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EFFECT OF PRE-HARVEST FOLIAR APPLICATION OF CITRIC ACID, MALIC ACID AND TRYPTOPHAN ON THE GROWTH, FLOWERING AND POST-HARVEST VASE LIFE OF TUBEROSE PLANTS

I- Effect of pre-harvest treatments on vegetative growth and flowering

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ABESTRACT

This study was carried out during the two seasons of 2013 and 2014 at the nursery, Department of Floriculture, Ornamental Horticulture and Landscape Gardening, Faculty of Agriculture, Alexandria University, Egypt. Tuberose (*Polianthes tuberosa*, L. cv. "Double") corms with average of 3.8 cm diameter and 70.0 g of fresh weight were planted in 30 cm diameter plastic pots, filled with 10 kg. sandy soil , on 13th May 2013 and 2014 in the first and second seasons, respectively. The plants were sprayed with Citric acid, Malic acid and Tryptophan at concentrations of 0, 100, 200 and 300 ppm, every 15 days from July 4th till August 15th in both seasons. Control plants were sprayed with tap water. The end of the experiment was September 1st (in both seasons).

The obtained results showed that spraying *Polianthes tuberosa* plants with malic acid at 300 ppm significantly increased plant height, leaf number, leaf dry weight, leaf area, time to showing color, the number of flowers per spike, flowering duration, flower dry weight, spike dry weight, rachis length, corm diameter, the number of new cormlets, total chlorophyll content, carbohydrate content and nitrogen percentage in the leaves. Spraying tryptophan at 200 ppm resulted in increasing corm dry weight.

Key words: *Polianthes tuberosa - Citric acid - Malic acid – Tryptophan.*

1. INTRODUCTION

Tuberose (*Polianthes tuberosa* L.), a member of the Agavaceae family and native to Mexico, has long been cherished for the aromatic oils extracted from its fragrant white flowers (Trueblood, 1973). It has recently gained popularity as a cut flower and in a number of countries including Kenya, India and Mexico. It is grown commercially for export to the USA, Europe and Japan. Tuberose inflorescences (spikes) bear 10-20 pairs of florets which open acropetally. Commercially, spikes 60-90 cm long are harvested when two or three of the basal florets are open. Lesss than 50% of the buds normally open after harvest, and florets and buds usually abscond after only few days in the vase. Postharvest performance is worse in tuberose which has been shipped to distant markets. Since tuberose originated in the sub-tropics, this loss of quality might be due to chilling injury induced by exposure to low, but non-freezing, temperatures during marketing. Alternatively, it might be the result of postharvest desiccation, or improper temperature management.

Tuberose (*Polianthes tuberosa* L.) is a very popular cut flower in Egypt. It has white flowers having sweet scent. Its flowering occurs during summer and early autumn, when planted in spring. There are up to 30 flowers in one spike and the length of rachis varies between 14 and 28 cm, depending upon the size of the planted corms. Besides being source of essential oils for perfume industry, it is commonly used in bouquets for presenting and in vases for interior decoration. The grading standard for tuberose marketing is a disease-free straight stem of about

70 cm and spike with a minimum of 10 pairs of pure white florets (Steenstra and Brundell 1986). Since it has delicate flowers so that the sellers and consumers are keen in extending its vase-life, this necessitates to improve its postharvest life. Keeping quality of the spikes is only 3 days per floret, and vase-life of the flowers is only few days.

Citric acid is a regular ingredient in many vase solution formulations that acts as a pH regulator that reduces bacterial proliferation and enhances water conductance in the xylem of cut flowers (Goszczynska and Rudnicki, 1988 and Van Doorn, 2010). Citrate and malate are among the intermediate organic acids in Krebs cycle which produces cellular energy by oxidative phosphorylation (Wills *et al.,* 1981). Citrate complex is one of the mobile forms of iron inside the plant so it plays an important role in iron transport inside plants (Hell and Stephan, 2003).

