Effect of some Amino Acids and Vitamins on Chrysanthemum Production

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ABSTRACT

The present study was designed to study the effects of different concentrations of ascorbic acid (0 and 500 ppm), glutamic acid (0, 750 and 1500 ppm) and cystine (0, 250 and 500 ppm) and their combined effect on the vegetative growth and flowers characteristics of *Dendranthema grandiflorum* Ramat c.v "Hawaii". The experiment was carried out during 2001 and 2002 at Antoniades Research branch, Hort. Res. Instit., Alex., Egypt. . The results indicated that glutamic acid, cystine and ascorbic acid were very effective to improve the most characters of the vegetative growth and flowering, especially with 1500 ppm glutamic acid in the most characters. While cystine and ascorbic acid were less effective than glutamic acid. Furthermore, the combined effects of the two rates of glutamic acid and ascorbic acid at 500 ppm were effective on the most characters of the vegetative growth. While, the combined effects of the two rates of glutamic acid and cystine at 500 ppm was effective on the most characters of inflorescence. The combined effects of cystine and ascorbic acid too, the combined effects of glutamic acid and ascorbic acid and cystine were little effective on the most characters. It can be recommended to spray *Dendranthema grandiflorum* Ramat c.v "Hawaii" plants; by glutamic acid at rate of 1500 ppm, or a mixture of glutamic acid at 750 ppm and ascorbic acid at 500 ppm, or a mixture of glutamic acid at 750 ppm and cystine at 500 ppm, once after 90 day's from the final transplanting date to improve the vegetative growth and produce a high quality of inflorescences of Chrysanthemum plants.

Key words: Chrysanthemum, amino acids, vitamins.

INTRODUCTION

Chrysanthemum is the most popular florist's flower, know as "queen of the East", Chrysanthemum has its admirers and enthusiasts allover the world. The fact that Chrysanthemum shows draw biggest crowds everywhere is an ample proof of the popularity of this flower (Kher, 1976). The incurved type of Chrysanthemum (*Dendranthema grandiflorum* Ramat) c.v "Hawaii" plant has a globular bloom and beautiful large incurved florets with soft pink flower, it has many uses in the decorative purposes (Graf, 1985).

Recent studies revealed the importance of vitamins and amino acids as plant growth substances, which improve plant production without environmental pollution. (Chawdhary, 1979) reported that most free amino acids occurred in higher amounts in the healthy leaves of *Chrysanthemum morifolium*. Whereas, (Takahashi and Sato 1979) stated that free amino acids were detected in the petals of *Chrysanthemum morifolium* Ramat, on the other hand (Li Chao Hai *et. al.*, 1996) revealed that foliar application with a multiple trace elements fertilizer containing amino acids to cotton significantly improved boll setting rate and

yield. (Liu Qiang *et. al.*, 1998), concluded that spraying rice with double acid fertilizer (which derived from beer yeast and is rich in nucleotides and amino acids) increased biosynthesis of chlorophylls in leaves, photosynthesis, the activities of respiration enzymes, formation of ATP, uptake and assimilation of N, biosynthesis of reserve carbohydrate in the stem sheath at booting and translocation of them after heading from the stem sheath to the panicle, and also increased grain yield and grain protein content. (Refaat and Naguib 1998) on Peppermint (*Mentha piperita*), stated that, amino acid applications increased yields and oil quality. (Reda *et. al.*, 1999) on *Hyoscyamus muticus L.* mentioned that, photosynthetic pigments (chlorophylls a, b and carotenoids) as well as total N contents in the leaves varied with most amino acid treatments, depending on the developmental stage and vegetative growth criteria were significantly increased, especially with 50 mg ornithen/liter or 100 mg of cystine/ liter. (Haberland, 2000) showed that greatest yield increases were found after the use of liquid Mn and Potavit (including trace elements, amino acids, betaine and plant phenols) as foliar application for potatoes. (Gobara *et. al.*, 2002) on Red Roomy grape vines showed that single or combined application of yeast and micro nutrients was very effective in improving growth (yeast contains vitamin B1 , B6 and glycine.). On the same concern, (Hend *et. al.*, 2002) on *Antholyza aethiopica*, mentioned that tryptophan and aspartic as foliar spray at 0, 25, 50 and 75 ppm on *Antholyza aethiopica,* increased the vegetative growth, flowering parameters and total carbohydrates, nitrogen, phosphorus and potassium in leaves. (Naguib *et. al.*, 2003) on periwinkle (*Catharanthus roseus* G. Don), revealed that, seedlings were sprayed three times with IAA, phenylalanine or methionine at 50 or 100 ppm. All treatments significantly increased plant height, branching, fresh and dry weights of the plant.

