function by scavenging free radicals via donation of an electron or hydrogen atom, or by deactivation of pro oxidant metal ions and singlet oxygen. **Dat *et al*., (1998)** stated that the primary role of antioxidants is to prevent degradation induced by free radical reactions. They noted that antioxidants function by hydrogen abstraction and metal ion assisted electron transfer. The antioxidant donates hydrogen atoms to the free radicals, thus inhibiting the propagation of the autocatalytic chain reaction. The same authors confirmed the beneficial effect of antioxidants on enhancing cell division and organic foods.

Previous studies emphasized the beneficial effects of antioxidants on growth characters, leaf chemical composition, yield and yield components of different horticultural crops **(Gad El- Hak *et al*., 2002; Al- Qubaie, 2002; Ali *et al*., 2003 and 2006; Abd El- Hakim, 2006; Al- Shareif, 2006; Ayat, 2007; Abdou *et al*., 2009a, and 2009b; Abd El- Naeem and Abd El- Hakim, 2009; Reda- Faten *et al*., 2010; Ibrahim, 2010 and Abdou *et al*., 2011).**

This work was designed to investigate the response of sunflower cv. Giza 102 to some antioxidants in order to improve sunflower productivity.

2. Material and Methods

This field experiment was carried out at the experimental Farm of King Abdulaziz Univ. at Hoda Al- Sham that located about 120 km northeast of Jaddah, Saudi Arabia during 2009 and 2010 seasons on sunflower cv. Giza 102. Soil texture is sandy soil.

Sunflower cv. Giza 102 seeds were sown in the first week of May in 2009 and 2010 seasons in hills 25 cm apart on ridges 60 cm apart and 3.5 meter length, leaving one plant per hill at thinning times (21 days after sowing) with a plot area of 10.5 m^2.

This experiment included the following eight treatments from control as well as single and combined applications of three antioxidant (citric acid, vitamin E and the three amino acids):-

1. Control (untreated plants).
2. Spraying the plants with citric acid (100 %) at 500 ppm (0.5 g/ LW).
3. Spraying the plants with vitamin E (soluble in ethyl alcohol) at 50 ppm.
4. Spraying the plants with mixture of powdered amino acids contains tryptophan, methionene and cystein at 500 ppm.
5. Spraying the plants with citric acid at 500 ppm + vitamin E at 50 ppm.
6. Spraying the plants with vitamin E at 50 ppm + amino acids at 500 ppm.
7. Spraying the plants with citric acid at 500 ppm + amino acids at 500 ppm.
8. Spraying the plants with all antioxidants at the named concentrations.

Each treatment was replicated three times, one plot per each. The complete randomized block design was followed. The three antioxidants at the previous concentrations **(Al- Shareif, 2006)** were sprayed three times at 30, 40 and 50 days after sowing. Triton B as a wetting agent was added to all spraying solutions at 0.05 %. Control plants were sprayed with tap water containing Triton B. The preceding crop was *Vicia faba* L. in both seasons. Other cultural practices were carried out as usual. At heading, the heads of two central rows, heads of five plants were chosen at random from external ridges of each plot and bagged at early seed development (by using magazine paper) to avoid birds damage until maturity. The sunflower plants were hand- harvested at the stage of physiological maturation when the back of the head has turned from green to yellow and the bracts are turning brown.

At harvest, a sample of five plants from every treatment in the three replications were chosen at random to measure the following growth characters:-

1. Plant height (cm.).
2. Stem diameter (cm.).
3. Number of leaves per plant.
4. Leaves area/ plant (cm^2) **(**according to **Bremner and Taha, 1966).**

Also, samples of five bagged plants were taken and the following traits were recorded.

