

## Influence of Diatomite, Putrescine and Alpha-Tocopherol on Some Vegetative Growth and Flowering of *Antirrhinum majus* L. Plants

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**Abstract:** Two pot experiments were conducted during the seasons of 2011/2012 and 2012/2013 to study the effect of diatomite (10, 20 and 30%), Putrescine (100, 200 and 300 ppm) and alpha-tocopherol (Vitamin E) (400, 800 and 1200 ppm) on growth and flowering of *Antirrhinum majus* L. plants. Data indicated that, most criteria of vegetative growth expressed as plant height (cm), number of branches/plant, number of leaves/plant, leaf area (cm<sup>2</sup>)/plant, fresh and dry weight of shoot (g), root length (cm), fresh and dry weight of root (g), flowering characters expressed as number of spikes/plant, spike length, number of flowers, fresh and dry weight of flowers/plant (g) were significantly increased by the application of diatomite, Putrescine and alpha-tocopherol as compared with control plants. Addition of diatomite at concentration of 30% gave the highest increment of vegetative growth and flowering characters than the other concentrations and untreated plants in the 1<sup>st</sup> and 2<sup>nd</sup> seasons at 75 days from transplanting. Foliar application of Putrescine at the concentration of 200 ppm gave the highest increment of vegetative growth and flowering characters at the period of 75 days from transplanting. Spraying with alpha-tocopherol at the concentration of 800 ppm gave the highest results in all characters such as vegetative growth and flowering characters after 75 days from transplanting.

**Key words:** *Antirrhinum majus* L. • Diatomite • Putrescine • Alpha-tocopherol • Growth • Flowering characters

### INTRODUCTION

*Antirrhinum majus* L. commonly known as Snapdragon to family Scrophulariaceae, native to the Mediterranean Region. Recently, 36 species and 20,000 cultivars of *Antirrhinum* have been renowned [1], “Snapdragon” hinged flowers open and close like the mouth of a dragon when pinched at the sides with thumb. These cultivars are classified on the basis of their growth and flowering response to day length and temperatures [2]. Snapdragons are usually planted as bedding annuals, often with petunias or pansies. For landscape dwarf snapdragon cultivars are excellent for border edges or raised beds and rock gardens. Use of the tall varieties are using as background or as the main feature in a mixed bed as well as cut flowers. The dwarf and trailing cultivated are great in containers. Growing flower crops compared with traditional crops provide more marketing at both small and large scale for growers and it becoming more selective choice nowadays. Globally, horticultural crops

are cultivated in more than 140 countries [3]. Diatomite has neutral pH and stable and will not contribute to change in pH [4, 5]. Putrescine concentration increases in plants in response to a number of stress factors including water stress, acid treatment, mineral deficiency and osmotic shock or CO<sub>2</sub> treatment [6]. Vitamin E is a powerful biological antioxidant; fertilizers and amendments also induced positive effects on ameliorate the bad effects of salinity stress, [7]. In the this respect, phyto regulator compounds (Vitamin E) suggested to elevate and tolerate the adverse effects of biotic and abiotic stresses such as moisture and salt stress on plant growth and yield [8,9]. However, El-Bassiouny *et al.* [10] stated that, the foliar spray with all treatments of antioxidants on bean plants induced increments on the number of branches, leaves and leaf area/plant, fresh and dry weights of shoots. On the other hand, Hussein and El-Greadly [11] found that all onion plant growth characters did not show any significant response to spraying Vitamin E. Nevertheless, significant responses

were detected on bulb diameter, fresh weight of bulb and dry matter of bulbs. However, Abd El-Hakim [12] and Al-Qubaie [13] emphasized the beneficial effects of antioxidants on growth characters, leaf chemical composition, yield and yield components of different horticultural crops.

The aim of this study was to investigate the effects of Daitomites, Putrescine and Alpha-tocopherol on growth and flowering of *Antirrhinum majus* plant.

## MATERIALS AND METHODS

Two pot experiments were carried out during two seasons of 2011/2012 and 2012/2013 at the nursery of Ornamental Horticultural Department, Faculty of Agriculture, Cairo University, Giza, Egypt and Laboratories of Egypt Green Farm, Giza, Egypt to study the effect of using of Diatomites before transplanting and foliar spraying with different levels of Putrescine and alpha-tocopherol application on vegetative growth and flowering of *Antirrhinum majus* L. plant. Seedlings of *Antirrhinum majus* L. dwarf bicolor were obtained uniformly 5 cm in length and carry 2 pairs of leaves from Egypt Green Farm, Giza, Egypt cultured individually in (25 cm diameter) clay pots in the open field on the 15<sup>th</sup> of November 2011 and 2012, filled with 4 kg growing media (clay and sand at ratio of 1:1 (v/v). After one week from transplanting in both seasons; all seedlings received equal dose (4g/pot) of NPK fertilizer (19:19:19) in the form of ammonium nitrate (33%N), calcium super phosphate (15.5%P<sub>2</sub>O<sub>5</sub>) and potassium sulphate (48%K<sub>2</sub>O), respectively and irrigated regularly with tap water. Diatomites were added at one week before transplanting at the concentrations of (10%, 20% and 30% ) (40, 80 and 120 g/kg) of Diatomites, its pH is neutral and it is composed mainly of SiO<sub>2</sub> (86-89%) in a soluble form beneficial to plants after three weeks from 1<sup>st</sup> fertilization on 15<sup>th</sup> December in both seasons, the plants were sprayed for three times after one month from transplanting at fortnight intervals i.e. (15<sup>th</sup>December, 1<sup>st</sup> January and 15<sup>th</sup> January) in both seasons. Till runoff point with two growth regulators with Putrescine (Put) at the concentrations of (100, 200 and 300 ppm); Alpha-tocopherol (Vitamin E) at the concentrations of (400, 800 and 1200 ppm), while the control plants were sprayed with distilled water giving nine treatments plus control were carried out. The experiment was arranged in completely randomized design, each treatment had three replicates and each replicate contained five plants. The recorded vegetative growth characteristics were plant height (cm),