Therefore, different amino acids (cystine and glutamic acid), ascorbic acid doses, and their mixtures as foliar application were used to improve vegetative growth and flowering of Chrysanthemum plants *(Dendranthema grandiflorum* Ramat).

MATERIAL AND METHODS

The experimental trails were carried out 2001 and 2002 seasons at nursery of Antoniades Research branch, Hort. Res. Inst., Alexandria, Egypt. It was intended to find out the individual and combined effects of different amino acids and ascorbic acid doses as foliar application on growth, flowering and chlorophyll content of the leaves of Chrysanthemum plants *(Dendranthema grandiflorum* Ramat).

Plant material:

Offsets of *Dendranthema grandiflorum* Ramat c.v "Hawaii" plants were taken with an average length of 8 cm. on March 15,2001 and planted in 10 cm. diameter plastic pots (one offset/pot) using a mixture of sand, clay and peat moss 1:1:1 (v/v). The pots were set under plastic house conditions; the pinching

process of the growing points of all the plants was done to accelerate the basal branches. On June 1st all the plants were transplanted to the final pots (30 cm. diameter clay pots) using the same soil mixture used before. When preparing this medium, 300 g of ammonium nitrate (33.5%N), 150 g of calcium super phosphate (15.5%P2O5), 25 g of potassium sulphate (48.5%K2O) and 3.5 g of magnesium sulphate (9.5% Mg), were added per cubic meter of substrate as base fertilizer. (Kofranek and Lunt, 1966). All plants were sitting under open field conditions. On June 15, the three well formed and distributed shoots on each plant were chosen for the experimental purposes. The disbudding process was done for each branch to allow one terminal bud to develop on each stem.

Procedure:

Ascorbic acid, glutamic acid and cystine were used one time as foliar application on the experimental plants after 90 days from the final transplanting (on September 1st 2001), with the rates as follow:
Ascorbic acid with two rates 0.0 and 500 ppm. glutamic acid with three rates 0, 750 and 1500 ppm. and cystine with three rates 0, 250 and 500 ppm. With all combinations which produce, 18 treatments:

1- Control
2- Cystine 250 ppm
3- Cystine 500 ppm
4- Glutamic acid 750 ppm
5- Glutamic acid 750 ppm + Cystine 250 ppm
6- Glutamic acid 750 ppm + Cystine 500 ppm
7- Glutamic acid 1500 ppm
8- Glutamic acid 1500 ppm + Cystine 250 ppm
9- Glutamic acid 1500 ppm + Cystine 500 ppm
10- Ascorbic acid 500 ppm
11- Ascorbic acid 500 ppm + Cystine 250 ppm
12- Ascorbic acid 500 ppm + Cystine 500 ppm
13- Ascorbic acid 500 ppm + Glutamic acid 750 ppm
14- Ascorbic acid 500 ppm + Glutamic acid 750 ppm + Cystine 250 ppm
15- Ascorbic acid 500 ppm + Glutamic acid 750 ppm + Cystine 500 ppm
16- Ascorbic acid 500 ppm + Glutamic acid 1500 ppm
17-Ascorbic acid 500 ppm + Glutamic acid 1500 ppm + Cystine 250 ppm
18-Ascorbic acid 500 ppm + Glutamic acid 1500 ppm + Cystine 500 ppm

The treatments were arranged in three replicates with three plants per experimental unit in a complete randomize block in factorial design, throughout each experimental season.