1. Head diameter (cm.).
2. Average head fresh weight/ plant (g.) was obtained from five guarded plants sample/ plot.
3. Seed yield/ plant (g.) was obtained from a five guarded plants sample per plot.
4. Shelling percentage was calculated by dividing seed yield/ plant by head weight per plant and multiplying the product by 100.
5. Seed index (g.) was estimated by weighing of two random 100- seed samples per plot (g.).
6. Number of seeds per head was calculated by dividing seed yield/ plant by seed index and multiplying the product by 100.
7. Straw yield/ plant (g.) was obtained from a five guarded plants sample per plot.
8. Above ground biomass/ plant (g.) was estimated by summation of seed yield/ plant and straw yield/ plant.
9. Seed yield/ fed (tons). Heads of two bagged plants inner ridges of each plot were harvested and left two weeks until fully air dried and seed yield/ plant was used to estimate yield/ fed (tons).
10. Oil percentage in the seeds was determined according to **A.O.A.C., (1995)** using soxhlet apparatus using petroleum ether as a solvent.
11. Oil yield/ fed. (kg.) was calculated by multiplying oil % in the seeds by seed yield/ fed (kg.).
12. Chlorophylls a and b as well as total caroteniods and total chlorophylls (mg/ 1 g fresh weight) (according to the procedure of **Moran, 1982**)
13. Total nitrogen in the seeds was determined by Kjeldahl method according to **Cottenie *et al*., (1982).**
14. Protein % was calculated by multiplying the N by the converting factor 6.25 **(Hymowitz *et al*., 1972).**

All the obtained data were subjected to the proper statistical analysis according to **Mead *et al*., (1993)** and mean comparisons were done using New L.S.D test at 5 %.

3. Results and Discussion

1. Growth characters:

Data in Table (1) clearly show that single and combined applications of the three antioxidants namely citric acid at 500 ppm, vitamin E at 50 ppm and amino acids (tryptophan, methionene and cystein) at 500 ppm significantly stimulated the four growth characters namely plant height, stem diameter, number of leaves/ plant and leaves area per plant in

relative to the control treatment. The stimulation was associated with using vitamin E, citric acid and amino acids, in ascending order. Double and triple applications of these antioxidants significantly were accompanied with maximizing these growth characters comparing with using each antioxidant alone. The maximum values were recorded with using the three antioxidants together. Untreated plants had the lowest values. Similar trend was noticed during the two seasons.

The essential role of antioxidants on promoting cell division and the biosynthesis of organic foods could result in enhancing growth aspects (Foyer *et al*., 1991).

These results are in harmony with those obtained by Al- Qubaie (2002) on *Ficus netida*; Ali *et al*., (2006) on anise and Abdou *et al*., (2009a) on carawy.

2. Head characters:-

It is worthy to mention that significant differences on diameter and fresh weight of head per plant were obtained with varying antioxidant treatments. They were significantly increased with using the three antioxidants either singly or in various combinations rather than non- application. The best antioxidant in this respect was the three amino acids followed by citric acid and vitamin E ranked the last position in this respect. Combined applications were significantly preferable than single ones in enhancing diameter and weight of head per plant. Treating sunflower Giza 102 plants with all antioxidants gave the maximum values. The lowest values were recorded on untreated plants. These results were true during both seasons (Tables 1 & 2).

The promoting effect of these antioxidants on growth surely reflected on improving diameter and weight of head per plant.

3. Yield:-

It is reveal from the data in Tables (2 & 3) that single and combined applications of the three antioxidants caused a significant promotion on seed yield/ plant, seed yield/ fed, straw yield/ plant, oil yield/ fed and biomass in relative to the check treatment. The best antioxidant was amino acids. Combined applications were significantly effective in improving yields in relative to using each antioxidant alone. The best results were obtained with using all antioxidants together. Under such promised treatment, seed yield/ fed (ton) reached 1.86 and 1.95 ton and oil yield/ fed (kg) reached 604.7 and 635.9 kg during both seasons, respectively. The untreated plants produced 1.01 and1.15 tons seed yield and 314.2 and 315.6 kg oil yield per feddan during both seasons, respectively. These results were true during both seasons.

The promoting effect of these antioxidants on growth, head characters and yield components surely reflected on enhancing seed and oil yields.

Similar results were announced by Ali *et al*., (2003) on coriander; Al- Shareif (2006) on caraway; Ibrahim (2010) on geranium and Abdou *et al*., (2011) on clove Basil.

4. Yield components:-

Data in Tables (2 & 3) clearly show that all antioxidant treatments significantly improved all yield components namely shelling %, seed index, number of seeds per head and oil % in relative to the check treatment. The best antioxidant in this connection was amino acids followed by citric acid. Using all antioxidants together gave the maximum values. The lowest values were recorded on untreated plants. These results were true during both seasons.