Malic acid is the organic acid which could be metabolized by the reaction of malic enzyme in mitochondria and considered as ability limited to plant. Malate is a common reserve anion acting as a counter ion for K and Ca in plant vacuoles, especially in nitrate dependent plants (Day and Hanson, 1977).

Ramaih *et al.* (2003) confirmed that tryptophan is the major precursor of Indol Acitic Acid (IAA) in most organisms. Plants produce IAA from tryptophan through indole-3-pyruvic acid (Mashiguchi *et al.*, 2011 and Won, 2011). IAA is also produced from tryptophan through indole-3-acetaldoxime in Arabidopsis (Satoko *et al.,* 2009). El-Bassiouny (2005) demonstrated that tryptophan and nicotinamide increased IAA, giberellic acid (GA_3), cytokinens, and decreased abscicic Acid (ABA) in wheat. Nicotinamide is a stress induced compound to provide defense mechanism against a specific stress. Wyszkowska (1999) and El-Bassiouny (2005) observed an increase in some minerals K^+, Ca^{2+} and Mg^{2+} in wheat plant tissues by tryptophan treatment.

The present study was conducted to evaluate the use of citric acid, malic acid and tryptophan in increasing the performance of tuberose. In this study, we aimed to test the effect of applying foliar sprays of citric acid, malic acid and tryptophan in increasing the quality and performance of tuberose plant.

2. MATERIALS AND METHODS

This study was carried out during the two successive seasons of 2013 and 2014 at the nursery, Department of Floriculture, Ornamental Horticulture and Landscape Gardening, Faculty of Agriculture, Alexandria University, Egypt.

Tuberose (*Polianthes tuberosa*, L. cv. "Double") corms with an average of 3.8 cm diameter and 70.0 g of fresh weight were obtained from a commercial nursery in El-Kanater El-Khayreya and planted in 30 cm diameter plastic pots at a depth of 5 cm on the 13*th* of May 2013 and 2014 in the first and second seasons, respectively. The pots were filled with sandy soil (10 kg per pot). The analysis of the sandy soil according to Jackson (1958) are illustrated in Table (1). Before planting, all side buds on the planted corms were removed to allow only the terminal bud to develop in each corm.

The plants were sprayed with Citric acid, Malic acid and Tryptophan at the concentrations of 0, 100, 200 and 300 ppm, every 15 days starting from the 4*th* of July till the15*th* of August in both seasons. The control plants were sprayed with tap water. the plants and corms were harvested, on the 1*st* of September in both seasons.

In both seasons, all plants received NPK chemical fertilization using fertilizer (Milagro Aminoleaf 20-20-20) at the rate of 3 g/ pot. Fertilization was repeated every 30 days throughout the growing season (from the 20*th* of April till the 15*th* of August). In addition, weeds were removed manually upon emergence.

Table (1): Chemical analysis of the used sandy soil for the two successive seasons 2013 and 2014.

Season	pH	EC (dSm^{-1})	Soluble cations (mg/l)				Soluble anions (mg/l)		
			Ca^{++}	Mg^{++}	Na^+	K^+	HCO_3^-	Cl^-	SO_2^{--}
2013	7.87	1.51	3.1	4.2	6.4	1.1	3.5	6.5	2.4
2014	7.92	1.43	3.4	2.9	6.2	0.9	3.2	6.3	2.1

Data recorded

1-Vegetative growth parameters: Plant height (cm), number of leaves per plant, leaf area (cm^2) and leaf dry weight (g).

2- Flowering characteristics: Time to showing color (day), number of flower per spike, flowering duration (day), flower dry weight (g), spike dry weight (g) and rachis length (cm).

3- Corm production: Corm dry weight (g), corm diameter (cm) and number of new cormlets.

4- Chemical analysis determination

- Chlorophyll content were determined as SPAD units of the fresh leaves of the plants for the different treatments under the experiment at the end of the season using Minolta (chlorophyll meter) SPAD 502 according to Yadava (1986).
- Carbohydrate contents of the leaves were determined according to Dubios *et al.*(1956).
- Nitrogen (%) was determined in the digested solution by the modified micro kjeldahl method as described by Pregl, (1945).

