

EFFECT OF PUTRESCINE AND UNICONAZOLE ON SOME VEGETATIVE GROWTH, FLOWERING AND CHEMICAL CONSTITUENTS OF *Salvia splendens* F. PLANT

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ABSTRACT

A pot experiment was carried out during 2006-2007 and 2007-2008 seasons at the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, Egypt and laboratories of the National Research Centre, Dokki, Cairo. The aim of this work was to study the effect of foliar spraying of putrescine at the concentrations of (0, 50, 100 and 150 ppm) and uniconazole at the concentrations of (0, 10, 15 and 20 ppm) and their interaction on vegetative growth and chemical constituents of *Salvia splendens* F. plant. Most criteria of vegetative growth expressed as plant height, stem diameter, number of leaves/plant, fresh and dry weights of leaves and stems, and flowering characteristics expressed as number of spikes/plant, were significantly affected by the two growth bioregulators. Putrescine at the concentration of 150 ppm was the most effective in increasing plant height, stem diameter, number of leaves/plant, fresh and dry weights of leaves and stems and number of spikes/plant. Uniconazole at the concentration of 10 ppm increased significantly all the vegetative growth and flowering characters except stem diameter which increased by using 20 ppm uniconazole. The combined treatment of putrescine at 150 ppm + 10 ppm uniconazole produced the highest values of the number of leaves, fresh and dry weights of leaves and stems, also putrescine at 150 ppm + 20 ppm uniconazole gave the highest value of stem diameter. The highest values in the number of spikes/plant were found when the plants were treated with 150 ppm putrescine + 10 ppm uniconazole in the 1st season and plants treated with 100 ppm putrescine + 10 ppm uniconazole in the 2nd season. The content of N, P and K recorded the highest values when plants were treated with 150 ppm putrescine. Uniconazole at 10 ppm gave the highest values in N%, P%, while uniconazole at 15 ppm gave the highest values of K%. Concerning the interaction between putrescine and uniconazole the results revealed that the plants treated with putrescine at 150 ppm + uniconazole at 10 ppm gave the highest values of N% and P%, while the plants treated with putrescine at 150 ppm + uniconazole at 15 ppm gave the highest values of K%.

Key words: mineral content, putrescine, *Salvia splendens* F., uniconazole, vegetative growth.

1. INTRODUCTION

Salvia splendens 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 planted for extracting volatile oils and some medical components. For that, this genus is called "Salvia", which designates 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.

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 (Kosson and Prang, 2005).

Uniconazole is one of triazole plant growth regulators having important role in crop production, manipulation of plant growth and to yield and induce a variety of morphological and biochemical responses in plants (Fletcher and Hofstra, 1988).

All triazole compounds, its derivatives act as antigibberellin *i.e.*, interfere with the biosynthesis of endogenous gibberellins by preventing the oxidation of entkauren to entkaureonic acid, (Izumi *et al.*, 1988).

Therefore, the work embodied in this experiment was planned to study the effect of putrescine and uniconazole and their interaction on some vegetative growth, flowering characteristics and chemical constituents of *Salvia splendens* F. plant.

2. MATERIALS AND METHODS

The experimental trial was consummated throughout two successive seasons (2006/2007 and 2007/2008) at the nursery of the Ornamental Horticultural Department, Faculty of Agriculture, Cairo University, Giza, Egypt and the laboratories of the 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 the vegetative growth 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 seedling height attained 15 cm and had about 10-15 leaves, they were sprayed with the 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

Plant height (cm), stem diameter (cm), number of leaves/plant, fresh weight of leaves/plant (g), dry weight of leaves/plant (g), fresh weight of stems/plant (g), dry weight of stems/plant (g) and the number of spikes/plant.

2.2. NPK determination: Elements extraction was made using a known weight of the dried shoot samples (0.5 g). The wet digestion procedure was performed (Piper, 1950). Nitrogen contents were determined by the modified Kjeldahl method as described by Cottenie *et al.* (1982), phosphorus content was estimated using ammonium molybdate method according to Snell and Snell (1949) and potassium content was measured in the digested solution by flame photometer according to Chapman and Pratt (1961) and the results were represented as g/100g D.W. of plant.