Regular agricultural practices such as weeding and watering as a basic dressing were carried out whenever necessary as recommended.

The following data were recorded:

A- Vegetative growth:

1- Plant height (cm), stem diameter (m.m), fresh and dry weight (g).

2- Leaves number, area (cm^2) and fresh and dry weight (g)/plant.

B- Flowering characteristics:

1- Inflorescence duration on plant in day (from flower bud showing color to the date of flower fading).

2- Inflorescence diameter (cm.) at full opening stage.

3- Inflorescence fresh and dry weight (g.).

C- Total chlorophyll content as mg/g. fresh weight of leaves, at flower bud stage according to Moran and Porath (1980).

The experiment was repeated in the second year (2002) at the same date and site. The same steps and techniques of the first year were exactly followed in the second year.

Data were tested by analysis of variance. Duncan's Multiple Rang Test was used for comparison between the treatments means Duncan, (1955), Sendecor, and Cochran (1974).

RESULTS AND DESCUSSION

A- Vegetative growth:

1- Plant height:

Amino acids and ascorbic acid treatments caused increases in the values of plant height as it shown in Table (1) comparing to control plants. Whereas, application of a mixture of glutamic acid at 1500 ppm and ascorbic acid at 500 ppm or a mixture of cystine at 250 ppm and ascorbic acid at 500 ppm in the first and the second seasons, respectively, gave the maximum plant height. These results are in agreement with those of Gobara *et. al.,* (2002) on Red Roomy grape vines and Reda *et. al.,* (1999) on *Hyoscyamus muticus L.* and Naguib; *et. al.,* (2003) on Periwinkle (*Catharanthus roseus*) plants.

2- Stem diameter:

Insignificant effect was observed on stem diameter, Table (1).

3- Stem fresh weight:

Application of amino acids and ascorbic acid on the foliage of Chrysanthemum significantly increased stem fresh weight/plant as it clear in Table (1), especially using glutamic acid at 1500 ppm. This increase may be related to reserve carbohydrates in the stem; Liu Qiang *et. al.,* (1998) described similar results, on rice plants. Naguib *et. al.*, (2003) on Periwinkle (*Catharanthus roseus*) plants and Refaat and Naguib (1998) on Peppermint.

4- Stem dry weight:
As it shown in Table (1) highly significant effect was recorded on stem dry weight/plant as a result of using amino acids and ascorbic acid as foliar application in the first season. The highest value was obtained with using 1500 ppm of glutamic acid. While it was significant in the second season and the highest value was occurred with using mixture of 750 ppm glutamic acid and 500 ppm of cystine. These results are in agreement with those of Reda *et. al.*, (1999) in *Hyoscyamus muticus L.* and Naguib *et. al.*, (2003) on Periwinkle (*Catharanthus roseus*) plants.

5- Leaves number:
Data in Table (2) show that leaves number was affected by all amino acids and ascorbic acid treatments and the highest number of leaves was given by spaying the plants with a mixture of 500 ppm ascorbic acid + 750 ppm glutamic acid in the two seasons. These results are in agreement with those obtained by Liu Qiang *et. al.*, on rice (1998), who stated that, spraying rice with bear yeast (rich with nucleotides and amino acids) increased ATP, uptake, assimilation of N and accumulation of reserve carbohydrates in the stem, so increased vegetative growth. Too, similar results were obtained by Naguib *et. al.*, (2003) on *Catharanthus roseus* plants.

6- Leaves fresh weight:
Data in Table (2) reveal that all treatments of amino acids and ascorbic acid did not significantly affect the leaves fresh weight in the two seasons.