The experimental design was a complete randomized block design (RCBD) contained 10 treatments with three replicates; each replicate contained three plants. Data were subjected to analysis of variance (ANOVA) using the SAS program, SAS Institute (Snedecor and Cochran,1974) and the mean the values were compared using L.S.D level (SAS Institute, 2002).

3. RESULTS AND DISCUSSION

3.1.Vegetative growth

3.1.1. Plant height (cm)

Plant height was significantly affected by spraying the plants with citric acid, malic acid and tryptophan. In both seasons, plant height was increased gradually when the malic acid concentration was raised from 0 ppm (control) to 300 ppm. Accordingly, it can be seen from the data in Table (2) that *Polianthes tuberosa* plants sprayed with 300 ppm malic acid were significantly taller (with mean plant heights of 94.55 and 94.33 cm in the first and second season, respectively) than plants sprayed with any of citric acid and tryptophan concentrations. The increase in height of *Polianthes tuberosa* plants as a result of spraying with malic acid is similar to the increases in height that had been recorded on other ornamental plant species, by Darandeh and Hadavi (2012) on *Lilium* cv. Brunello, Talebi *et al.* (2014) on *Gazania rigens* and Kumar *et al.* (2013) on *Tulipa gesneriana*.

3.1.2. Number of leaves per plant

The effects of citric acid, malic acid and tryptophan treatments on the number of leaves per plant were significant. In the first season, the highest number of leaves per plant (99.10) was formed on plants sprayed with malic acid at 300 ppm , In the case of the second season, the highest number of leaves per plant (95.44) was formed on plants sprayed with malic acid at 200 ppm. On the other hand, the lowest numbers of leaves per plant 84.99 and 84.21 in the first and second seasons, respectively were obtained in the control plants. The increase in the number of leaves of plants sprayed with malic acid at 300 ppm supports the results reported by Kumar *et al.* (2013) on *Tulipa gesneriana*.

3.1.3. Leaf dry weight (g) per plant

The data presented in Table (2) also show that spraying *Polianthes tuberosa* plants with malic acid at 300 ppm significantly increased the dry weight of leaves giving values of 19.43 and 18.74 g per plant in the first and second seasons, respectively, compared to the control (16.66 and 16.51 g per plant) in the first and second season, respectively. Accordingly, it can be found from the data in Table (2) that *Polianthes tuberosa* plants sprayed with 300 ppm malic acid gave significantly heaviest leaf dry weight than plants sprayed with any other citric acid and tryptophan concentration. The increase in the leaf dry weight of *Polianthes tuberosa* plants as a result of spraying with malic acid is similar to the data obtained on other ornamental plant species, by Kazemi (2013) on Strawberry cv. 'Selva' and Talebi *et al.* (2014) on *Gazania rigens*.

3.1.4. Leaf area (cm^2)

The data presented in Table (2) show that, the different citric acid, malic acid and tryptophan treatments had a significant effect on leaf area of *Polianthes tuberosa* plants. Plants sprayed with malic acid at 300 ppm formed significantly larger leaves (with a mean area of 1234.89 and 1760.02 cm^2 in the first and second season, respectively, than those formed by the control plants (916.89 and 1185.18 cm^2). Similar increases in leaf area as a result of malic acid treatments, have been reported by Kazemi (2013) on Strawberry cv. 'Selva' and Kumar *et al.* (2013) on *Tulipa gesneriana*.

Generally, the average plant height due to spraying with malic acid at 300 ppm was 94.55 and 94.33 cm in first and second seasons, respectively. The extent of any fall in the first grade (Class I) of export (which is how far along spike length between 80 - 90 cm), GOEIC (1988). The plant height for control was 75.99 and 77.22 cm in first and second seasons, respectively. The extent of any fall in the second

Table (2): Means of vegetative growth characteristics of *Polianthes tuberosa* plants as influenced by citric acid, malic acid and tryptophan in the two seasons of 2013 and 2014.