2.3. Statistical analysis

Data on vegetative growth and some chemical constituents in the two seasons were statistically analyzed as described by Snedecor and Cochran (1980). Means of all characters were compared by L.S.D test at 0.05 level of significance.

3. RESULTS AND DISCUSSION

3.1. Vegetative growth

3.1.1. Plant height

The data recorded in Table (1) show that foliar application of putrescine at the concentrations of 50, 100 and 150 ppm on *Salvia splendens* significantly increased plant height, giving the values of 49.33, 61.08 and 61.33 cm, respectively, compared to the untreated plants (38.83 cm) through the 1st season, the same trend was found in the 2nd one. These results are in agreement with those obtained by many investigators, *i.e.* Youssef *et al.* (2004) on *Matthiola incana*, Talaat *et al.* (2005) on *Catharanthus roseus*, Mahgoub *et al.* (2006) on carnation, El-Quesni *et al.* (2007) on *Bougainvillea glabra*, El-Sayed (2009) on *Chrysanthemum indicum*, Mahgoub *et al.* (2011) on *Dahlia pinnata* and Youssef (2011) on *Populus* sp. 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.

On the other hand, using uniconazole at the concentrations of 10, 15 and 20 ppm significantly decreased plant height in most cases in all the applications, giving the values of 53.33, 50.50 and 49.33 cm, respectively, compared with the untreated plants which recorded 57.42 cm in the 1st season, a similar trend was found in the 2nd one. The results are in accordance with those found by Mahgoub *et al.* (2006) on *Calendula officinalis*,

Table (1): Effect of putrescine and uniconazole on the vegetative growth and flowering of *Salvia splendens* F. plants during 2006/2007 and 2007/2008 seasons.

Measurements Treatments	Plant height (cm)		Stem diameter (cm)		No. of leaves/plant		N0. of spikes/plant	
	1 st season	2 nd season						
Effect of Putrescine								
Put. 0	38.83	42.17	0.74	0.90	169.00	430.25	11.83	16.17
Put. 50 ppm	49.33	51.25	0.81	0.97	230.25	475.00	19.92	24.17
Put. 100 ppm	61.08	65.58	0.88	1.03	360.08	657.58	28.08	33.92
Put. 150 ppm	61.33	66.50	0.99	1.11	352.42	644.58	29.50	33.17
LSD_{0.05}	1.33	2.24	0.08	0.08	14.86	25.78	1.61	1.28
Effect of Uniconazole								
Uni. 0	57.42	62.58	0.70	0.86	247.75	511.83	20.25	22.25
Uni. 10 ppm	53.33	56.92	0.78	0.92	314.25	619.58	26.58	32.25
Uni. 15 ppm	50.50	53.17	0.93	1.07	288.17	559.50	22.50	27.50
Uni. 20 ppm	49.33	52.83	1.02	1.16	261.58	516.76	20.00	25.42
LSD_{0.05}	1.33	2.24	0.08	0.08	14.86	25.78	1.61	1.28
Effect of interaction								
Put. 0 + Uni. 0	40.33	41.67	0.60	0.77	163.00	425.00	8.67	12.00
Put. 0 + Uni. 10 ppm	39.00	42.33	0.63	0.80	176.67	456.33	15.33	19.33
Put. 0 + Uni. 15 ppm	43.67	40.67	0.80	0.97	169.00	440.00	12.67	18.00
Put. 0 + Uni. 20 ppm	32.33	44.00	0.93	1.07	167.33	399.67	10.67	15.33
Put. 50 ppm + Uni. 0	50.33	53.00	0.67	0.83	265.67	373.33	23.33	24.00
Put. 50 ppm + Uni. 10 ppm	48.67	50.00	0.73	0.93	243.00	518.67	21.00	29.00
Put. 50 ppm + Uni. 15 ppm	51.00	47.33	0.87	1.00	215.67	470.67	18.00	21.67
Put. 50 ppm + Uni. 20 ppm	47.33	54.67	0.97	1.10	196.67	537.67	17.33	22.00
Put. 100 ppm + Uni. 0	65.67	76.33	0.70	0.87	273.00	634.83	24.00	26.33
Put. 100 ppm + Uni. 10 ppm	63.00	65.67	0.73	0.90	414.67	714.33	33.67	41.67
Put. 100 ppm + Uni. 15 ppm	53.67	65.00	1.00	1.13	397.00	681.00	28.00	36.33
Put. 100 ppm + Uni. 20 ppm	62.00	55.33	1.07	1.20	355.67	548.68	26.67	31.33
Put. 150 ppm + Uni. 0	73.33	79.33	0.83	0.97	289.33	614.67	25.00	26.67
Put. 150 ppm + Uni. 10 ppm	62.67	69.67	1.00	1.03	422.67	789.00	36.33	39.00
Put. 150 ppm + Uni. 15 ppm	53.67	59.67	1.03	1.17	371.00	646.33	31.33	34.00
Put. 150 ppm + Uni. 20 ppm	55.67	57.33	1.10	1.27	326.67	581.00	25.33	33.00
LSD_{0.05}	2.66	4.48	0.16	0.17	29.71	51.57	3.21	2.55