7- Leaves dry weight:
Data in Table (2) reveal that leaves dry weight was significantly increased by amino acids and ascorbic acid application, especially with adding a mixture of 500 ppm of ascorbic acid and 750 ppm of glutamic acid in the two seasons. This increase may be related to increasing the leaves number, or and other photosynthetic pigments as it mentioned by Reda *et. al.*, (1999) on *Hyoscyamus muticus L.*, and Naguib *et. al.*, (2003) on Periwinkle (*Catharanthus roseus*) plants.

8- Leaves area:
Data in Table (2) show that amino acids and ascorbic acid significantly increased leaves area per plant, where the maximum value was recorded with using a mixture of 500 ppm ascorbic acid and 1500 ppm glutamic acid in the first season and with 1500 ppm glutamic acid alone in the second season. These results are in agreement with those of Liu Qiang *et. al.*, (1998) on rice, and Naguib *et. al.*, (2003) on Periwinkle (*Catharanthus roseus*) plants.

B- Flowering characteristics:

1- Inflorescence fresh weight:

It appears from Table (3) that amino acids and ascorbic acid significantly increased inflorescence fresh weight. The highest values were recorded with application of a mixture of glutamic acid at 750 ppm and 500 ppm cystine or 500 ppm cystine + 500 ppm ascorbic acid + 750 ppm glutamic acid in the first and second seasons, respectively. These increases in the fresh weight may be related to increase of amino acids in the petals as it detected by Takashi and Sato (1979) in *Chrysanthemum morifolum* plants. In this concern, Hend *et. al.*, (2002) on *Antholyza aethiopica* stated that, foliar spray of amino acids (tryptophan and asparatic) led to the increased flowering parameters.

2- Inflorescence dry weight:

Amino acids and ascorbic acid showed evident effect on inflorescence dry weight as it clears in Table (3). Using glutamic acid at1500 ppm had the biggest effect in the first season, while it was observed with treatment of a mixture of 750 ppm glutamic acid and 500 ppm cystine in the second season. These results may be related to increase assimilation of N and biosynthesis of reserve carbohydrate, Liu Qiang *et. al.*, (1998). and Hend *et. al.*, (2002).

3- Inflorescence diameter:

Highly significant increase was observed with application of amino acids and ascorbic acid in concern of inflorescence diameter. Using a mixture of 500 ppm of ascorbic acid and 500 ppm of cystine were more effective treatment as it observed in the two seasons as shown in Table (3). This increase may be due to increase vegetative growth criteria as suggested by Reda *et. al.*, (1999) in *Hyoscyamus muticus L.* and Hend *et. al.*, (2002) on *Antholyza aethiopica* plants.

4- Inflorescence duration:

Non-significant effect was observed with amino acids and ascorbic acid application on inflorescence duration as shown in Table (4). In this concern, the environmental conditions especially temperature more effective than the treatments.

C- Total chlorophyll content:

Data in Table (4) indicated that total chlorophyll content of the leaves of chrysanthemum was significantly affected by treating the plants with amino acids and ascorbic acid. The biggest value was recorded with treating the plants by a mixture of 1500 ppm glutamic acid and 500 cystine in the first season and 1500 ppm glutamic acid alone in the second season. These results are in agreement with those of Liu Qiang *et. al.*, (1998) and Reda *et. al.*, (1999).

Table 1. Effect of glutamic acid, cystine and ascorbic acid on plant height, stem diameter, stem fresh and dry weight of *Dendranthema grandiflorum*, Ramat C.V. "Hawaii" plants during 2001 and 2002 seasons.