The promotion on growth and nutritional status of sunflower plants due to application of these antioxidants surely reflected on enhancing yield components.

Similar results were announced by Ali *et al*., (2003) on coriander; Al- Shareif (2006) on caraway; Ibrahim (2010) on geranium and Abdou *et al*., (2011) on clove Basil.

5. Protein % and plant pigments:-

It is evident from the data in Table (4) that treating the plants three times with these antioxidants either singly or in all combinations significantly resulted in enhancing protein % and plant pigments in the fresh leaves namely chlorophylls a & b, carotenoids and total chlorophylls in relative to the control treatment. Using amino acids at 500 ppm gave the maximum values in relative to the other antioxidants. Using all antioxidants together effectively maximized these chemical traits. The lowest values were recorded on untreated plants. These results were true during both seasons.

The beneficial effect of these antioxidants on building most organic foods and plant pigments could explain the present results.

These results are in conformity with those obtained by Abd El- Hakim (2006) and Abd El- Naem and Abd El- Hakiem (2009) on different legumes.

Finally, it is advised to spray sunflower cv. Giza 102 plants three times with a mixture of antioxidants contains citric acid at 500 ppm, E vitamin at 50 ppm and the three amino acids (tryptophan, methionene and cystein) at 500 ppm for promoting the yield quantitively and qualitatively.

Table (1): Effect of some antioxidants on some vegetative growth characters and head diameter of sunflower cv. Giza 102 plants during 2009 and 2010 seasons.

Antioxidant treatments	Plant height (cm.)		Stem diameter (cm.)		Number of leaves per plant		leaves area/ plant (cm^2)		Head diameter (cm.)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Control (untreated plants).	136.3	137.0	2.11	2.05	22.0	23.0	431.0	436.0	16.90	17.00
Spraying citric acid at 500 ppm.	145.0	145.7	2.33	2.27	24.9	26.6	459.0	464.3	17.13	17.23
Spraying vitamin E at 50 ppm.	141.0	141.8	2.22	2.16	23.6	24.7	446.0	452.0	17.02	17.11
Spraying amino acids at 500 ppm.	147.9	148.0	2.51	2.45	26.4	28.3	474.3	481.0	17.25	17.35
Spraying citric acid + vitamin E.	152.3	153.0	2.58	2.52	28.3	30.0	487.2	493.3	17.51	17.61
Spraying vitamin E + amino acids.	155.0	156.0	2.66	2.60	30.0	31.8	501.0	507.7	17.64	17.74
Spraying citric acid + amino acids.	157.6	158.7	2.74	2.68	31.7	32.3	521.0	527.7	17.71	17.81
Spraying all antioxidants.	161.0	162.3	2.81	2.75	33.0	33.0	533.3	541.7	17.90	18.02
New L.S.D at 5 %	**1.9**	**2.0**	**0.06**	**0.05**	**1.3**	**1.6**	**10.1**	**11.0**	**0.09**	**0.08**

Table (2): Effect of some antioxidants on weight of head per plant (g.), seed yield/ plant (kg.), shelling %, seed index (g.) and number of seeds/ head of sunflower cv. Giza 102 plants during 2009 and 2010 seasons.

Antioxidant treatments	Head weight/ Plant (g.)		Seed yield/ Plant (g.)		Shelling %		Seed index (g.)		Number of Seeds/ head	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Control (untreated plants).	75.2	75.9	46.1	46.5	61.3	61.3	5.91	5.95	780.0	781.5
Spraying citric acid at 500 ppm.	75.7	76.5	46.6	47.0	61.6	61.4	6.14	6.17	559.0	761.8
Spraying vitamin E at 50 ppm.	75.5	76.2	46.3	46.7	61.3	61.3	6.03	6.07	767.8	769.4
Spraying amino acids at 500 ppm.	76.0	76.8	47.0	47.4	61.8	61.7	6.30	6.34	746.0	747.6
Spraying citric acid + vitamin E.	76.2	77.0	47.4	47.8	62.2	62.1	6.45	6.49	734.9	736.5
Spraying vitamin E + amino acids.	76.3	77.6	48.0	48.5	62.9	62.5	6.63	6.68	724.0	726.0
Spraying citric acid + amino acids.	76.5	78.3	48.7	49.2	63.7	62.8	6.79	6.85	717.2	718.2
Spraying all antioxidants.	76.8	78.7	49.1	50.0	63.9	63.5	6.92	6.97	709.5	717.4
New L.S.D at 5 %	**0.2**	**0.2**	**0.2**	**0.2**	**0.4**	**0.4**	**0.10**	**0.09**	**6.0**	**5.9**

