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. 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 CO₂ treatment.

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.

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. 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.

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 plant tissues i.e. flowers 12.

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.

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.

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 1\textsuperscript{st} and 2\textsuperscript{nd} 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 2\textsuperscript{nd} 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 1\textsuperscript{st} and 2\textsuperscript{nd} seasons, respectively.

### 3.1.3. Dry weight of spikes/plant (g)

Data in Fig. (1) and Fig. (2) illustrated that, \emph{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 1\textsuperscript{st} season compared to the untreated plants which recorded 2.01 g. The same trend was found in the 2\textsuperscript{nd} 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 1\textsuperscript{st} and 2\textsuperscript{nd} 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 \emph{Dianthus caryophyllus} plants reported that, application of 200 ppm putrescine significantly increased fresh and dry weight of spikes and 16 on \emph{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 \emph{Calendula officinalis} plants, 21 on \emph{Bougainvillea glabra} plants and 16 on \emph{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 \emph{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 1\textsuperscript{st} and 2\textsuperscript{nd} seasons, respectively.
Fig. 1: Effect of putrescine and uniconazole on flowering characteristics of *Salvia splendens* F. during 2006/2007 (first season).

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 *Dalia 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 *Bougainvillea 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 reductase. 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.
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 1<sup>st</sup> season. Similar trend was found in the 2<sup>nd</sup> 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 1<sup>st</sup> and 2<sup>nd</sup> 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.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Measurements</th>
<th>Total carbohydrates (% D.W.) of shoots</th>
<th>Magnesium (% D.W.) of shoot</th>
<th>Copper in shoot (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1st season</td>
<td>2nd season</td>
<td>1st season</td>
</tr>
<tr>
<td>Effect of Putrescine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Put. 0</td>
<td></td>
<td>15.90</td>
<td>18.46</td>
<td>0.51</td>
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<td></td>
<td>18.77</td>
<td>22.36</td>
<td>0.64</td>
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<tr>
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<td>24.74</td>
<td>27.28</td>
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<td>Put. 150 ppm</td>
<td></td>
<td>26.32</td>
<td>29.11</td>
<td>0.69</td>
</tr>
<tr>
<td>LSD_{0.05}</td>
<td></td>
<td>0.41</td>
<td>0.72</td>
<td>0.03</td>
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<tr>
<td>Effect of Uniconazole</td>
<td></td>
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<td></td>
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<tr>
<td>Uni. 0</td>
<td></td>
<td>19.54</td>
<td>22.53</td>
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</tr>
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<td>Uni. 10 ppm</td>
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<td>23.63</td>
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<td>Uni. 15 ppm</td>
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<td>24.71</td>
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<td>Uni. 20 ppm</td>
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<td>23.35</td>
<td>0.69</td>
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<tr>
<td>LSD_{0.05}</td>
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<td>0.41</td>
<td>0.72</td>
<td>0.03</td>
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<td>Effect of interaction</td>
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<tr>
<td>Put. 0 + Uni. 0</td>
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<td>13.51</td>
<td>16.50</td>
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<td>17.32</td>
<td>19.85</td>
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<td>19.23</td>
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<td>20.17</td>
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<td>Put. 100 ppm + Uni. 0</td>
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<td>22.01</td>
<td>24.35</td>
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<td>23.87</td>
<td>28.01</td>
<td>0.76</td>
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<tr>
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<td>22.22</td>
<td>25.40</td>
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<tr>
<td>Put. 150 ppm + Uni. 10 ppm</td>
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<td>29.27</td>
<td>32.46</td>
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<tr>
<td>Put. 150 ppm + Uni. 15 ppm</td>
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<td>28.74</td>
<td>29.60</td>
<td>0.74</td>
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<tr>
<td>Put. 150 ppm + Uni. 20 ppm</td>
<td></td>
<td>25.07</td>
<td>28.97</td>
<td>0.76</td>
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<tr>
<td>LSD_{0.05}</td>
<td></td>
<td>0.82</td>
<td>1.43</td>
<td>0.05</td>
</tr>
</tbody>
</table>

*Chrysanthemum indicum.* They reported that, using putrescine 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


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