number of branches/plant, number of leaves/plant, leaf area (cm<sup>2</sup>), fresh and dry weight of shoot (g), root length (cm) and fresh and dry weight of roots. The flowering characters were expressed as number of spikes/plant, spike length, number of flowers and fresh and dry weight of flowers/plant were measured.

**Statistical Analysis:** The data were subjected to statistical analysis of variance according to Snedecor and Cochran [14].

## RESULTS AND DISCUSSION

### Vegetative Growth

**Plant Height:** Data presented in Table 1 indicated that, application of Diatomite at 10, 20 and 30% increased plant height (cm) of *Antirrhinum majus* L. compared with control plants. The Diatomite concentration of 30% gave the highest significant value by 14.51 cm after 75 days as compared with untreated plants and other concentrations during the 1<sup>st</sup> season. The same trend was obtained in the 2<sup>nd</sup> season. These results are in agreement with those obtained by Kamenidou *et al.* [15] on Sunflower plants, Wagner *et al.* [16] on *Phalaenopsis* spp, Abdalla [17] on Faba bean (*Vicia faba*), Abdalla [18] on *Lupinus albus*, Ahmed *et al.* [19] on Sorghum, Angn *et al.* [20] on strawberry plants, Abou Basha *et al.* [21] on wheat plants, Ogbaji *et al.* [22] on Tomato (*Solanum lycopersicum* L.). Diatomite can be used in light textured soils to improve water retention capacity. Pore size of media is a critical physical property which affects water and nutrition absorption by root system [23]. The proper portion of macro pores to micro pores is necessary for drainage, water retention capacity and sufficient gas exchange [24]. Increasing Diatomites in mixture increased meso, micro and ultra-pores, which are important for plant water requirements, however, it also increased macro pores which are desired for optimum plant growth and root distribution [20].

Regarding the effect of foliar applications of Putrescine at the concentrations of 100, 200 and 300 ppm on *Antirrhinum majus* L. plant data showed highly significant increase in plant height, giving the highest values 12.70, 13.97 and 15.53cm compared with the untreated plants which recorded 6.67, 7.37 and 8.70 cm in the 1<sup>st</sup> season, respectively, the same trend was found at 75 day from transplanting in the 2<sup>nd</sup> season, giving the highest values as a result of using 200 ppm Putrescine in both seasons compared to control plants. These results are in accordance with those found by Youssef *et al.* [25]

Table 1: Effect of Diatomite, Putrescine and alpha-tocopherol on plant height of *Antirrhinum majus* L. during 2011/2012 and 2012/2013

	2011/2012			2012/2013		
	Days from transplanting					
Treatments	45	60	75	45	60	75
	Plant height (cm)					
Control	6.67	7.37	8.70	8.53	9.40	14.04
DM 10 %	7.02	8.01	9.30	9.67	10.54	15.83
DM 20 %	8.55	9.00	10.63	10.80	12.25	17.16
DM 30 %	12.00	12.97	14.51	14.25	16.45	24.53
Put 100 ppm	10.83	11.60	12.63	13.00	15.37	21.60
Put 200 ppm	12.70	13.97	15.53	15.50	17.37	25.30
Put 300 ppm	9.08	9.75	11.00	11.25	13.45	18.33
VE 400 ppm	9.58	10.25	11.66	12.10	14.33	20.50
VE 800 ppm	11.40	12.07	13.60	13.57	16.66	22.77
VE 1200 ppm	7.96	8.35	10.04	10.02	11.20	16.60
LSD 0.05	3.41	0.99	0.93	0.99	1.22	1.14

DM: Diatomite, Put: Putrescine, VE: alpha tocopherol

on *Metthiola incana*, Youssef [26] on *Populus* species, El-Sayed [27] on *Chrysanthemum indicum* plants, El-Lethy *et al.* [28] on flax plant, Razieh *et al.* [29] on African violet *Saintpaulia ionantha* plant and Farahi *et al.* [30] on Rose plants. Polyamines are recognized as a new class of plant growth bioregulators causing increases in shoot growth which might be due to enhancement of cell division activity. It was observed that, increasing Putrescine level led to higher cell division activity in plants.

Concerning the effect of foliar spray with alpha-tocopherol (Vitamin E) at different concentrations 400,800 and 1200 ppm, on *Antirrhinum majus* L. plant, data showed highest significant increase in plant height (cm), was found at 45, 60 and 75 days from transplanting, respectively; when plants treated with 800 ppm alpha-tocopherol giving 11.40, 12.07 and 13.60, respectively over control plants and other treatments in the 1<sup>st</sup> season. Similar trend was found in the 2<sup>nd</sup> season. These results are in agreement with those obtained by El-Bassiouny *et al.* [10] on faba bean, El-Tohamy and El-Greadly [31] on snap bean, they attributed these effects to the fact that tocopherol is low molecular weight lipophilic antioxidant, which protects membranes from oxidative damage. The increment in plant height may be due to the enhancement of cell division and or cell enlargement, Arrigoni *et al.* [32] and or the influence of DNA replication [33].

