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Effect of Putrescine and Uniconazole on Some Flowering Characteristics, and Some Chemical Constituents of *Salvia Splendens* F. Plant

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Abstract: The objective of this study was to evaluate the effect of using putrescine at the levels of 50, 100 and 150 ppm, uniconazole at the levels of 10, 15 and 20 ppm and their interaction in addition to the control (distilled water) on flowering and chemical composition of *Salvia splendens* F. plant during 2006-2007 and 2007-2008.

Foliar application of putrescine significantly increased spikes part length, fresh and dry weight of spikes, photosynthetic pigments, anthocyanin, total carbohydrates and mineral content. The best results, in most of these characters, were found when plants treated with 150 ppm putrescine.

On the other hand, uniconazole treatments decreased spikes part length as compared with control plant, while other characters were increased by the treatments. The best results were found when plants treated with 10 ppm chlorophyll a, chlorophyll b, anthocyanin content and magnesium content, the best results were found with 20 ppm, while 15 ppm uniconazole gave the best results in total carotenoids.

For the interaction between the two bioregulators, it's found that the combination between putrescine at 150 ppm and uniconazole at 10 ppm gave the best results in the most of taken characters.

Key words: *Salvia splendens* F., Putrescine, Uniconazole, Spikes, Photosynthetic pigments, Anthocyanin, Carbohydrates, Minerals.

1. Introduction

Salvia plants are considered as the most important flowering herbaceous plants. They are famous for their beautiful spikes which have various colors as red, purple, pink, salmon, or bicolor flowers, as well as some species of this genus are planting for extracting volatile oils and some medical components. For that, this genus is called "Salvia", which is designate from the Latin name "Salvare" which means "to be saved". This genus belongs to family "Lamiaceae" which is known by its aromatic and medicinal plants.[1]

Salvia splendens F. is a popular bedding plant used primarily to add a splash of brilliant color. Despite an official common name of "scarlet sage", many people refer the plant simply as "red salvia". Its native home is Brazil. It is a perennial plant. Its height can be up to 100 cm. It has simple leaves. The leaves have an ovate

shape with serrate margin. The flowers shape is spiral limited inflorescence which is called spike. The spikes have whorls of two lipped flowers which are carried on racemes. It is known for its fiery red spikes and it has mat medium to dark green leaves. The bright red color with dark green leaves is especially striking. The newer color varieties include shades of cream, peach and purple [1]. In Egypt it can be planted by sowing seeds from August to the beginning of October, it blooms in the winter until spring and it can carry its spikes to the next summer.

Polyamines are beneficial subgroup of amines. Polyamines are unbranched aliphatic di-, tri-, and tetra-amines, e.g. putrescine, spermidine, spermine, respectively. The main polyamine in vegetables and fruits is either putrescine or spermidine. Polyamines possess diverse biological functions and are formed during metabolic processes in living organisms. Polyamines in plants are involved in many steps of protein synthesis, embryogenesis, transcription of genes, cell division, organ development, fruit ripening, leaf senescence, tuber dormancy and stress minimization of plant organs. Moreover, there is a strong association between polyamine metabolism in plants and environmental stress, e.g. nutrient deficiency, drought, soil salinity or temperature stress. 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_2 treatment, [2]

Uniconazole is one of triazole plant growth regulators having important role in crop production, toward to manipulation of plant growth and yield and induce a variety of morphological and biochemical responses in plants, [3]

All triazoles compounds, its derivatives act as antigibberellins i.e. interfere with the biosynthesis of endogenous gibberellins by preventing the oxidation of entkaureon to entkaureonic acid, [4]. These compounds also reduced the endogenous content of auxins (IAA) by its effect on increasing the activity of oxidases and peroxidases of auxines as IAA enzymes, but led to increase of endogenous content of abscisic acid (ABA) in treated plant, [5].

The aim of this study is to investigate the effect of both putrescine and uniconazole on growth, flowering and chemical components of *Salvia splendens* F. plant in pots to present this plant as winter flowering pot plant.

2. Materials and Methods

The experiment trial was consummated throughout two successive seasons (2006/2007 and 2007/2008) at the nursery of Ornamental Horticultural Department, Faculty of Agriculture, Cairo University, Giza, Egypt and laboratories of National Research Centre, Dokki, Cairo, Egypt. The aim of this work was to study the effect of foliar spraying with different levels of putrescine and uniconazole and their interaction on vegetative growth, flowering and chemical constituents of *Salvia splendens* F. plant.

Salvia splendens F. seeds were obtained from the Department of Horticulture Plants, Ministry of Agriculture, Giza, Egypt.

The seeds were cultured in plastic trays on the 1st of August 2006 and 2007. Seedlings (10 cm in length with 2 pairs of leaves) were individually transplanted on the 1st of September in both seasons in a plastic pot (30 cm diameter) filled with 3 Kg mixture of silt and sand (1:1 v/v). The layout of the experiment was a complete randomized block design.

When the seedlings height attained 15 cm and had about 10-15 leaves, they were sprayed with two growth regulators; putrescine (Put) at the concentrations of (50, 100 and 150 ppm), uniconazole (Uni) at the concentrations of (10, 15 and 20 ppm) and combination between them, while the control plants were sprayed with distilled water. Fifteen treatments plus control were carried out, each treatment had three replicates and each replicate contained five plants. The plants were sprayed again after one month from the first spray. During the two seasons, the following data were recorded:

2.1. Measurements of growth parameters

Spikes part length (cm) - Fresh weight of spikes/plant (g) - Dry weight of spikes/plant (g).

2.2. Pigments determination

2.2.1. Photosynthetic pigments (mg/g of fresh matter): Chlorophyll a, b and total Carotenoids were determined in leaf samples (mg/g F.W.) according to [6]

2.2.2. Inflorescences pigments (Anthocyanin g/100g of fresh spikes): Anthocyanin content in fresh petals was determined colorimetrically according to [7]

2.3. Total carbohydrates determination: Total carbohydrates content was determined using the phenol - sulphuric acid method, according to [8]

2.4. Minerals determination: Elements extraction was made using a known weight of the dried shoot samples (0.5 g). The wet digestion procedure was performed [9]. Magnesium and Copper contents were measured by Atomic Absorption Spectroscopy.