Table (3): Effect of some antioxidants on straw yield/ plant (g.), above ground biomass/ plant (g.), seed yield/ fed (ton.), oil yield/ fed (g.) and oils % of sunflower cv. Giza 102 plants during 2009 and 2010 seasons.

Antioxidant treatments	Straw yield/ plant (g.)		Above ground biomass/ plant (g.)		Seed yield/ fed (ton)		Oil yield/ fed (kg.)		Oils %	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Control (untreated plants).	167.5	170.0	213.6	216.5	1.01	1.15	314.2	315.6	31.11	31.25
Spraying citric acid at 500 ppm.	175.0	177.5	221.6	224.5	1.26	1.40	398.4	400.2	31.62	31.76
Spraying vitamin E at 50 ppm.	171.0	173.6	217.3	220.3	1.16	1.30	364.4	410.2	31.41	31.55
Spraying amino acids at 500 ppm.	180.0	182.3	227.0	229.7	1.38	1.50	436.4	476.4	31.62	31.76
Spraying citric acid + vitamin E.	182.0	185.0	230.0	232.8	1.52	1.61	482.3	512.3	31.77	31.82
Spraying vitamin E + amino acids.	185.0	188.0	233.0	236.5	1.63	1.72	521.6	552.3	32.00	32.11
Spraying citric acid + amino acids.	187.6	191.0	236.3	240.2	1.75	1.83	563.9	593.1	32.22	32.41
Spraying all antioxidants.	191.0	194.0	240.1	244.0	1.86	1.95	604.7	635.9	32.51	32.61
New L.S.D at 5 %	**2.1**	**2.2**	**2.1**	**2.2**	**0.10**	**0.10**	**11.9**	**12.0**	**0.15**	**0.15**

Table (4): Effect of some antioxidants on protein %, chlorophylls a & b, total carotenoids and total chlorophylls (mg/ 1.0 F.W) of sunflower cv. Giza 102 plants during 2009 and 2010 seasons.

Antioxidant treatments	Protein %		Chlorophyll a (mg/ 1.0 g F.W)		Chlorophyll b (mg/ 1.0 g F.W)		Carotenoids (mg/ 1.0 g F.W)		Total chlorophylls (mg/ 1.0 g F.W)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Control (untreated plants).	15.8	15.9	2.19	2.30	1.05	1.12	1.41	1.38	3.24	3.42
Spraying citric acid at 500 ppm.	16.4	16.5	2.48	2.59	1.24	1.31	1.64	1.61	3.72	3.90
Spraying vitamin E at 50 ppm.	16.1	16.1	2.34	2.45	1.15	1.22	1.51	1.47	3.49	3.67
Spraying amino acids at 500 ppm.	16.7	16.8	2.63	2.75	1.35	1.42	1.77	1.74	3.98	4.17
Spraying citric acid + vitamin E.	17.0	16.9	2.79	2.90	1.46	1.53	1.90	1.88	4.25	4.43
Spraying vitamin E + amino acids.	17.2	17.3	2.94	3.05	1.57	1.64	1.95	1.92	4.51	4.69
Spraying citric acid + amino acids.	17.5	17.6	3.09	3.20	1.69	1.76	2.02	1.99	4.78	4.96
Spraying all antioxidants.	17.8	17.9	3.25	3.37	1.84	1.92	2.10	2.05	5.09	5.29
New L.S.D at 5 %	**0.2**	**0.2**	**0.11**	**0.11**	**0.05**	**0.05**	**0.03**	**0.03**	**0.20**	**0.19**

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7/22/2012