**Number of Branches/Plant:** Data presented in Table 2 indicated that using Diatomites on *Antirrhinum majus* L.

plant at different concentrations increased number of branches/plant compared to control plants in both seasons. The highest significant increase was found when plant treated with 30% Diatomate giving 55.67 and 60.33 branches compared with untreated plants which giving 27.75 and 30.76 branches in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. The best results were obtained when plants treated with 30% diatomite at the period of 75 days from transplanting. These results are in line with those obtained by Abdalla [18] and Abd El-Hady and El-Dardiry [24], on *lupines albus* L. plant, Angn *et al.* [20] on strawberry plants, Gerami *et al.* [34] on rice plants, Gholami and Falah [35] on rice plants, they found that Diatomites affect as amendment to improve water holding capacity of light textured soils and pore size distribution of media. In case of spraying Putrescine on plants, data revealed that, all concentrations recorded significantly increased the number of branches/plant compared to untreated plants. The highest values were obtained when the plants were treated with 200 ppm Putrescine, giving 16.33, 26.15 and 68.00 in the 1<sup>st</sup> season compared to control plants which giving 8.33, 11.77 and 27.75/branches at 45, 60 and 75 days from transplanting, respectively. The highest values were found when plants were treated with 200 ppm Putrescine at 75 days from transplanting giving 46.76 and 50.33 branches in the 1<sup>st</sup> season and 2<sup>nd</sup> seasons, respectively. These results are in accordance with those obtained by El-Quesni *et al.* [36] on *Bougainvillea glabra*, El-Tohamy *et al.* [37] on *Solanum melongena*, El-Sayed [27] on *Chrysanthemum indicum*, El-Quesni *et al.* [38] on *Syngonium podophyllum* and Mahgoub *et al.* [39] on *Dahlia pinnata*. Polyamines have been implicated in a wide range of biological processes including growth development, cell division, differentiation and development [40].

Regarding the effect of spraying with alpha-tocopherol (Vitamin E) at different concentrations 400,800 and 1200 ppm on the number of branches /plant of *Antirrhinum majus* L., data revealed that, all the concentrations increased this character compared to control plants. Using alpha-tocopherol (Vitamin E) at the concentration of 800 ppm at 75 days from transplanting gave the highest significant increase values 53.33 and 57.67 in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively compared with untreated plants. These results are in agreement with those reported by Hussein *et al.* [7] on cowpea plants, Soltani *et al.* [41] on *Calendula officinalis* L. plants, Shafeek *et al.* [42] on *Lactuca sativa* L. cv Nevada. They found that, all concentrations of alpha-tocopherol increased number of branches/plant.

Table 2: Effect of Diatomite, Putrescine and alpha-tocopherol on Number of branches/plant of *Antirrhinum majus* L. during 2011/2012 and 2012/2013

Treatments	2011/2012			2012/2013		
	Days from transplanting					
	45	60	75	45	60	75
Number of branches						
Control	8.33	11.77	27.75	9.33	13.55	33.76
DM 10 %	9.00	13.25	33.10	10.87	15.00	38.33
DM 20 %	10.53	15.10	44.67	12.30	17.50	47.08
DM 30 %	15.00	24.75	55.67	18.00	28.33	60.33
Put 100 ppm	13.25	18.67	50.00	15.10	20.15	56.33
Put 200 ppm	16.33	26.15	68.00	19.75	30.67	72.00
Put 300 ppm	11.40	16.33	46.76	13.07	18.00	50.33
VE 400 ppm	12.33	17.50	48.93	14.10	19.33	53.00
VE 800 ppm	14.07	21.33	53.33	16.67	23.67	57.67
VE 1200 ppm	9.80	14.00	40.97	11.27	16.33	45.30
LSD 0.05	1.53	2.02	5.06	1.77	4.33	4.78

DM: Diatomite, Put: Putrescine, VE: alpha tocopherol

Table 3: Effect of Diatomite, Putrescine and alpha-tocopherol on Number of leaves/plant of *Antirrhinum majus* L., during 2011/2012 and 2012/2013

Treatments	2011/2012			2012/2013		
	Days from transplanting					
	45	60	75	45	60	75
Number of leaves						
Control	71.77	105.00	180.00	96.67	123.33	190.00
DM 10 %	113.33	123.33	200.33	123.33	147.33	220.00
DM 20 %	140.33	162.00	230.00	142.33	170.67	244.33
DM 30 %	200.00	230.00	300.00	212.33	268.00	340.00
Put 100 ppm	164.00	200.00	271.00	170.00	236.67	284.67
Put 200 ppm	207.00	264.00	363.00	226.70	286.67	381.00
Put 300 ppm	145.67	175.33	246.33	150.00	196.00	255.33
VE 400 ppm	156.67	190.33	260.33	163.33	215.00	274.67
VE 800 ppm	170.00	220.00	291.67	177.33	250.00	310.00
VE 1200 ppm	135.00	144.00	210.00	136.67	156.00	235.67
LSD 0.05	10.21	16.88	15.87	18.72	8.87	19.53