2.5. Statistical analysis

Data on flowering and chemical constituents in the two seasons were statistically analyzed as described by [10] . Means of all characters were compared by L.S.D test at 0.05 level of significance.

3. Results and Discussions

3.1. Flowering Characteristics

3.1.1. Spikes part length (cm)

Data in Fig. (1) and Fig. 2 mentioned that, spraying *Salvia splendens* F. plant with putrescine increased significantly spikes part length in all used concentrations compared to untreated plants in both seasons. The best results were found when plants treated with 150 ppm putrescine which recorded 28.67 and 36.00 cm compared to untreated plants (18.72 and 23.08 cm) in the 1st and the 2nd seasons, respectively.

Our results are in agreement with those obtained by [11] on gladiolus plants who reported that, putrescine at different concentrations increased the length of florets and cormes, it may be due to putrescine enhanced the accumulation of the produced in the produced in the plant tissues *i.e.* flowers [12].

In case of uniconazole; data show that, as concentration was raised, the recorded mean value for this character decreased to reach its minimum value at 20 ppm uniconazole (22.58 and 28.75 cm) in the 1st and 2nd season, respectively, compared to the control plant giving 26.25 and 32.50 cm in the 1st and 2nd seasons, respectively.

These results were in harmony with those obtained by [13] on *Gerbera jamesonii* plant and [14] on some ornamental plants. They found that, length of flower or main inflorescence significantly reduced with increasing concentration of paclobutrazol.

Concerning the interaction between putrescine and uniconazole treatments data show that, the highest values were recorded 35.33 and 41.67 cm when plants treated with 150 ppm putrescine compared to the other treatments and the control plants, while the minimum values recorded 17.67 and 21.67 cm when plants treated with 0 ppm putrescine + 20 ppm uniconazole and 0 ppm putrescine + 15 ppm uniconazole in the 1st and 2nd seasons, respectively.

3.1.2. Fresh weight of spikes/plant (g)

Data presented in Fig. (1) and Fig. (2) significantly increased fresh weight of spikes/plant in *Salvia splendens* F. plants when plants treated with all used concentrations of putrescine. The highest values (31.59

and 61.50 g) were obtained in plants treated with 150 ppm putrescine compared to the control plants (9.96 and 22.15 g) in the 1st and 2nd seasons, respectively.

Concerning the application of uniconazole, data indicated that, all concentrations increased significantly fresh weight of spikes/plant giving 25.70, 23.82 and 19.00 g) when plants treated with 10, 15 and 20 ppm uniconazole compared to the control plants (18.11 g) in the first season, and the same trend was found in the 2nd season.

Regarding to interaction between putrescine and uniconazole treatments, data show that, using putrescine at the concentration of 150 ppm + uniconazole at the concentration of 10 ppm gave the highest values for this character (39.39 and 76.39 g) in the 1st and 2nd seasons, respectively.

3.1.3. Dry weight of spikes/plant (g)

Data in Fig. (1) and Fig. (2) illustrated that, *Salvia splendens* F. plants treated with putrescine and uniconazole significantly increased dry weight of spikes/plant compared to the control plants.

Using putrescine at 50, 100 and 150 ppm gave the values 3.96, 6.40 and 7.64 g in the 1st season compared to the untreated plants which recorded 2.01 g. The same trend was found in the 2nd season.

Application of uniconazole at the three used concentrations gave high significant increase in both seasons. The highest values were found when plants treated with 10 ppm uniconazole which recorded 6.17 and 10.07 g compared to the control giving 4.02 and 6.72 g in the 1st and 2nd seasons, respectively.

Concerning the interaction between putrescine and uniconazole, data revealed that, application of putrescine at the concentration of 150 ppm + uniconazole at the concentration of 10 ppm gave the highest values of dry weight of spikes/plant.

These results are in accordance with the findings of [15] on *Dianthus caryophyllus* plants reported that, application of 200 ppm putrescine significantly increased fresh and dry weight of spikes and [16] on *Chrysanthemum indicum* plants reported that, application of 200 ppm putrescine increased fresh and dry weight of inflorescences. These results may be due to the promotive effect of putrescine, which is essential for plant growth and differentiation and thus involved in various physiological processes, [17] and [18].

In case of uniconazole, these results are in agreement with[19] on rose plants, [20] on *Calendula officinalis* plants, [21] on *Bougainvillea glabra* plants and[16] on *Chrysanthemum indicum* plants. They found that, paclobutrazol or uniconazole increased fresh and dry weight of inflorescences.