Treatments	Plant height (cm)		Stem diameter (m.m)		Stem fresh weight (g)		Stem dry weight (g)	
Seasons	2001	2002	2001	2002	2001	2002	2001	2002
Control	67.57c	55.50f	5.73	4.67	30.24g	16.90c	7.07e	4.76b
C 250 ppm	80.47ab	68.33abc	6.00	5.50	43.55bcdef	33.30abc	9.96bcde	10.36a
C 500 ppm	77.77ab	66.25bcd	6.00	5.80	36.30fg	30.02abc	9.72cde	10.59a
G 750 ppm	75.63bc	69.83abc	6.30	6.17	37.25fg	28.95abc	10.09bcde	10.48a
G 750 ppm + C 250 ppm	82.23ab	67.50abcd	6.57	5.17	38.28ef	31.91abc	11.86abcd	10.31a
G 750 ppm + C 500 ppm	78.23ab	68.33abc	6.30	6.17	39.90cdef	26.14abc	9.03de	10.80a
G 1500 ppm	85.17ab	66.00bcd	6.47	5.80	55.39	42.25a	15.07a	8.83ab
G 1500 ppm + C 250 ppm	77.97ab	70.25ab	5.97	5.30	39.11def	25.44abc	10.21bcde	7.95ab
G 1500 ppm + C 500 ppm	82.20ab	65.67cd	6.10	5.30	39.84cdef	27.57abc	13.67ab	9.38a
A 500 ppm	80.80ab	61.67e	5.57	5.30	43.69bcde	22.93bc	11.77abcd	7.58ab
A 500 ppm + C 250 ppm	81.90ab	71.17a	6.40	5.80	45.84bcde	27.54abc	13.86ab	9.74a
A 500 ppm + C 500 ppm	82.47ab	63.50de	5.77	5050	50.59a	31.92abc	14.42a	10.24a
A 500 ppm + G 750 ppm	81.67ab	66.67bcd	7.13	6.50	40.23cdef	36.46ab	12.20abcd	10.69a
A 500 ppm + G 750 ppm + C 250 ppm	78.43ab	68.33abc	6.57	5.50	41.67bcdef	29.41abc	13.50abc	8.73ab
A 500 ppm + G 750 ppm + C 500 ppm	84.57ab	65.83cd	5.80	5.00	47.90ab	25.58abc	12.69abcd	9.00ab
A 500 ppm + G 1500 ppm	87.80a	63.33de	6.20	4.80	47.08bcd	22.00bc	12.34abcd	6.81ab
A 500 ppm + G 1500 ppm + C 250 ppm	86.57ab	66.00bcd	6.10	5.30	47.53abc	28.07abc	12.16abcd	8.83ab
A 500 ppm + G 1500 ppm + C 500 ppm	83.67ab	67.00abcd	6.20 N.S	5.30 N.S	36.17fg	26.82abc	10.28bcde	9.29a
L.S.D. G	3.815	1.969	N.S	N.S	3.310	4.041	0.839	0.725
C	3.815	1.969			3.310	4.041	0.839	0.725
A	3.115	1.607			2.702	3.300	0.685	0.592
A x C	5.442	2.809			4.945	5.674	1.197	1.034
A x G	5.442	2.809			4.945	5.764	1.197	1.034
C x G	6.665	3.440			6.056	7.060	1.467	1.266
A x C x G	9.426	4.865			8.565	9.984	2.074	1.791

* A = ascorbic acid G = glutamic acid C = cystine

* Means of each factor designated by the same letter are not significantly different at 5% level using Duncan's Multiple Range Test.

* N.S = non-significant.

Table 2. Effect of glutamic acid, cystine and ascorbic acid on leaves number, fresh weight, dry weight and leaves area of *Dendranthema grandiflorum*, Ramat C.V. "Hawaii" plants during 2001 and 2002 seasons.