DM: Diatomite, Put: Putrescine, VE: alpha tocopherol

**Number of Leaves /Plant:** Data presented in Table 3 indicated that application of different Diatomite concentrations on *Antirrhinum majus* L. plant significantly increased the number of leaves in comparison to control plants. The application with Diatomite at all concentration gave 200.00, 230.00 and 300.00 /leaf in the 1<sup>st</sup> season at 45, 60 and 75 day from transplanting, respectively, compared to control plants 71.77, 105.00 and 180.00 leaf/plant in the 1<sup>st</sup> season. Similar trend was found in the 2<sup>nd</sup> season. The highest significant values were obtained when plants treated with 30%

Diatomite at 75 days from transplanting giving 300 and 340 leaf/plant in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in agreement with those obtained by Abdalla [18] on *Lupinus albus* L. plant, Gerami *et al.* [34] on rice plants, Gholami and Falah [35] on wheat plants, Angn *et al.* [20] on strawberry plants, they reported that diatomite affected as amendment to improve water holding capacity of light textured soils [24] and as pore size distribution of media [20].

Regarding the effect of Putrescine treatments data revealed that, all concentrations highly significant increased number of leaves/plant in both seasons compared with control plants. The highest values (363 and 381 leaf/plant) were obtained with application of 200 ppm Putrescin at 75 days from transplanting compared with control plants giving an increment 101.67 and 100.53% in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in accordance with those found by El-Quesni *et al.* [36] on *Bougainvillea glabra*, El-Tohamy *et al.* [37] on *Solanum melongena*, El-Sayed [27] on *Chrysanthemum indicum*, El-Quesni *et al.* [38] on *Syngonium podophyllum* and Mahgoub *et al.* [39] on *Dahlia pinnata*. Polyamines have been implicated in a wide range of biological processes including growth development, cell division and differentiation [40]. Spraying the plants with alpha-tocopherol (Vitamin E) at the concentrations of 400,800 and 1200 ppm significantly increased number of leaves compared with control plants, meanwhile alpha-tocopherol (Vitamin E) at the concentration of 800 ppm at 75 day from transplanting gave the highest significant values 291.67 and 310.00 leaf/plant compared with the untreated plants giving 180,190 leaf in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in agreement with those obtained by Hussein *et al.* [7] on cowpea plants, Soltani *et al.* [41] on *Calendula officinalis* L. plants, Shafeek *et al.* [42] on *Lactuca sativa* L.cv Nevoda. They found that using all concentrations of alpha-tocopherol increased number of leaves /plant.

**Leaf Area (cm<sup>2</sup>)/Plant:** Data in Table 4 cleared that, application of Diatomite on *Antirrhinum majus* L. plant at different concentrations increased leaf area (cm<sup>2</sup>) compared with untreated plants in both seasons. The highest values (4.50, 4.73 and 5.00 cm<sup>2</sup>/plant) were obtained at 30% concentration compared with untreated plants 2.45, 2.65 and 2.85 leaf area cm<sup>2</sup> in the 1<sup>st</sup> season at 45, 60 and 75 days, respectively. Similar trend was recorded in the 2<sup>nd</sup> season. The highest values were obtained at 75 days from transplanting showed increment

Table 4: Effect of Diatomite, Putrescine and alpha-tocopherol on Leaf area (cm<sup>2</sup>) of *Antirrhinum majus* L. during 2011/2012 and 2012/2013

	2011/2012			2012/2013		
	Days from transplanting					
Treatments	45	60	75	45	60	75
	Leaf area(cm <sup>2</sup> )					
Control	2.45	2.65	2.85	3.05	3.20	3.40
DM 10 %	2.50	2.72	3.00	3.34	3.50	3.68
DM 20 %	3.07	3.15	3.50	3.70	3.85	4.10
DM 30 %	4.50	4.73	5.00	4.70	4.90	5.25
Put 100 ppm	3.75	4.00	4.50	4.30	4.53	4.75
Put 200 ppm	4.70	4.90	5.26	4.97	5.25	5.50
Put 300 ppm	3.28	3.50	3.75	3.89	4.00	4.23
VE 400 ppm	3.45	3.70	4.10	4.08	4.22	4.49
VE 800 ppm	4.10	4.35	4.78	4.50	4.75	5.00
VE 1200 ppm	2.80	2.90	3.25	3.52	3.70	3.85
LSD 0.05	0.21	0.42	0.41	0.36	0.45	0.55

DM: Diatomite, Put: Putrescine, VE: alpha tocopherol

values of 75.44 and 54.41% in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in harmony with those obtained by Gang and Jiashu [43] on melon, Abdalla [17] on Faba bean (*Vicia faba*) plants, [19] on Sorghum plants; they concluded that Diatomites at different concentrations increased leaf area/plant. Concerning the effect of Putrescine the date, revealed that, all used concentrations significantly increased leaf area in comparison to control plants, the highest values were obtained when the plants treated with 200 ppm, 100 ppm and 300 ppm. After 75 days from transplanting the value were 5.26, 4.50 and 3.75 cm<sup>2</sup> in the 1<sup>st</sup> season compared with untreated plants giving 2.85, similar was found in the 2<sup>nd</sup> season. These results are in line with those reported by El-Quesni *et al.* [36] on *Bougainvillea glabra*, El-Tohamy *et al.* [37] on *Solanum melongena*, El-Sayed [27] on *Chrysanthemum indicum*, El-Quesni *et al.* [38] on *Syngonium podophyllum* and Mahgoub *et al.* [39] on *Dahlia pinnata*. Polyamines exhibit their effect on growth through enhancing cell division and expansion in cells [44] and they can also act as source of nitrogen which stimulates growth [45]. Spraying the plants with alpha-tocopherol at the rate of 400,800 and 1200 ppm increased leaf area (cm<sup>2</sup>) in comparison with the untreated plants. Using alpha-tocopherol at the concentration of 800 ppm resulted in the highest increment of 14.04 and 13.24% value at 75 days from transplanting in both seasons, respectively. Ismail *et al.* [46] on black cumin and Abdalla [47] on *Bougainvillea* cutting. Zhang and Schmidt [48] found a positive correlation between

antioxidants and growth in Kentucky blue grass. The increment in growth may be due to the enhancement of cell division and cell enlargement [32].