Treatments		Plant height (cm)		Number of leaves per plant		Leaf dry weight (g)		Leaf area (cm^2)	
		2013	2014	2013	2014	2013	2014	2013	2014
Control	000 ppm	75.99	77.22	84.99	84.21	16.66	16.51	916.89	1185.18
Citric acid	100 ppm	82.44	82.55	91.33	90.88	17.90	17.82	1062.71	1407.99
	200 ppm	83.66	83.11	92.11	91.00	18.06	17.84	1114.32	1536.38
	300 ppm	86.32	85.44	94.55	93.66	18.53	18.36	1181.79	1621.42
Malic acid	100 ppm	90.25	89.99	96.21	93.44	18.86	18.32	1095.60	1588.85
	200 ppm	92.55	92.66	98.32	95.44	19.27	18.71	1225.42	1671.92
	300 ppm	94.55	94.33	99.10	94.44	19.43	18.74	1234.89	1760.02
Tryptophan	100 ppm	76.21	77.77	87.66	84.10	17.18	16.49	925.25	1244.89
	200 ppm	78.66	79.66	89.99	86.55	17.64	16.97	1079.05	1433.02
	300 ppm	79.88	80.33	91.88	87.22	18.01	17.10	1117.81	1496.44
L.S.D. at 0.05		1.86	1.75	4.16	6.45	0.81	1.23	144.99	58.46

grade (Class п) for export is how far spike length between 70 – 80 cm), GOEIC (1988).

3.2. Flowering characteristics

3.2.1. Time to showing color (day)

The data in Table (3-a) showthat considerable differences in the time to showing color (day) were detected in the plants receiving the different concentrations of citric acid, mailc acid and tryptophan treatments. The longest periods (61.33 and 63.00 days in the first and second seasons, respectively), were obtained from plants sprayed with tap water (control) treatment. Whereas, the shortest periods for showing color (47.33 and 49.33 day) in the first and second season, respectively, were obtained from plants sprayed with mailc acid at 300 ppm. Similar results were reported by Kumar *et al.* (2013) on *Tulipa gesneriana*.

3.2.2. Number of flowers per spike

Concerning the effect of citric acid, malic acid and tryptophan treatments on the number of flowers per spike, the data recorded in Table (3-a) show that malic acid treatment at 300 ppm resulted in significant increase in the number of flowers giving mean values of 30.99 and 31.22 flowers per spike in the first and second season, respectively, compared to that of the control plants (23.10 and 22.33 flowers per spike in the two seasons, respectively). The increase in the number of flowers per spike for plants sprayed with malic acid at 300 ppm agreed with the results reported by Kazemi (2013) on Strawberry cv. ‘Selva’.

3.2.3. Flowering duration (day)

The results in Table (3-a) show that, in both seasons, spraying the plants with citric acid, malic acid and tryptophan increased the flowering duration. Spraying the plants with 300 ppm malic acid gave the highest increase in flowering duration (22.33 and 21.55 days) in the first and second season, respectively. These values were significantly higher than those of the control plants 14.77 and 13.88 days, in the first and second seasons, respectively. Increases in the flowering duration as a result of malic acid treatments had been reported by Kumar *et al.* (2013) on *Tulipa gesneriana*.

3.2.4. Flowers dry weight (g)

The results recorded in the two seasons in Table (3-b) show that, in both seasons, spraying the plants with citric acid, malic acid and tryptophan increased the dry weight of flowers. Spraying the plants with 300 ppm malic acid gave the heaviest dry weight of flowers 6.45 and 6.22 g per plant in the first and second season, respectively. These values were significantly higher than those of the control plants (3.27 and 3.10 g per plant) in the first and second seasons, respectively. Increases in the flowers dry weight as a result of malic acid treatments had been reported by Talebi *et al.* (2014) on *Gazania rigens*.

3.2.5. Spike dry weight (g)

Spraying *Polianthes tuberosa* plants with malic acid at 300 ppm gave the heaviest spike dry weight (7.42 and 7.19 g) as compared with The control plants giving 5.39 and 5.05 g in the first and second seasons, respectively. The increase in the spike dry weight of the plants sprayed with malic acid at 300 ppm supports the results reported by Talebi *et al.* (2014) on *Gazania rigens*.