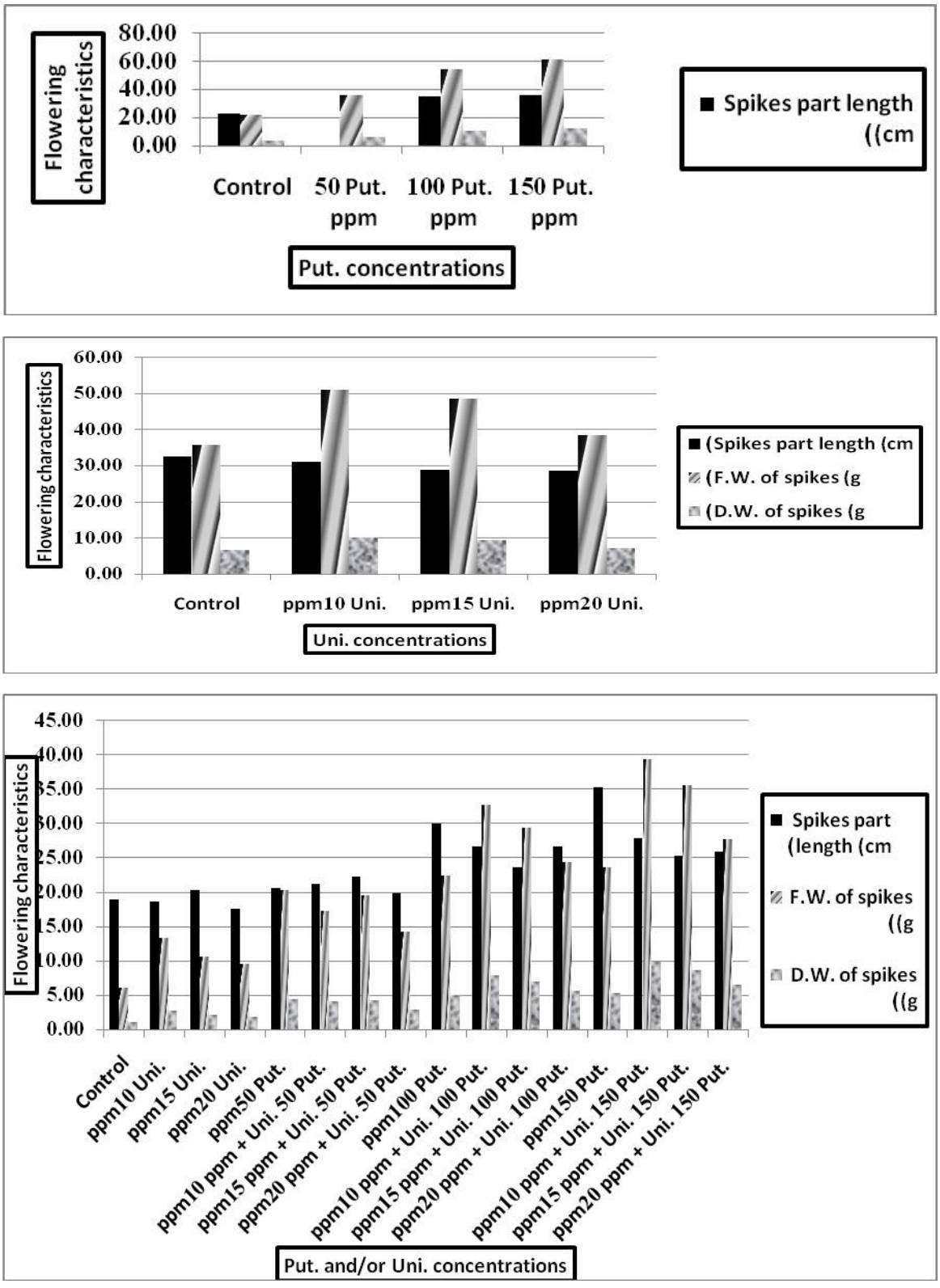
3.2. Chemical constituents

3.2.1. Photosynthetic pigments

3.2.1.1.Chlorophyll (a) [mg/g. F.W.]

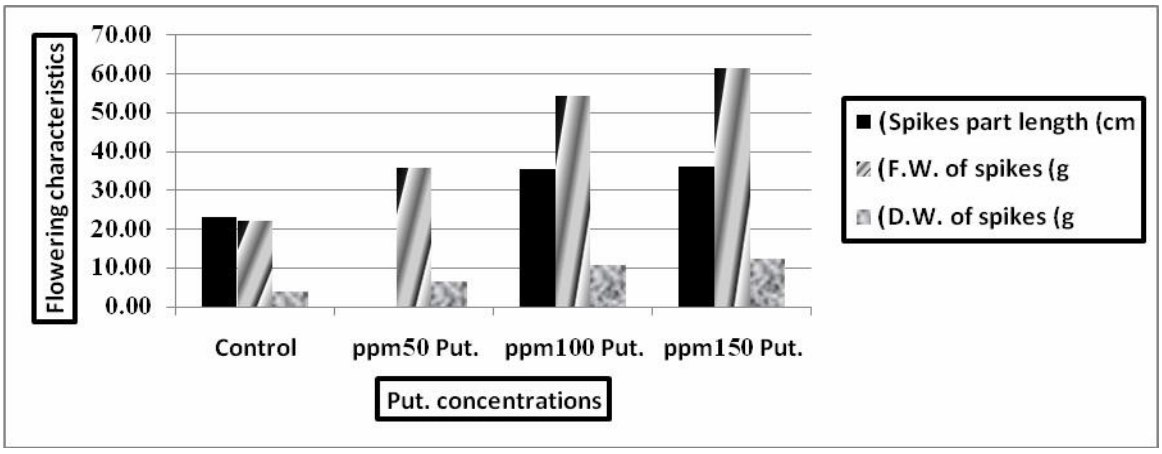
The process of photosynthesis is affected by photosynthetic pigments which in turn are affected by exogenous application of bio-regulators.

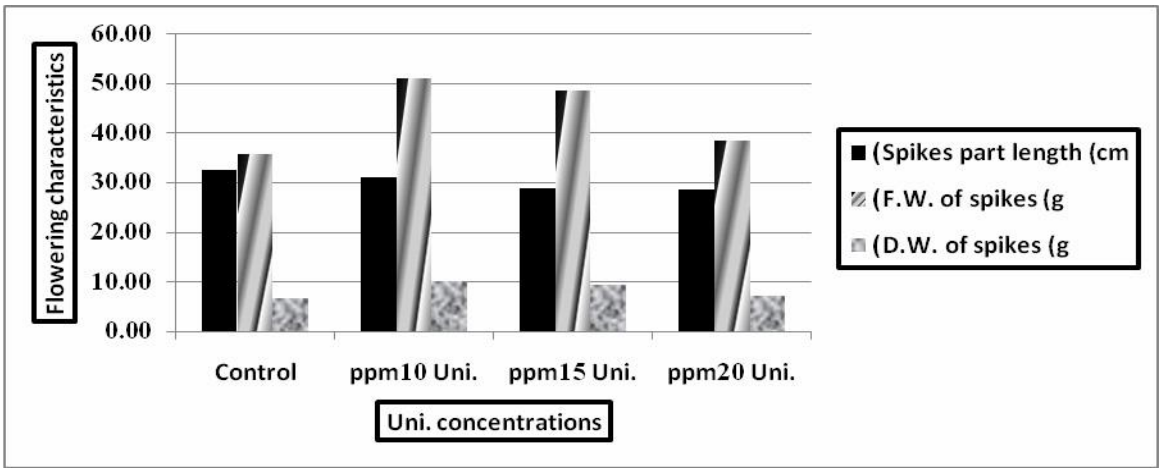
Data in Table (1) illustrated that, foliar application of putrescine at the concentrations 50, 100 and 150 ppm on *Salvia splendens* F. plants significantly increased the content of chlorophyll (a) in recent leaves of plants. Data showed that, using putrescine at the level of 150 ppm recorded the highest values compared to the two other treatments and the control plants which gave 1.71 and 1.77 mg/g. F.W. of leaves in the 1st and 2nd seasons, respectively.