**Root Length (cm)/Plant:** Data in Table 5 showed that, addition of Diatomite at the different concentrations significantly increased the length of roots /plant in both seasons. Meanwhile, treating the plants with 30% Diatomite resulted in the highest significant values (37.65 and 39.50cm) of root length in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, the increment estimated by 50.60 and 49.34%, respectively. These results are in accordance with those obtained by Ogbaji *et al.* [22] on three cultivars of tomato, Abdalla [18] on *Lupines albus* L., Wagner *et al.* [16] on hybrid *Phalaenopsis* orchid (*Phalaenopsis* spp.), Mohaghegh *et al.* [49] on cucumber plant. Many studies pointed out that one of the important roles of silica may be related to its function of maintaining more erect leaves [50].

Regarding the effect of Putrescine treatments, the data showed that, plants treated with all concentrations of Putrescine significantly increased the length of roots/plant compared with the untreated plants. The highest significant values (38.15 and 40.04cm) of root length were obtained with plants treated with 200 ppm Putrescine, while the lowest (25.0 and 26.45cm) were obtained by the untreated plants in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively (Table 5). These results are similar to those obtained by Youssef [26] on *Populus* species, Abd El-Aziz *et al.* [51] on gladiolus plants found that spraying Putrescine increased length of roots/plant. Foliar spraying with alpha-tocopherol at different concentrations significantly increased the length of roots /plant in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, i.e. spraying plants with 800 ppm alpha-tocopherol gave the highest significant values (36.45 and 37.90cm) in roots length /plant in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in agreement with those obtained by El-Bassiouny *et al.* [10] on Faba bean, Hussein and El-Greadly [11] on Onion. They found that treating plants with alpha-tocopherol significantly increased length of roots/plant.

**Fresh and Dry Weight of Roots/Plant:** Data in Table 5 showed that, application of Diatomite at different concentrations significantly increased the fresh and dry weight of roots /plant in the 1<sup>st</sup> and 2<sup>nd</sup> seasons. The highest values (12. 65 and 13.15 g) in fresh weight of roots/plant and dry weight (4.56 and 4.79 g) of roots/plant were obtained from plants treated with 30% Diatomite in the 1<sup>st</sup> and 2<sup>nd</sup> season, respectively. These results are in a

Table 5: Effect of Diatomite, Putrescine and alpha-tocopherol on root length and fresh weight of root of *Antirrhinum majus* L. during 2011/2012 and 2012/2013

Treatments	Root length (cm)		Fresh weight of root (g)		Dry weight of root (g)	
	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season
Control	25.00	26.45	6.08	7.10	2.48	2.59
DM 10 %	27.35	28.55	7.44	8.35	2.95	3.27
DM 20 %	30.75	32.45	8.57	9.75	3.22	3.66
DM 30 %	37.65	39.50	12.65	13.15	4.56	4.79
Put 100 ppm	35.04	36.40	11.25	11.85	4.45	4.69
Put 200 ppm	38.15	40.04	13.00	13.75	4.69	4.90
Put 300 ppm	32.00	33.65	10.20	10.65	4.08	4.26
VE 400 ppm	33.09	35.23	10.75	11.25	4.16	4.35
VE 800 ppm	36.45	37.90	11.75	12.35	4.37	4.59
VE 1200 ppm	28.50	30.15	8.00	9.05	3.05	3.45
LSD 0.05	2.64	2.97	1.26	1.30	0.43	0.45

DM: Diatomite, Put: Putrescine, VE: alpha tocopherol

harmony with those obtained by Kaya *et al.* [52] on maize plant, Mohaghegh *et al.* [49] on cucumber plant, Wagner *et al.* [16] on hybrid *Phalaenopsis* orchid (*Phalaenopsis* spp.), they concluded that all concentrations of Diatomites increased significantly fresh and dry weight values of roots/plant.

Concerning the effect of Putrescine, data in Table 5 indicated that, plants treated with all concentrations of Putrescine significantly increased fresh and dry weight of roots /plant compared with control plants giving the highest values (13.0 and 13.75 g) fresh weight and (4.69 and 4.90g) dry weight at 200 ppm Putrescine in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in agreement with those obtained by Abd El-Wahed and Gamal El-Din [53] on Chamomile plants, El-Lethy *et al.* [28], on Flax plant, Ayad *et al.* [54] on *Pelargonium graveolens*. They found that all concentrations of Putrescine increased fresh and dry weight of roots/plant. The data revealed that, using different concentrations of alpha-tocopherol significantly increased fresh and dry weight of roots /plant in the 1<sup>st</sup> and 2<sup>nd</sup> seasons giving the highest significant values (11.75 and 12.35g) in fresh weight with increment values of 93.25 and 73.94 % and dry weight (4.37 and 4.59 g) having increment values of 76.21 and 77.22% from treating the plants with 800 ppm in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in accordance with those obtained by Hussein *et al.* [7] on cowpea plants, El-Lethy *et al.* [28] on flax plant, Abdallah *et al.* [55] on sunflower plants (Giza 102). They found that spraying the plants with alpha-tocopherol increased fresh and dry weight of roots/plant.