3.2.6. Rachis length (cm)

The data in Table (3-b) indicate that citric acid, malic acid and tryptophan treatments had a significant effect on the rachis length. In both seasons, plants sprayed with malic acid gave the tallest rachis length compared to the control plants. As with other flowering characteristic parameters, spraying the plants with malic acid at 300 ppm gave the tallest rachis length 30.50 and 30.42 cm in the first and second season, respectively. Similar increase in the rachis length as a result of malic acid treatments was recorded by Talebi *et al.* (2014) on *Gazania rigens*.

Generally, the average flower it was number per spike when sprayed with malic acid at 300 ppm was 30.99 and 31.22 in the first and second seasons, respectively. The extent of any fall in the first grade (Class I) of export is how far along flower number per spike between 25-30 flowers, GOEIC (1988). We found that the flower number per spike in the control was 23.10 and 22.33 in the first and second season, respectively. The extent of any fall in the second grade (Class п) for export is how far along flower number per spike between 20 – 25 flowers, GOEIC (1988).

3.3. Corm production

3.3.1. Corm dry weight (g)

The data recorded in Table (4) showed that spraying *Polianthes tuberosa* plants with tryptophan to 200 ppm gave the heaviest values of corm dry weight (20.32 and 23.32 g) as compared with the control treatment which gave 14.27 and 18.31 g in the first and second season, respectively. The increase in the corm dry weight due to spraying with tryptophan at 200 ppm supports the results reported by Hussein *et al.* (2014) on onion plants and Kumar *et al.* (2013) on *Tulipa gesneriana*.

3.3.2. Corm diameter (cm)

The data recorded in Table (4) showed that spraying *Polianthes tuberosa* plants with malic

Table (3-a): Means of flowering characteristics of *Polianthes tuberosa* plants as influenced by citric acid, malic acid and tryptophan in the two seasons of 2013 and 2014.

Treatments		Time to showing color (day)		Number flower per spike		Flowering duration (day)	
		2013	2014	2013	2014	2013	2014
Control	000 ppm	61.33	63.00	23.10	22.33	14.77	13.88
Citric acid	100 ppm	57.66	60.66	26.99	25.88	17.33	16.21
	200 ppm	55.33	58.00	26.77	27.33	18.33	17.10
	300 ppm	52.00	55.33	28.44	27.99	19.22	18.88
Malic acid	100 ppm	55.33	58.00	29.11	27.44	20.22	19.99
	200 ppm	50.66	53.33	30.21	29.55	21.44	20.21
	300 ppm	47.33	49.33	30.99	31.22	22.33	21.55
Tryptophan	100 ppm	60.66	63.33	24.44	23.33	16.10	14.88
	200 ppm	58.66	61.00	25.44	24.66	15.77	15.55
	300 ppm	58.33	60.00	26.44	26.33	17.77	17.55
L.S.D. at 0.05		0.98	1.32	1.33	0.83	1.82	1.46

Table (3-b): Means of flowering characteristics of *Polianthes tuberosa* plants as influenced by citric acid, malic acid and tryptophan in the two seasons of 2013 and 2014.

Treatments		Flower dry weight (g)		Spike dry weight (g)		Rachis length (cm)	
		2013	2014	2013	2014	2013	2014
Control	000 ppm	3.27	3.10	5.39	5.05	24.51	24.90
Citric acid	100 ppm	4.37	4.55	5.82	6.89	26.59	26.62
	200 ppm	4.94	4.79	6.27	5.73	26.98	26.80
	300 ppm	5.94	5.79	6.66	7.66	27.84	27.56
Malic acid	100 ppm	5.87	5.69	6.42	8.18	29.11	29.03
	200 ppm	6.20	5.94	7.01	8.92	29.85	29.89
	300 ppm	6.45	6.22	7.42	7.19	30.50	30.42
Tryptophan	100 ppm	3.37	3.21	5.51	4.80	24.58	25.08
	200 ppm	4.45	4.30	5.95	6.00	25.37	25.69
	300 ppm	4.77	4.62	6.08	6.34	25.76	25.91
L.S.D. at 0.05		0.40	0.09	0.33	0.56	0.60	0.56