Treatments	Leaves number		Leaves fresh weight (g)		Leaves dry weight (g)		Leaves area (cm^2)	
Seasons	2001	2002	2001	2002	2001	2002	2001	2002
Control	54.76e	37.67b	41.44	29.72	6.36e	3.81c	690.71f	538.69d
C 250 ppm	70.80bcd	57.17ab	67.93	41.83	8.04cd	7.13abc	1227.08cde	800.54bcd
C 500 ppm	62.80cde	52.83ab	48.65	55.22	6.32e	9.08ab	1307.78cde	1124.21ab
G 750 ppm	59.23de	57.0ab	62.60	58.68	8.10cd	9.50ab	1273.97cde	861.94abcd
G 750 ppm + C 250 ppm	80.47ab	50.33ab	72.29	40.54	9.20bc	7.72abc	1555.29bcd	1048.54abc
G750 ppm + C 500 ppm	74.13bc	57.67ab	71.49	42.72	9.99b	8.11abc	1128.45def	996.72abcd
G 1500 ppm	80.67ab	73.0ab	94.80	34.77	7.98cd	8.59abc	1761.28abc	1327.82a
G 1500 ppm + C 250 ppm	64.07cde	56.0ab	52.22	36.64	8.22cd	6.51abc	1177.86def	861.94abcd
G 1500 ppm + C 500 ppm	79.67ab	70.0ab	69.06	42.48	8.80bc	8.70abc	1455.88bcde	1013.06abcd
A 500 ppm	73.0bcd	49.33ab	30.93	61.86	8.74c	8.92ab	1307.08cde	621.37cd
A 500 ppm + C 250 ppm	65.8bcde	44.67ab	21.85	58.82	8.36cd	5.80abc	1358.65cde	595.79cd
A 500 ppm + C 500 ppm	87.73ab	60.0ab	49.14	79.94	8.13cd	7.25abc	1900.35ab	1047.93abc
A 500 ppm + G 750 ppm	94.57a	93.67a	48.03	65.82	11.41a	10.53a	1624.11bcd	1071.88abc
A 500 ppm + G 750 ppm + C 250 ppm	70.23bcd	51.33ab	33.89	60.39	8.33cd	7.27abc	1461.22bcde	735.46bcd
A 500 ppm + G 750 ppm + C 500 ppm	59.33de	52.67ab	38.02	44.76	7.22de	5.78abc	933.94ef	933.46abcd
A 500 ppm + G 1500 ppm	74.13bc	49.33ab	33.87	68.49	9.23bc	4.94bc	2234.81a	754.15bcd
A 500 ppm + G 1500 ppm + C 250 ppm	71.90bcd	48.67ab	40.76	59.06	7.26de	6.55abc	1084.39def	816.13bcd
A 500 ppm + G 1500 ppm + C 500 ppm	65.9bcde	44.67ab	33.94 N.S	52.68 N.S	7.80cd	6.81abc	1154.44def	660.66bcd
L.S.D. G	5.517	10.960	N.S	N.S	0.529	1.075	221.04	168.23
C	5.517	10.960			0.529	1.075	221.04	168.23
A	4.505	8.944			0.429	0.877	180.48	137.36
A x C	7.671	15.627			0.749	1.563	315.328	239.99
A x G	7.871	15.627			0.749	1.563	315.328	239.99
C x G	9.639	19.140			0.918	1.914	386.197	293.93
A x C x G	13.632	27.067			1.298	2.707	546.165	415.68

* A = ascorbic acid G = glutamic acid C = cystine

* Means of each factor designated by the same letter are not significantly different at 5% level using Duncan's Multiple Range Test.

* N.S = non-significant.

Table 3. Effect of glutamic acid, cystine and ascorbic acid on inflorescence fresh and dry weight and diameter of *Dendranthema grandiflorum*, Ramat C.V. "Hawaii" plants during 2001 and 2002 seasons.