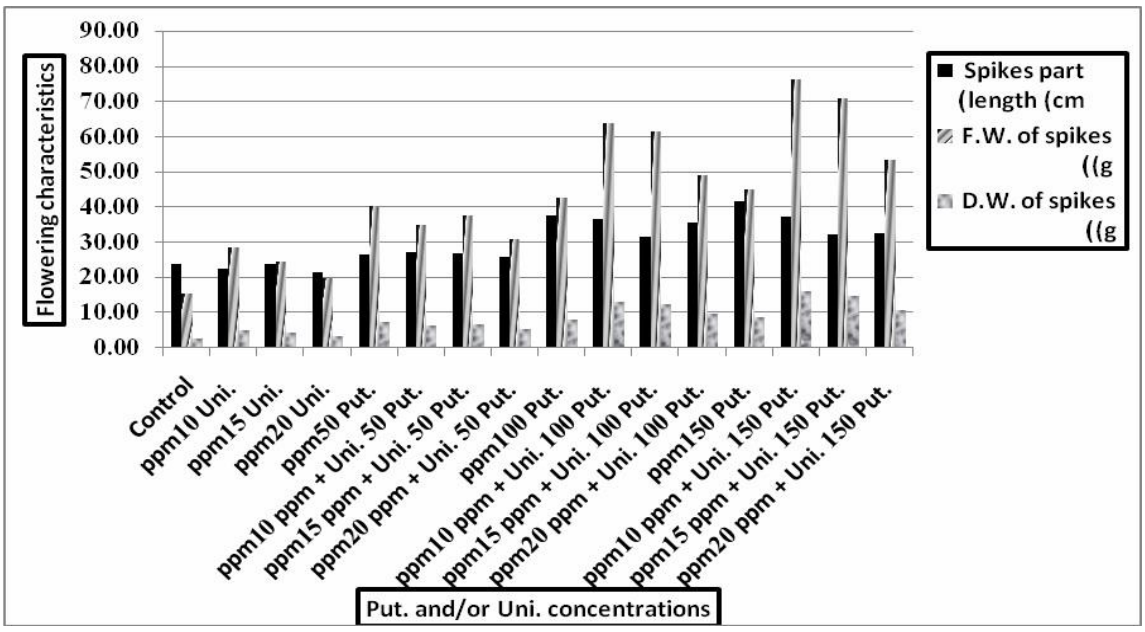


Putrescine: Put., Uniconazole: Uni., Fresh weight: F.W., Dry weight: D.W.

Fig. 1: Effect of putrescine and uniconazole on flowering characteristics of *Salvia splendens* F. during 2006/2007 (first season).







Putrescine: Put., Uniconazole: Uni., Fresh weight: F.W., Dry weight: D.W.

Fig. 2: Effect of putrescine and uniconazole on flowering characteristics of *Salvia splendens* F. during 2007/2008 (second season).

With regard to the effect of uniconazole on salvia plants, indicated that, uniconazole treatments at 15 and 20 ppm gave a significant increase the content of chlorophyll (a) than the untreated plants. Also it's noticed that, the content of chlorophyll (a) increased when the concentration of uniconazole raised which recorded 1.60, 1.67 and 1.71 mg/g. F.W. of leaves compared to the untreated plants giving 1.55 mg/g. F.W. of leaves in the 1st season. Similar trend was found in the 2nd season.

In case of interaction between two bio-regulators, data indicated that, using putrescine at 150 ppm + uniconazole at 20 ppm gave the highest values of the content of chlorophyll (a).

3.2.1.2.Chlorophyll (b) [mg/g. F.W.]

Data presented in Table (1) showed that, foliar application of putrescine and uniconazole significantly affected the photosynthetic pigments content of leaves of *salvia splendens* F. plants.

Foliar application of putrescine significantly increased chlorophyll (b) at 150 ppm which gave the highest values (0.53 and 0.57 mg/g. F.W. of leaves) compared to the control plants (0.38 and 0.42 mg/g. F.W. of leaves) in the 1st and 2nd season, respectively.

Concerning using uniconazole treatments, data show that, spraying the plants with uniconazole at the concentration of 10,15 and 20 ppm significantly increased the content of chlorophyll (b) in *Salvia splendens* plants giving the highest content at the highest concentration, while the low concentration gave the lowest contents of chlorophyll (b) compared to the two other treatments in the 1st and 2nd season.

In case of interaction between putrescine and uniconazole, data found that, using putrescine at the concentration of 150 ppm combined with uniconazole at the concentration of 20 ppm gave the highest content of chlorophyll (b), while putrescine at 0 ppm + uniconazole at 10 ppm recorded the lowest values.

3.2.1.3.Total carotenoids content (mg/g. F.W.)

Data presented in Table (1) revealed that, spraying *Salvia splendens* F. plant with putrescine and uniconazole at the different concentrations significantly increased total carotenoids content in leaves in the two seasons.

Using putrescine at all used concentrations, as data show, significantly increased the content of total carotenoids content than the untreated plants. Putrescine at 100 and 150 ppm resulted the same values in the 1st season. In the 2nd season the highest content was found when plants treated with 150 ppm putrescine.

Concerning uniconazole treatments, it was found that, spraying the plants with 10, 15 and 20 ppm uniconazole significantly increased total carotenoids content in leaves in the 1st season giving 0.24, 0.31 and 0.29 mg/g. F.W. of leaves compared to the untreated plants which giving 0.20 mg/g. F.W. of leaves. The highest content was found at 15 ppm uniconazole. Similar trend was found in the 2nd season.

With regard to the effect of putrescine combined with uniconazole treatments, data show that, the highest total carotenoids content was found when the plants sprayed with 150 ppm putrescine + 15 ppm uniconazole in the two seasons.

These results are in line with those obtained by [22] on *Metthiola incana*, [23] on *Catharanthus roseus* L.), [11] on gladiolus plant, [16] on *Chrysanthemum* indicum plant, [24] on *Syngonium podophyllum* plant and [25] on *Dahlia pinnata* plant. They reported that, putrescine treatments increased chlorophyll (a), (b) and total carotenoids content.