acid up to 300 ppm gave the largest corm diameter 6.69 and 6.42 cm in the first and second seasons, respectively. Whereas, it was found that spraying with tap water (control) decreased the bulb diameter (5.38 and 5.12 cm) as compared with other treatments in the first and second seasons, respectively. The increase in the corm diameter due to spraying with malic acid at 300 ppm supports the results reported by Kumar *et al.* (2013) on *Tulipa gesneriana*.

3.3.3. Number of cormlets per plant

The data show that plants sprayed with malic acid at 300 ppm formed the highest number of cormlets per plant which gave 24.66 and 20.16 in the first and second seasons, respectively. Whereas, the control plants gave the lowest number of cormlets per plant 13.83 and 11.33 in the first and second season, respectively. The increase in the number of cormlets per plant due to spraying with malic acid at 300 ppm supports the results reported by Kumar *et al.* (2013) on *Tulipa gesneriana*.

3.4. Chemical constituents

3.4.1. Total chlorophyll content (SPAD unit)

The results obtained in Table (5) show that citric acid, malic acid and tryptophan treatments had clear effect on the total chlorophyll content. The highest mean values (37.88 and 38.56 SPAD) in the first and second seasons, respectively, were obtained from in plants sprayed with malic acid at 300 ppm as compared with (31.56 and 30.33 SPAD) for the control plants, in the first and second season, respectively. Similar results were reported by Darandeh and Hadavi (2012) on *Lilium* cv. Brunello and Kazemi *et al.* (2012) on carnation.

3.4.2. Total carbohydrate content (%)

The results in Table (5) also show that most of the tested citric acid, malic acid and tryptophan concentrations increased the mean

Table (4): Means of corm production of *Polianthes tuberosa* plants as influenced by citric acid, malic acid and tryptophan in the two seasons of 2013 and 2014.

Treatments		Corm dry weight (g)		Corm diameter (cm)		Number New Cormlets	
		2013	2014	2013	2014	2013	2014
Control	000 ppm	14.27	18.31	5.38	5.12	13.83	11.33
Citric acid	100 ppm	14.77	17.90	5.76	5.50	16.83	15.16
	200 ppm	16.69	20.59	5.85	5.66	17.66	16.33
	300 ppm	17.53	21.05	6.03	6.05	18.33	17.33
Malic acid	100 ppm	17.62	21.26	6.36	6.24	22.50	17.00
	200 ppm	16.38	20.07	6.58	6.34	23.66	18.33
	300 ppm	18.86	22.37	6.69	6.42	24.66	20.16
Tryptophan	100 ppm	19.92	22.83	5.56	5.26	14.83	12.50
	200 ppm	20.32	23.32	5.82	5.47	15.83	13.33
	300 ppm	17.91	21.94	5.82	5.58	16.66	14.33
L.S.D. at 0.05		0.72	0.15	0.21	0.22	0.55	1.04

Table (5): Means of chemical constituents of *Polianthes tuberosa* plants as influenced by citric acid, malic acid and tryptophan in the two seasons of 2013 and 2014.

Treatments		Total chlorophyll content (SPAD)		Total Carbohydrate content in corm (%)		Nitrogen Content in leaves (%)	
		2013	2014	2013	2014	2013	2014
Control	000 ppm	31.56	30.33	22.93	24.51	0.88	0.68
Citric acid	100 ppm	34.06	33.64	24.10	25.52	1.08	0.88
	200 ppm	33.80	34.82	24.47	26.13	1.21	1.01
	300 ppm	35.03	35.99	25.83	26.97	1.47	1.27
Malic acid	100 ppm	35.76	36.97	26.57	27.30	1.52	1.32
	200 ppm	36.52	37.80	26.91	27.84	1.77	1.57
	300 ppm	37.88	38.56	27.96	27.94	1.91	1.71
Tryptophan	100 ppm	32.59	31.68	23.33	23.28	0.96	0.76
	200 ppm	33.33	32.30	23.81	25.70	1.14	0.94
	300 ppm	33.76	33.16	24.11	25.82	1.21	1.01
L.S.D. at 0.05		0.71	0.74	0.63	0.45	0.004	0.004

total carbohydrates % in the corms of *Polianthes tuberosa* plants, compared to the control. It was found that the plants sprayed with 300 ppm malic acid contained the highest total carbohydrates % in the corms of 27.96 and 27.94 % in the first and second season, respectively.