**Fresh and Dry Weight of Shoots/Plant:** Data presented in Table 6 indicated that, treating plants with Diatomite at

different concentrations significantly increased fresh and dry weight of shoots /plant in the 1<sup>st</sup> and 2<sup>nd</sup> seasons. Using Diatomite at 30% gave the highest significant values (36.33 and 41.58 g) in fresh weight of shoot/plant and (10.90 and 12.47g) dry weight of shoots/plant in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in agreement with those obtained by Vendrame *et al.* [56] on *Phalaenopsis* orchid liners, Abdalla [17] on Faba bean (*Vicia faba*), Ahmed *et al.* [19] on Sorghum plants, Basha *et al.* [21] on wheat plant, Tahir *et al.* [57] on sunflower hybrid Hysun-33. They reported that different concentrations of diatomite increased fresh and dry weight of shoots/plant.

Regarding the effect of Putrescine, data in Table 6 showed that, sprayed plants with all concentrations of Putrescine significantly increased fresh and dry weights of shoots/plant compared to untreated plants. Application of 200 ppm Putrescine resulted in the highest significant values (38.67 and 42.27g) of fresh weight of shoots/plant and dry weight (11.75 and 12.85g) of shoots/plant in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are similar to those obtained by Youssef *et al.* [25] on *Matthiola incana* L. plants, Talaat *et al.* [58] on *Catharanthus roseus* L. plants, Mahgoub *et al.* [59] on *Dianthus caryophyllus* L. plants, El-Sayed [27] on *Chrysanthemum indicum* L. plants, El-Quesni *et al.* [38] on *Syngonium podophyllum* L. plants and Mahgoub *et al.* [39] on *Dahlia pinnata* L. plants. It is well known that polyamines exhibit their effect on growth through enhancing cell division and expansion [44] and they can also act as source of nitrogen, which stimulates growth [45]. Spraying plants with alpha-tocopherol, at all used concentrations significantly increased fresh and dry weight of shoots /plant compared to the control plants.

Table 6: Effect of Diatomite ,Putrescine and alpha-tocopherol on Dry weight of roots , Fresh weight of shoots and Dry weight of shoot of *Antirrhinum majus* L., during 2011/2012 and 2012/2013

Treatments	Fresh weight of shoot (g)		Dry weight of shoot (g)	
	1 <sup>st</sup> season	2 <sup>nd</sup> season	1 <sup>st</sup> season	2 <sup>nd</sup> season
Control	23.50	24.29	6.22	6.43
DM 10 %	29.76	30.00	8.00	8.07
DM 20 %	30.58	32.96	8.48	9.16
DM 30 %	36.33	41.58	10.90	12.47
Put 100 ppm	33.67	38.55	9.79	11.21
Put 200 ppm	38.67	42.27	11.75	12.85
Put 300 ppm	31.11	35.00	8.77	9.87
VE 400 ppm	32.33	36.33	9.27	10.42
VE 800 ppm	34.88	39.50	10.32	11.69
VE 1200 ppm	30.00	30.66	8.22	8.40
LSD 0.05	1.31	1.54	0.19	0.94

DM: Diatomite, Put: Putrescine, VE: alpha tocopherol

Treating plants with 800 ppm alpha- tocopherol caused highest significant values (34.88 and 39.50g) in fresh weight and dry weight (10.32 and 11.69g) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in accordance with those obtained by El-Tohamy et al.[31] on snap bean, Al-Qubaie [13] on sunflower cv. Giza 102. They found that treating plants with all concentrations of alpha-tocopherol increased fresh and dry weight of shoots/plant.

### Flowering Characters

**Spike Length:** Data in Fig. 1 illustrated that, treating of *Antirrhinum majus* L. plant with Diatomite at the concentrations of 10, 20 and 30% significantly increased the spike length/flower in both seasons, giving the highest significant values (7.95 and 12.30 cm) for the plants treated with 30% compared with untreated plants (5.65 and 7.0 cm) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. Foliar spray of Putrescine at different concentrations i.e. 100,200 and 300ppm significantly increased the spike length/flower in both seasons compared with the control plants (Fig. 1). The highest values (8.43 and 13.60 cm) were recorded for the plants treated with 200 ppm Putrescine compared with the untreated plants (5.65 and 7.0cm) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These findings are in accordance with those obtained by Taha and Eid [60] on tuberose *Polianthes tuberosa* L. plant. Farahi et al. [30] on Rose plants cv. Dolcvita. This might be explained that, the conjugated polyamines are known to be associated with the physiology of flowering [61].

In this regard to the effect of alpha-tocopherol the data indicated that, foliar application of alpha-tocopherol at the concentrations of 400,800 and 1200 ppm significantly increased the spike length/inflorescences than the untreated plants in both seasons (Fig. 1). Application of alpha-tocopherol at the concentrations of 800 ppm gave the highest values (7.70 and 11.65cm) compared with the control plants (5.65 and 7.0cm) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in agreement with those obtained by Eid et al. [62] on *Jasminum grandiflorum* L. plant, Al-Qubaie [13] on sunflower plants cv. Giza 102. Tocopherols act in relation to their antioxidant properties as being prominent in protection of polytocopherol, which is considered as a group of compounds synthesized only by photosynthetic organisms plants treated with alpha-tocopherol and this protects chloroplast membrane from photooxidation and help to provide an optimal environment for photosynthetic machinery [63].