Polyamines have been found to affect protein synthesis and nitrogen compound metabolism, [26] and [27]. Moreover, putrescine induced effects on chlorophylls content, polyamines stimulated some physiological responses including vegetative growth and photosynthetic activity, [28] and [29].

With regard to the effect of uniconazole on photosynthetic pigments, the obtained results are in harmony with those obtained by [5] on thyme plants, [20] on *Calendula* officinalis plant, [21] on *Bouganivillea glabra* plants and [16] on

Chrysanthemum indicum plant. They stated that, treating the plants with triazole compound at 100 ppm concentrations increased chlorophyll content.

Plants treated with uniconazole tended to have a darker green color than untreated plants, this darker color is desirable to consumers and makes the plants more saleable, these darker foliage can be attributed to greater chlorophyll concentrations in the leaves,[30]; [31]and [32].

The increase of chlorophyll content caused by treating with uniconazole can be relatively well explained by the preferred inhibition of cell extension by the growth regulator, due to the inhibition of cell extension there are more cells per leaf blade and per fresh matter. Thus, even at constant chlorophyll content per cell, chlorophyll content per leaf blade or per fresh matter would be increased, [33].

3.2.2.Anthocyanin content (g/100g. F.W.)

The data presented in Table (1) revealed that, spraying salvia plants with putrescine and uniconazole at different concentrations significantly increased anthocyanin content in spikes in the two seasons.

For putrescine the recorded data were higher in the three concentrations. The highest values of anthocyanin content were determined when plants treated with 150 ppm putrescine giving 0.20 and 0.25 g/100g. F.W. of spikes in the 1st and 2nd season, respectively, compared to untreated plants.

These results are in agreement with those obtained by [34] on grapes seedlings, [35] Tradescantia plants, [36] on *Arabidopsis thaliana*, [37]on *Curcuma alismatifolia* and [38] on *Lilium longiflora*. In this concern [39] reported that, gibberellic acid can infuse some genes of essential enzymes in anthocyanin production pathway such as chalkon synthetase, chalkon isomerase, di-hydro flavenol redoctase. [40] reported that, gibberellic acid regulate phenyl alanin amoniliyase activity which increase anthocyanin content in plant culture.

Regarding to the effect uniconazole treatments it was found that, spraying salvia plants with 10, 15 and 20 ppm resulted in significant increased by 0.9, 0.13 and 0.15 g/100g. F.W. of spikes in the 1st season. The highest values were found when plants treated with 20 ppm uniconazole. Similar trend was found in the 2nd season.

These results are in harmony with were obtained by [41] on tapioca plants and [42] on catharanthus plants. They reported that, the increases in anthocyanin content may be due to triazoles induced a transient raise in abscisic acid content. This increase in ABA content induced by triazole might be the cause for increased anthocyanin content.

Concerning the interaction between putrescine and uniconazole treatments, the data showed that, treating plants with 150 ppm putrescine combined with 20 ppm uniconazole recorded the highest significant values.

Table 1. Effect of putrescine and uniconazole on pigments of *Salvia splendens* F. plant during 2006/2007 and 2007/2008 season.

Measurements / Treatments	Chlorophyll a (mg/g. F. W.)		Chlorophyll b (mg/g. F. W.)		Carotenoids (mg/g. F. W.)		Anthocyanin (g/100g. F.W.)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of Putrescine								
Put. 0	1.51	1.58	0.38	0.42	0.17	0.25	0.04	0.09
Put. 50 ppm	1.64	1.71	0.49	0.52	0.27	0.29	0.10	0.17
Put. 100 ppm	1.68	1.75	0.51	0.55	0.30	0.33	0.14	0.19
Put. 150 ppm	1.71	1.77	0.53	0.57	0.30	0.35	0.15	0.20
$LSD_{0.05}$	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**
Effect of Uniconazole								
Uni. 0	1.55	1.64	0.42	0.46	0.20	0.22	0.07	0.12
Uni. 10 ppm	1.60	1.67	0.45	0.49	0.24	0.29	0.09	0.15
Uni. 15 ppm	1.67	1.73	0.51	0.54	0.31	0.37	0.13	0.18
Uni. 20 ppm	1.71	1.76	0.53	0.58	0.29	0.35	0.15	0.20
$LSD_{0.05}$	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**
Effect of interaction								
Put. 0 + Uni. 0	1.49	1.58	0.38	0.41	0.16	0.24	0.04	0.07
Put. 0 + Uni. 10 ppm	1.47	1.55	0.36	0.39	0.15	0.23	0.04	0.09
Put. 0 + Uni. 15 ppm	1.52	1.59	0.39	0.43	0.19	0.28	0.05	0.10
Put. 0 + Uni. 20 ppm	1.54	1.61	0.41	0.44	0.17	0.26	0.06	0.10
Put. 50 ppm + Uni. 0	1.55	1.63	0.42	0.46	0.20	0.19	0.06	0.12
Put. 50 ppm + Uni. 10 ppm	1.62	1.70	0.47	0.50	0.25	0.29	0.09	0.17
Put. 50 ppm + Uni. 15 ppm	1.68	1.75	0.52	0.55	0.31	0.33	0.14	0.19
Put. 50 ppm + Uni. 20 ppm	1.71	1.76	0.53	0.58	0.32	0.35	0.14	0.21
Put. 100 ppm + Uni. 0	1.57	1.66	0.44	0.47	0.23	0.22	0.08	0.13
Put. 100 ppm + Uni. 10 ppm	1.65	1.72	0.48	0.52	0.26	0.31	0.11	0.17
Put. 100 ppm + Uni. 15 ppm	1.73	1.79	0.55	0.59	0.36	0.43	0.16	0.22
Put. 100 ppm + Uni. 20 ppm	1.77	1.82	0.58	0.63	0.33	0.37	0.19	0.23
Put. 150 ppm + Uni. 0	1.59	1.69	0.45	0.49	0.21	0.21	0.09	0.15
Put. 150 ppm + Uni. 10 ppm	1.67	1.73	0.50	0.54	0.28	0.32	0.12	0.18
Put. 150 ppm + Uni. 15 ppm	1.76	1.81	0.56	0.61	0.38	0.44	0.17	0.22
Put. 150 ppm + Uni. 20 ppm	1.80	1.85	0.61	0.64	0.35	0.41	0.20	0.25
$LSD_{0.05}$	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**

Putrescine: Put., Uniconazole: Uni., Fresh weight: F.W.