3.4.3. Nitrogen percentage in the leaves

The results in Table (5) also show that the mean value of nitrogen in the leaves was slightly increased by spraying the plants with 300 ppm malic acid which gave nitrogen contents of 1.91 and 1.71 % as compared with 0.88 and 0.68 % for the control plants in the first and second seasons, respectively.

Conclusions

Our results reveal a positive effect of applied organic acids on the vegetative growth, flowering characteristics and corm production. This indicates that these organic acids could improve the ornamental value of tuberose as a cut flowers plant. The increase in our experiment could be considered relatively similar with the previous findings obtained from spraying malic and citric acid as reported by Eidyan *et al.* (2014) on tuberose, Darandeh and Hadavi (2012) on lilium, and Jafari and Hadavi (2012) on dill plant. However, our results show for the first time that both organic acids increased the lifespan of attached flowers to the plant. The taller plants in response to spraying of both organic acids are consistent with that earlier reported by Jafari and Hadavi (2012) on dill plant, where it was observed that both organic acids and their combination resulted in taller dill plants.

Citric acid and malic acid possibly affected carbohydrates content in corm under our study. Citric acid and malic acid as they affect the plants in relatively high concentrations, a distinct pattern of regulative effects could be noted. The fact that organic acids affect plants in higher concentrations. These are both environment-friendly and low cost agents.

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تأثير معاملات ما قبل الحصاد عن طريق الرش بحمض الستريك وحمض الماليك والتربتوفان على النمو والإزهار وحياة ما بعد الحصاد لنباتات التبروز
(أ) تأثير معاملات ما قبل الحصاد على النمو الخضرى والإزهار

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ملخص

تمت هذه الدراسة فى موسمى 2013 و 2014 فى مشتل قسم الزهور ونباتات الزينة بكلية الزراعة جامعة الإسكندرية وفيها تم زراعة كورمات التبروز الصنف المجوز بمتوسط قطر 3,8 سم ومتوسط وزن 70 جم. زرعت الكورمات فى أصص بلاستيكية بقطر 30 سم مملوءة 10 كجم تربة رملية. تمت الزراعة يوم 13 مايو فى كلا موسمى الدراسة.

رشت النباتات بثلاث مواد هى حمض الستريك وحمض الماليك والتربتوفان كل منها بثلاث تركيزات مختلفة هى (100 , 200 , 300 جزء فى المليون). كان بين الرشة والأخرى 15 يوم بداية من 4 يوليو إلى 15 أغسطس فى كلا الموسمين. بينما رشت نباتات المقارنة (الكنترول) بماء الصنبور. فى أول سبتمبر كانت نهاية التجربة فى كلا الموسمين.

أظهرت النتائج المتحصل عليها أن رش نباتات التبروز بحمض الماليك بتركيز 300 جزء فى المليون أعطت زيادة كبيرة فى أرتفاع النبات , عدد الأوراق , الوزن الجاف للأوراق , المساحة الورقية , وقت التزهير , عدد الأزهار على الشمراخ , مدة الأزهار , الوزن الجاف للأزهار , الوزن الجاف للشمراخ الزهرى , طول الجزء المزهر , قطر الكورمة , عدد الكوريمات الجديدة , محتوى الكلوروفيل والكربوهيدرات الكلية , نسبة النيتروجين فى الأوراق. بينما أظهرت النتائج أن رش النباتات بالتربتوفان بتركيز 200 جزء فى المليون أدى إلى زيادة فى الوزن الجاف للكورمات.

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