Treatments	Inflorescence fresh weight (g)		Inflorescence dry weight (g)		Inflorescence diameter (cm)	
Seasons	2001	2002	2001	2002	2001	2002
Control	27.02f	12.69d	4.11f	2.35b	13.44d	11.96h
C 250 ppm	47.59abcd	27.26abc	6.93abcde	5.33a	14.14abc	12.23fgh
C 500 ppm	34.61ef	33.42abcd	5.86bcdef	5.73a	13.93abcd	12.47cdefgh
G 750 ppm	46.19abcde	32.02bcd	7.15abcd	4.90b	14.10abc	12.53cdefgh
G 750 ppm + C 250 ppm	56.03abc	45.83ab	6.98abcde	6.67a	14.15abc	13.10abc
G750 ppm + C 500 ppm	61.67a	40.75abc	8.0ab	6.60a	14.25abc	12.83abcdef
G 1500 ppm	58.58ab	33.47abcd	8.59a	8.29a	14.09abc	13.23ab
G 1500 ppm + C 250 ppm	48.50abcde	38.60abc	7.33bcd	6.48a	13.68bcd	12.30efgh
G 1500 ppm + C 500 ppm	47.44abcde	24.91bcd	6.38abcdef	4.74b	14.33ab	12.70bcdefg
A 500 ppm	60.70a	31.19bcd	7.37abc	6.57a	14.21abc	12.90abcde
A 500 ppm + C 250 ppm	47.12abcde	34.84abc	7.35abcd	7.78a	14.11abc	13.03abcd
A 500 ppm + C 500 ppm	38.05def	39.71abc	5.45cdef	6.44a	14.76a	13.37a
A 500 ppm + G 750 ppm	44.13bcde	28.09bcd	6.8abcde	5.32a	14.17abc	12.41defgh
A 500 ppm + G 750 ppm + C 250 ppm	41.25cdef	30.71bcd	4.95cdef	7.31a	13.70bcd	12.8abcdef
A 500 ppm + G 750 ppm + C 500 ppm	43.88bcde	53.85a	5.74bcdef	6.28a	13.85abcd	12.57cdefgh
A 500 ppm + G 1500 ppm	42.19cde	22.29cd	4.92def	5.07a	14.12abc	12.63bcdefg
A 500 ppm + G 1500 ppm + C 250 ppm	52.19abcd	35.80abc	6.01bcdef	6.05a	14.18abc	12.8abcdef
A 500 ppm + G 1500 ppm + C 500 ppm	48.17abcde	44.90abc	4.60ef	5.69a	13.35cd	12.10gh
L.S.D. G	5.536	5.309	0.839	0.725	0.323	0.229
C	5.536	5.309	0.839	0.725	0.323	0.229
A	4.520	4.335	0.685	0.592	0.263	0.187
A x C	7.898	7.574	1.197	1.034	0.461	0.327
A x G	7.898	7.574	1.197	1.034	0.461	0.327
C x G	9.673	9.276	1.467	1.266	0.560	0.400
A x C x G	13.679	13.118	2.074	1.791	0.800	0.566

* A = ascorbic acid G = glutamic acid C = cystine

* Means of each factor designated by the same letter are not significantly different at 5% level using Duncan's Multiple Range Test.

Table 4. Effect of glutamic acid, cystine and ascorbic acid on inflorescence duration and chlorophyll content of *Dendranthema grandiflorum*, Ramat C.V. "Hawaii" plants during 2001 and 2002 seasons.