3.2.3. Total carbohydrates (% D.W. of shoots)

Data presented in Table (2) revealed that, significant effect of putrescine and uniconazole treatments on total carbohydrates content in the shoots of *Salvia splendens* F.

As for putrescine treatments, it is clear that, application of putrescine at the concentrations of 50, 100 and 150 ppm significantly increased total carbohydrates content giving 18.77, 24.74 and 26.32%), respectively over the untreated plants in the 1st season. Similar trend was found in the 2nd season.

Regarding the effect of uniconazole on carbohydrates content of *Salvia splendens*, the results showed that, spraying plants with the three concentrations of uniconazole significantly increased total carbohydrates content in salvia plants. The highest content of carbohydrates were found when plants treated with 10 ppm uniconazole giving 23.63 and 26.61% in the 1st and 2nd season, respectively, compared with the untreated plants.

Concerning the interaction between putrescine combined with uniconazole treatments, data revealed that, the highest content values were found when plants treated with 150 ppm putrescine combined with 10 ppm uniconazole.

Table 2. Effect of putrescine and uniconazole on some chemical constituents of *Salvia splendens* F. plant during 2006/2007 and 2007/2008 seasons.

Measurements / Treatments	Total carbohydrates (% D.W.) of shoots		Magnesium (% D.W.) of shoot		Copper in shoot (ppm)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of Putrescine						
Put. 0	15.90	18.46	0.51	0.54	3.46	5.83
Put. 50 ppm	18.77	22.36	0.64	0.67	4.87	6.47
Put. 100 ppm	24.74	27.28	0.67	0.70	6.92	7.39
Put. 150 ppm	26.32	29.11	0.69	0.72	7.03	7.69
$LSD_{0.05}$	**0.41**	**0.72**	**0.03**	**0.03**	**0.23**	**0.17**
Effect of Uniconazole						
Uni. 0	19.54	22.53	0.60	0.63	5.24	6.46
Uni. 10 ppm	23.63	26.61	0.56	0.59	5.93	7.09
Uni. 15 ppm	21.93	24.71	0.66	0.70	5.85	7.08
Uni. 20 ppm	20.64	23.35	0.69	0.72	5.25	6.77
$LSD_{0.05}$	**0.41**	**0.72**	**0.03**	**0.03**	**0.23**	**0.17**
Effect of interaction						
Put. 0 + Uni. 0	13.51	16.50	0.48	0.51	2.90	5.53
Put. 0 + Uni. 10 ppm	17.32	19.85	0.50	0.53	4.20	6.13
Put. 0 + Uni. 15 ppm	16.93	19.23	0.51	0.56	3.20	5.70
Put. 0 + Uni. 20 ppm	15.86	18.24	0.54	0.58	3.53	5.97
Put. 50 ppm + Uni. 0	20.43	23.86	0.62	0.65	5.40	6.63
Put. 50 ppm + Uni. 10 ppm	18.86	23.60	0.56	0.59	4.73	6.43
Put. 50 ppm + Uni. 15 ppm	18.00	21.80	0.68	0.70	5.00	6.53
Put. 50 ppm + Uni. 20 ppm	17.78	20.17	0.69	0.72	4.33	6.30
Put. 100 ppm + Uni. 0	22.01	24.35	0.64	0.67	6.47	6.77
Put. 100 ppm + Uni. 10 ppm	29.06	30.54	0.57	0.61	7.33	7.73
Put. 100 ppm + Uni. 15 ppm	24.04	28.22	0.71	0.75	7.40	7.83
Put. 100 ppm + Uni. 20 ppm	23.87	26.01	0.76	0.78	6.47	7.23
Put. 150 ppm + Uni. 0	22.22	25.40	0.65	0.69	6.20	6.90
Put. 150 ppm + Uni. 10 ppm	29.27	32.46	0.59	0.62	7.47	8.07
Put. 150 ppm + Uni. 15 ppm	28.74	29.60	0.74	0.77	7.80	8.23
Put. 150 ppm + Uni. 20 ppm	25.07	28.97	0.76	0.80	6.67	7.57
$LSD_{0.05}$	**0.82**	**1.43**	**0.05**	**0.05**	**0.45**	**0.34**

Put.: Putrescine; Uni.: Uniconazole; D.W.: Dry weight

These results are in agreement with those obtained by [43] on wheat plants, [15] on *Dianthus caryophyllus*, [21] on *Bougainvillea glabra* and [16] on *Chrysanthemum indicum*. They reported that, using putresine at different concentrations increased the total carbohydrates content in plants. These increments in total carbohydrates content may be due to the increase in photosynthetic process efficiency, which led to the increase assimilation of leaf CO_2.

Regarding the effect of uniconazole on carbohydrates content in plants, the results are in line to the results obtained by [13] on thyme plants and [16] on *Chrysanthemum indicum*. They mentioned that, application of uniconazole at different concentrations led to increase in total carbohydrates content in plants.

3.2.4. Magnesium percentage in shoot

Data in Table (2) indicated that, foliar application of putrescine at the rates of 50, 100 and 150 ppm significantly increased the content of magnesium in salvia plants by 0.64, 0.67 and 0.69% compared to the untreated plants which recorded 0.51% in the 1st season. The same trend was found in the 2nd season.

Concerning uniconazole treatment, the results show that, uniconazole at the concentration of 20 ppm gave the highest content value of magnesium in salvia plants which recorded 0.69% than the control plants (0.60%) in the 1st season, while the concentration of 10 ppm of uniconazole resulted in significant decrease in the content of magnesium in salvia plants than the control plants and the other treatments giving 0.56%. Similar trend was found in the 2nd season.

Regarding the combination between putrescine and uniconazole treatments, the data found significant increase in plants sprayed with 150 ppm putrescine + 20 ppm uniconazole which recorded the highest content from magnesium in salvia plants giving 0.76 and 0.80% compared with the control plants (0.48 and 0.51%) in the 1st and 2nd season, respectively.