**Number of Spikes/Plant:** The results in Fig. 2 showed that, application of diatomite at different concentrations significantly increased the number of spikes/plant in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, treated plants with 30% Diatomite gave the greatest number of spike/plant (15.89 and 16.00) compared with the untreated plants (6.42 and 7.50) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively, These results are in harmony with Savvas et al. [64]) on Gerbera plants, Kamenidou et al. [15] on *Helianthus annuus* 'Ring of Fire'. They found that treating plants with diatomite increased number of spikes/plant.

Regarding the effect of foliar spray of Putrescine at different concentrations of 100,200 and 300 ppm showed significantly increased in number of spikes/plant compared with the untreated plants (Fig. 2). The highest values (17.77 and 19.00) were obtained for plants treated with Putrescine at 200 ppm compared with the untreated plants (6.42 and 7.50) in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are similar to those obtained by Youssef et al. [25] on *Matthiola incana* L. plants, Talaat et al. [58] on *Catharanthus roseus* L. plants, Mahgoub et al. [59] on *Dianthus caryophyllus* L. plants, El-Sayed [27] on *Chrysanthemum indicum* L. plants, El-Quesni et al. [38] on *Syngonium podophyllum* L. plants and Mahgoub et al. [39] on *Dahlia pinnata* L. plants. They reported that, Putrescine at different concentrations increased length of spike/flower, which may be due to that Putrescine enhances the accumulation of the producer of the plant tissues i.e. flowers [61].

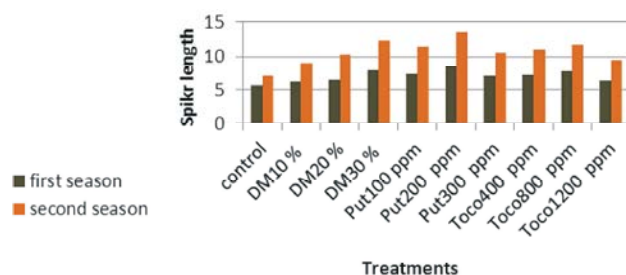


Fig. 1: Effect of Diatomite, Putrescine and Alpha-tocopherol (vitamin E) on spike length of *Antirrhinum majus* L. plant during 2011/2012 and 2012/2013 seasons

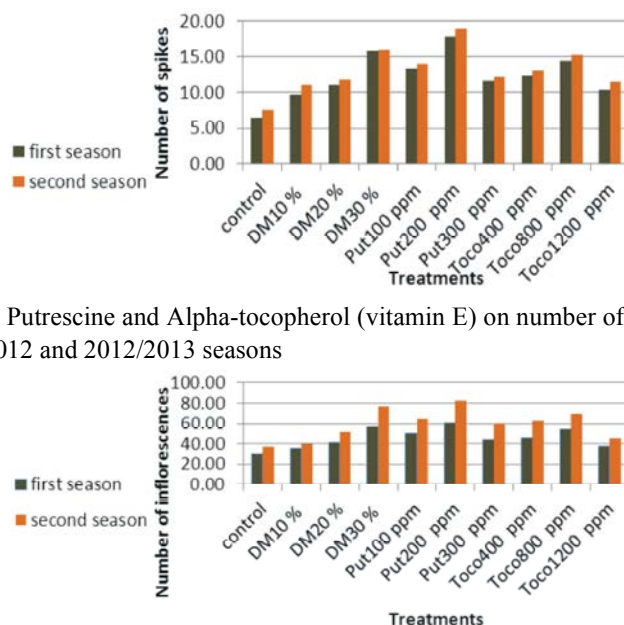


Fig. 2: Effect of Diatomite, Putrescine and Alpha-tocopherol (vitamin E) on number of spikes of *Antirrhinum majus* L. plant during 2011/2012 and 2012/2013 seasons

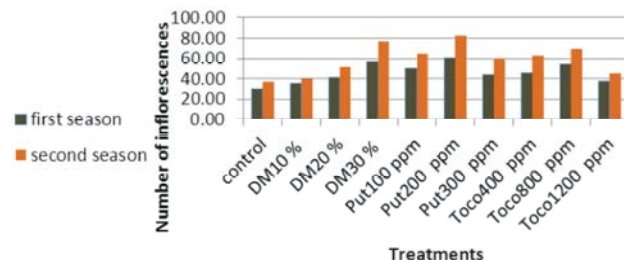


Fig. 3: Effect of Diatomite, Putrescine and Alpha-tocopherol (vitamin E) on number of inflorescences of *Antirrhinum majus* L. plant during 2011/2012 and 2012/2013 seasons

Concerning of the effect of foliar application of alpha-tocopherol (Vitamin E) on number of spikes/plant at different concentrations 400,800 and 1200 ppm on *Antirrhinum majus* L., data in Fig. 2 revealed that, all concentrations significantly increased this character as compared to control plants. Alpha-tocopherol (Vitamin E) at the concentration of 800 ppm gave the highest values 14.50 and 15.30 as compared to untreated plants in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in agreement with those found by Eid *et al.* [62] on *Jasminum grandiflorum* L. plant, Al-Qubaie [13] on sunflower plants cv. Giza 102. They reported that, all concentrations of Alpha-tocopherol increased the number of spikes/plant.