Treatments	Inflorescence duration		Chlorophyll contents	
Seasons	2001	2002	2001	2002
Control	48.67	51.67	0.87d	1.34de
C 250 ppm	51.67	54.67	1.04bcd	1.77abc
C 500 ppm	45.67	54.33	0.93bcd	1.70abc
G 750 ppm	45.00	56.33	1.23ab	1.89ab
G 750 ppm + C 250 ppm	46.67	56.33	1.20abc	1.87ab
G750 ppm + C 500 ppm	56.33	51.00	0.88cd	1.57bcd
G 1500 ppm	56.00	50.67	1.05bcd	1.94a
G 1500 ppm + C 250 ppm	53.67	53.33	1.11bcd	1.69abc
G 1500 ppm + C 500 ppm	53.33	55.67	1.49a	1.80abc
A 500 ppm	53.00	50.67	0.87bcd	1.50cd
A 500 ppm + C 250 ppm	42.67	57.67	0.92bcd	1.24e
A 500 ppm + C 500 ppm	40.33	51.67	0.99bcd	1.63abcd
A 500 ppm + G 750 ppm	49.00	57.67	1.13bcd	1.68abc
A 500 ppm + G 750 ppm + C 250 ppm	49.00	55.67	0.94bcd	1.66abc
A 500 ppm + G 750 ppm + C 500 ppm	54.00	55.67	0.91bcd	1.69abc
A 500 ppm + G 1500 ppm	55.00	47.33	1.14bc	1.56bcd
A 500 ppm + G 1500 ppm + C 250 ppm	54.33	55.00	0.99bcd	1.79abc
A 500 ppm + G 1500 ppm + C 500 ppm	52.33	54.67	0.96bcd	1.72abc
L.S.D. G	N.S	N.S	0.116	0.115
C			0.116	0.115
A			0.095	0.094
A x C			0.165	0.164
A x G			0.165	0.164
C x G			0.202	0.210
A x C x G			0.286	0.284

* A = ascorbic acid G = glutamic acid C = cystine

* Means of each factor designated by the same letter are not significantly different at 5% level using Duncan's Multiple Range Test.

* N.S = non-significant.

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الملخص العربى

تأثير بعض الأحماض الامينية والفيتامينات على إنتاج نباتات الاراولا

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مركز البحوث الزراعية

صممت هذه التجربة لدراسة تأثير التركيزات المختلفة من حمض الاسكوربيك بتركيز (صفر، ٥٠٠ جزء فى المليون) وحمض الجلوتاميك بتركيز (صفر، ٧٥٠، ١٥٠٠ جزء فى المليون) والسستين بتركيز (صفر، ٢٥٠، ٥٠٠ جزء فى المليون) وتأثيرهم المشترك على صفات النمو الخضرى والزهرى لنبات الاراولا صنف هاواى. وقد أجريت التجربة خلال الموسمين ٢٠٠١ و ٢٠٠٢ بفرع بحوث حديقة انطونيادس – معهد بحوث البساتين بالإسكندرية. وقد أشارت النتائج إلى أن حمض الجلوتاميك والسستين وحمض الاسكوربيك كانوا مؤثرين جدا فى تحسين النمو الخضرى وجودة النورات خصوصا حمض الجلوتاميك بتركيز ١٥٠٠ جزء فى المليون فى معظم الصفات. بينما السستين وحمض الاسكوربيك كانوا اقل تأثيرا مقارنة بحمض الجلوتاميك. علاوة على ذلك فان التأثير المشترك لحمض الجلوتاميك فى مستويه مع حمض الاسكوربيك بتركيز ٥٠٠ جزء فى المليون كانا اكثر تأثيرا لمعظم صفات النمو الخضرى. وكان التأثير المشترك لحمض الجلوتاميك فى مستويه مع السستين بتركيز ٥٠٠ جزء فى المليون اكثر تأثيرا فى معظم صفات النورات. أما التأثير المشترك لحمض الاسكوربيك مع السستين وكذلك التأثير المشترك لحمض الجلوتاميك مع حمض الاسكوربيك مع السستين كانوا اقل تأثيرا فى معظم الصفات. لذلك يمكن التوصية برش نباتات الاراولا صنف هاواى بحمض الجلوتاميك بتركيز ١٥٠٠ جزء فى المليون أو بخليط من حمض الجلوتاميك بتركيز ٧٥٠ جزء فى المليون مع حمض الاسكوربيك بتركيز ٥٠٠ جزء فى المليون أو بخليط من حمض الجلوتاميك بتركيز ٧٥٠ جزء فى المليون مع السستين بتركيز ٥٠٠ جزء فى المليون، و ذلك مرة واحدة بعد ٩٠ يوما من أخر تدوير للنباتات لتحسين النمو الخضرى وإنتاج نورات بجودة عالية من نباتات الاراولا.