In this concern, these results are harmony with those obtained by [44] ,[45] and [43] . They reported that, foliar application of putrescine at different concentrations accelerated the accumulation of magnesium in plants.

3.2.5. Copper content in shoots (ppm)

Data presented in Table (2) mentioned that, the significant increases were found in the content of copper in salvia plants when spraying plants with different concentrations of putrescine and uniconazole treatments.

In case of putrescine, the results show that, using putrescine at concentrations of 50, 100 and 150 ppm significantly increased the content of copper in the plants than the untreated once. The highest content was found at the concentration of 150 ppm putrescine giving 7.03 and 7.69 ppm compared to the control plants giving 3.46 and 5.83 ppm in the 1st and 2nd season, respectively.

Concerning the effect of uniconazole on the content of copper in salvia plants, it's clear that, copper content in shoot was increased when plants treated with uniconazole at the concentrations of 10, 15 and 20 ppm. The highest content was found when spraying plants with 10 ppm uniconazole giving 5.93, 7.09 ppm than the untreated plants giving 5.24, 6.46 ppm in the 1st and the 2nd season, respectively.

Regarding to combination between the two bioregulators, the data found that, putrescine at the concentration of 150 ppm combined with uniconazole at the concentration of 15 ppm recorded the highest significant content of copper in salvia plants giving 7.80 and 8.23 ppm in the 1st and 2nd season, respectively, compared to the control plants.

Recommendation:

From these results, it may be recommended that, it's could be sprayed *Salvia splendens* F. plant by 150 ppm putrescine alone, 10 ppm uniconazole alone or 150 ppm putrescine combined with 10 ppm uniconazole, to reach the best results in most taken characters (flowering characteristics and chemical constituents).

4. References

1. Clebsch, B. and Barner, C. D. (2003). The New Book of Salvias. Sages for Every Garden. Timber Press, United States. 344 pp.
2. Kosson, R. and Prange, R.K. (2005): The occurrence, physiological role and nutritive importance of polyamines in vegetables and fruits. Vegetable Crops Research Bulletin. (63): 5-24.
3. Fletcher, R. A. and Hofstra, G. (1988). Triazoles as potential plant protectants .In: Berg D and Plempel M (eds) sterol biosynthesis inhibitors. Pharmaceutical and Agricultural Aspects., Cambridge, England: Ellis Hard Wood Ltd pp 321-331.
4. Izumi, K.; Nakagawa, S.; Kobayashi, H.; Oshio, H.; Sakurai, A. and Takahashi, N. (1988). Levels of IAA, cytokinins, ABA and ethylene in rice plants as affected by gibberellin biosynthesis inhibitor, uniconazole. Plant Cell Physiol., 29 (1): 97-104.

5. Bekheta, M. A.; Abbas, S.; El-Kobisy, O. S. and Mahgoub, M. H. (2008). Influence of selenium and paclobutrazole on growth, metabolic activities and anatomical characters of *Gerbera jamesonii* L. Australian Journal of Basic and Basic Applied Sciences, 2 (4): 1284-1297.
6. Nornai, R. (1982). Formula for determination of chlorophyllus pigments extracted with N.N-dimethyl formamide. Plant Physiol., 69:1376-1381.
7. Husia, C.L.; Luh, B.S. and Chichester, C.D. (1965). Anthocyanin in free stone peaches. J. Food Sci., 30:5-12.
8. Dubois, M.; Smisth, F.; Gilles, K.A.; Hamilton, J.K. and Rebers, P.A. (1956). Colorimetric method for determination of sugars and related substances. Anal. Chem., 28:350-356.
9. Piper, C. S. (1950). Soil and Plant Analysis. Inter Sci., Pulb, New York, 368 pp.
10. Snedecor, G. W. and Cochran, W. G. (1980). Statistical Methods. 7th ed. Iowa Stat. Univ., Press, Ames. Iowa, USA.
11. Abd El-Aziz, N. G.; Taha, L. S. and Ibrahim, S. M. (2009). Some studies on the effect of putrescine, ascorbic acid and thiamine on growth, flowering and some chemical constituents of gladiolus plants at Nubaria. Ozean. Journal of Applied Sciences, 2 (2): 169-179.
12. Solcum, R. D. and Galston, A. W. (1985). Changes in polyamines associated with post fertilization and development in tobacco ovary tissue. Plant Physiol., 79:336- 343.
13. Bekheta, M.A.; Abbas, S.; El-Kobisy, O.S. and Mahgoub, M.H.(2008) Influence of selenium and paclobutrazol on growth, metabolic activities and anatomical characters of *Gerbera jamesonii L.* Australian Journal of Basic and Applied Sciences,2 (4):1284-1297.
14. Anna, P. (2008). The influence of growth retardants and cytokinins on flowering of ornamental plants. Acta Agrobotanica, 6(1):137-141.
15. Mahgoub, M. H.; El-Ghorab, A. H. and Bekheta, M. A. (2006a). Effect of some bioregulators on the endogenous phytohormones, chemical composition, essential oil and its antioxidant activity of carnation (*Dianthus caryophyllus* L.) J. Agric. Sci. Mansoura Univ., 31 (7): 4229-4245.
16. El-Sayed, I. M. (2009). Physiological and biological studies on *Chrysanthemum indicum* L. M. Sc. Thesis, Fac. Agri., Cairo Univ., Egypt, 132p.
17. Flores, H. E. and Galston, A. W. (1982). Polyamine and plant stress: Activation of putrescine biosynthesis by osmotic shock. Sci., 217:1259-1261.
18. Friedman, R. Altman, A. and Levin, N. (1989). The effect of salt stress on polyamine biosynthesis and content in mung bean plants and in halophytes. Physiol. Plant, 76(3):295-302.
19. Singh, A. K. and Bist, L. D. (2003). Effect of paclobutrazol on growth and flowering in rose cv. "Gruss-an-Teplitz". J. of Hort., 60 (2):188-191
20. Mahgoub, M. M.; Abd EL Aziz, N. G. and Youssef, A. A. (2006b). Influence of foliar spray with paclobutrazol or glutathione on growth, flowering and chemical composition of *Calendula officinalis* L. plant. Journal of Applied Sciences Research, 2(11):879-883.
21. El-Quesni, F. E.; Kandil, M. M. and Mahgoub, M. H. (2007). Some studies on the effect of putrescine and paclobutrazole on the growth and chemical composition of *Bougainvillea glabra* L. at Nubaria. America Eurasian J. Agric.& Environ. Sci., 2(5):552-558.
22. Youssef, A. A.; Mahgoub, M. H. and Talaat, I. M. (2004). Physiological and Biochemical Aspects of *Matthiola incana* plants under the effect of Putrescineand kinetin treatments.Egypt. J. Appl. Sci; 19 (9B): 492-510.
23. Talaat, I. M.; Bekheta, M. A. and Mahgoub, M. H. (2005). Physiological response of periwinkle plants (*Catharanthus roseus* L.) to tryptophan and putrescine. International Journal of Agriculture and Biology, 7 (2): 210-213.
24. El-Quesni, F. E.; Mahgoub, M. H. and Kandil, M. M. (2010). Impact of foliar spray of inorganic fertilizer and bioregulator on vegetative growth and chemical composition of *Syngonium podophyllum* L. plant at Nubaria. Journal of American Science. 6 (8): 288-294.
25. Mahgoub, M. H.; Abd El-Aziz, N. G. and Mazhar, A. M. (2011). Response of *Dahlia pinnata* L. to foliar spray with putrescine and thiamine on growth, flowering and photosynthetic pigments. American-Eurasian J. Agric. & Environ. Sci., 10 (5): 769-775.
26. Rowland-Bamford, A. J.; Borland, A. M. and Lea, P. J. (1988). The effect of air pollution on polyamine metabolism. Environ. Pollut., 53:410-412.