**Number of Inflorescences/Plant:** The results in Fig. 3 showed that, addition of Diatomite at the different concentrations significantly increased number of

inflorescences/plant in the 1<sup>st</sup> and 2<sup>nd</sup> seasons. Meanwhile, treating the plants with 30% Diatomite gave the highest values (57 and 77) of number of inflorescences /plant in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in accordance with those obtained by Ogbaji *et al.* [22] on three cultivars of tomato, Abdalla [18] on *Lupinus albus* L., Wagner *et al.* [16] on hybrid *Phalaenopsis* orchid (*Phalaenopsis* spp.), Mohaghegh *et al.* [49] on cucumber plant. Many workers pointed out that one of the important roles of silica may be related to its function of maintaining more erect leaves [50].

Data in Fig. 3 showed that, plants treated with all concentrations of Putrescine significantly increased number of inflorescences/plant as compared with untreated plants. The highest values (61 and 82) of number of inflorescences /plant compared with the untreated plants (30 and 33) were obtained from plants treated with 200 ppm Putrescine in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively



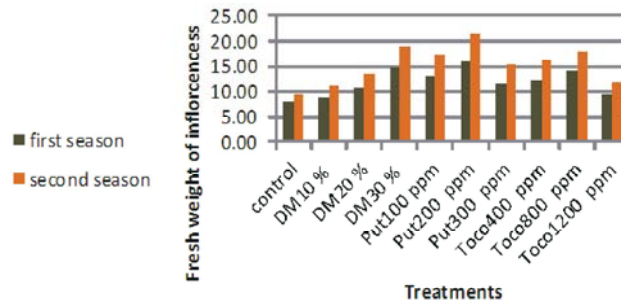


Fig. 4: Effect of Diatomite, Putrescine and Alpha-tocopherol (vitamin E) on fresh weight of inflorescences of *Antirrhinum majus* L. plant during 2011/2012 and 2012/2013 seasons

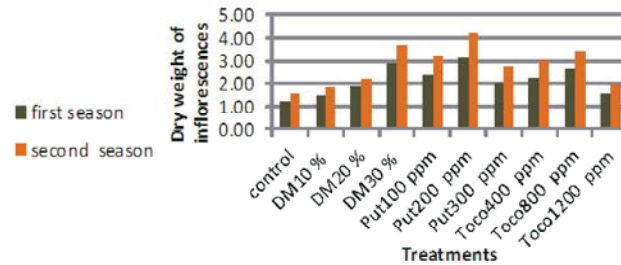


Fig. 5: Effect of Diatomite, Putrescine and Alpha-tocopherol (vitamin E) on dry weight of inflorescences of *Antirrhinum majus* L. plant during 2011/2012 and 2012/2013 seasons

These results are similar to those obtained by Youssef [26] on *Populus species*, El-Lethy *et al.* [28] on flax (*Linum usitatissimum*) plants. Fig. 3 also illustrated that foliar spray of alpha-tocopherol at different concentrations significantly increased number of inflorescences /plant in the 1<sup>st</sup> and 2<sup>nd</sup> season, giving the highest values (54 and 69) of number of inflorescences /plant as a result of using alpha tocopherol at 800 ppm in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in agreement with El-Bassiouny *et al.* [10] on Faba bean, El-Tohamy *et al.* [31] on snap bean. They reported that treating with alpha-tocopherol increased in number of inflorescences /plant.

**Fresh and Dry Weight of Inflorescences /Plant:** Fig. 4 and 5 illustrated that treating *Antirrhinum majus* L. plant with Diatomite at the concentrations of 10, 20 and 30% significantly increased fresh and dry weight of inflorescences/plant compared with control plants. The best results (14.82 and 19.06 g) were found when plants treated with 30% Diatomite for fresh weights and (2.90 and 3.72g) for dry weight in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively compared with the untreated plants (7.80 and 9.62g) for fresh weight and (1.26 and 1.54g) for dry weight in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in harmony with those obtained by Gong *et al.* [43] on melon, Tahir *et al.* [57] on sunflower hybrid plants.

Spraying the plants with Putrescine at the concentration of 100,200 and 300 ppm resulted in, significant increase in the fresh and dry weight compared with control plants (Fig. 4 and 5). The highest values (15.86 and 21.22g) were recorded for the plants treated with 200 ppm Putrescine for fresh weight and (3.17 and 4.28g) for dry weight compared with the untreated plants (7.80 and 9.62g) for fresh weight and (1.26 and 1.54g) for dry weight inflorescences /plant in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in agreement with Abd El-Aziz *et al.* [51] on gladiolus plants, El-Sayed [27] on *Chrysanthemum indicum*. They found that all concentrations of Putrescine increased fresh and dry weight of inflorescences.

Regarding of spraying alpha-tocopherol at the concentrations of 400,800 and 1200 ppm a significant increase was obtained compared with the control plants (Fig. 4 and 5). Spraying the plants with 800 ppm alpha-tocopherol, gave 14.04 and 18.03 g fresh weight for inflorescences /plant and 2.68 and 3.44 g for dry weight of inflorescences /plant in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. These results are in harmony with those obtained by, Al- Qubaie [13] on sunflower plants cv. Giza 102. Who, concluded that using alpha-tocopherol increased fresh and dry weight of inflorescences.

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