27. Serafini-Fracassini, D. (1991). Cell cycle-dependent changes in plant polyamines metabolism In Slocum, R. D., H. E. Flores (eds) Biochemistry and Physiology of polyamines in plants, CRC press, Boca Raton, FL.pp:159-171.
28. Yanghua, D.; Jiping, S.; Guangminl and Zhenging, S. (1996). Effect of Spermine and Spermidine on photosynthetic carboxylase activity of detached maize leaves. Plant Physiol. comm., 32: 268-270.
29. Chattopadayay, M. K.; Tiwari, B. S.; Chattopadhayay, G.; Bose, A.; Sengupta, D. N. and Ghosh, B. (2002). Protective role of exogenous polyamines on salinity-stressed rice (*Oryza sativa*) plants. Physiol. Plant, 116:192-199.
30. Robert, M. F. and Janet, C. C. (1992). Uniconazole effect on growth and chlorophyll content of pyracantha photinia and dwef purford holly. J. Plant Growth Reg., 11:143-148.
31. Gent, M. P. N. (1995). Paclobutrazole or Uniconazole applied early in the previous season promotes flowering of field grown Rhododendron and Kalmia. J. Plant Growth Regul.,14:205-210.
32. Zhou, W. and Ye, Q. (1996). Physiological and yield effects of Uniconazole on Winter Rape (*Brassica napus* L.) .Plant Growth Reg., 15:69-73.
33. Andel, O. and Van, M. (1973). Morphogenetic effects on vegetative plants *Poa pratensis* of 6-azauracil, (2 -chloroethyl) -hosphoric acid, and (2-chloroethyl) trimethyl ammonium chloride and their interaction with gibberellic acid. J. Exp. Bot., 78: 245-257.
34. Karim, M. F.; Hassan, A. K. and Awad, H. (1998). Enhancing color formation of flam seedless grapes using safe compounds or low dose of ethephon. Emir. J.Agric, Sci., 10:47-57.
35. Jeffrey, C. S. (2001). Effect of polyamines on ethylene production. Phytochemistry, 20(7):1477-1480.
36. Elena, L.; Giovanni, P.; Giacomo, N.; Cinzia, S.; Amedeo, A. and Pierdomenico, P. (2008). Gibberellins, jasmonate and abscisic acid modulate the sucrose- induced expression of anthocyanin biosynthetic genes in Arabidopsis.New Phytologist, 179:1004-1016.
37. Chutichudet, P.; Chutichudet, B. and Boontiang, K. (2010). Effect of 1-MCP on vase life and other postharvest qualities of patumma (*Curcuma alismatifolia*) cv. Chiang Mai Pink. Trends Hort. Res., (In Press).
38. Emami, H.; Saeidniia, M.; Olfati, J. A. and Hasani,M. (2011). Study on Lily longevity treated with growth regulator GA3 and BA by path analysis. American Eurasian J. Agric. and Environ. Sci., 10(5):814-820.
39. Weiss, D. (2000). Regulation of flower pigmentation and growth: multiple signalling pathways control anthocyanin synthesis in expanding petals. *Physiologia Plantarum*, 110:152–157.
40. Kwack, H.; Lee, J. and Lee, J. S. (1997). Effects of uniconazole and gibberellins on leaf variegation of ornamental plants under different light conditions. J. Korean Society Hort. Sci., 38:754-760.
41. Gomathinayagam, M.; Jaleel, A. C.; Azooz, M. M. and Panneerselvam, R. (2008). Triadimefon and hexaconazole enhances the photosynthetic pigment composition of tapioca an important tuber crop. Global J. of Molecular Sciencesm, 3(2):86-92.
42. Jaleel C. A.; Wang G. X.; Ahmad P. and Haq I. U. (2009). Changes in the photosynthetic characteristics of *Catharanthus roseus* L. as a result of exogenous growth regulators. Plant Omics. J., 2:169-174.
43. El-Bassiouny, H. M. S. and Bekheta, M. A. 2005. Effect of salt stress on relative water content, lipid peroxidation, polyamines, amino acids and ethylene of two wheat cultivars. Int. J. Agric. Biol., 7(3):363-368.
44. Hanafy, A. H.; Gad, M. M. A.; Hassan, H. M. and Amin, M. A. (2002). Improving growth and chemical composition of *(Myrtus communis*) grown under soil salinity conditions by polyamines foliar application. Proc. Minia 1st Conf. for Agric. and Environ. Sci., Minia; Egypt, March 25-28.
45. Shawky- Neveen, B. T. (2003). Physiological Studies on the Effect of Salinity, Ascorbic Acid and Putrescine on Sweet Pepper Plant. Ph.D. Thesis, Fac. Agric., Cairo Univ., Egypt, 141pp.

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