Putrescine: Put., Uniconazole: Uni.

El-Quesni *et al.* (2007) on *Bougainvillea glabra*, El-Sayed (2009) on *Chrysanthemum indicum*, Bekheta *et al.* (2008) on *Gerbera jamesonii* and El-Sayed (2011) on *Schefflera arboricola* plants. They found that the application of uniconazole caused a reduction in plant height. In this concern, Cosgrove and Sovonik-Dunford (1989) stated that uniconazole reduced wall relaxation, so growth retardation was affected *via* a reduction in the wall yield coefficient.

Concerning the interaction between putrescine and uniconazole at different concentrations, the data in Table (1) show that the plants treated with putrescine at the concentration of 150 ppm alone produced the tallest height (73.33 and 79.33 cm) in the 1st and the 2nd seasons, respectively, followed by the plants treated with 100 ppm putrescine, giving (65.67 and 76.33 cm) in the 1st

and the 2nd seasons, respectively, compared with plants treated with 100 ppm putrescine + 10 ppm uniconazole giving (63 and 65.67 cm) in the 1st and the 2nd seasons, respectively.

3.1.2. Stem diameter

The data presented in Table (1) indicate that spraying *Salvia splendens* at different concentrations of putrescine significantly increased stem diameter compared to the control. Using putrescine at the concentration of 150 ppm produced the thickest stems (0.99 and 1.11 cm) in the 1st and the 2nd seasons, respectively, compared to the untreated plants which had the thinnest stems (0.74 and 0.90 cm) in the 1st and the 2nd seasons, respectively. These results are in agreement with those obtained by El-Quesni *et al.* (2010) on *Syngonium podophyllum* L. Polyamines

have been implicated in a wide range of biological processes including growth development, cell division and differentiation (Kuehn and Phillips, 2005).

In the case of spraying uniconazole, the data revealed that all concentrations recorded significant increases in stem diameter compared to the untreated plants. The best results were found when the plants were treated with 20 ppm uniconazole. The mean values were 1.02 and 1.16 cm in the 1st and the 2nd seasons, respectively, compared to the untreated plants (0.70 and 0.86 cm in the 1st and the 2nd seasons, respectively). These results are in the line with those obtained by Mansuroglu *et al.* (2009) on *Consolida orientalis* who found that using uniconazole at different concentrations increased stem diameter than the control plants. The increases of stem diameter were directly in relation to the concentration of uniconazole.

The interaction between putrescine and uniconazole show that, 150 ppm putrescine + 20 ppm uniconazole produced the thickest stem (1.10 and 1.27 cm) in the 1st and the 2nd seasons, respectively, compared to the other treatments, while the thinnest stem was recorded when the plants were treated with Putrescine 0 ppm + 10 ppm uniconazole, the mean values were 0.63 and 0.80 cm in the 1st and the 2nd seasons, respectively.

3.1.3. Number of leaves/plant

The results in Table (1) indicate that treating *Salvia splendens* with different concentrations of putrescine increased significantly the number of leaves/plant than untreated plants. Putrescine at the concentration of 100 ppm produced the highest values (360.08 and 657.75) in the 1st and the 2nd seasons, respectively, compared to the other two concentrations. These results are in accordance with those found by Youssef *et al.* (2004) on *Matthiola incana*, El-Quesni *et al.* (2007) on *Bougainvillea glabra*, El-Tohamy *et al.* (2008) on *Solanum melongena*, El-Sayed (2009) on *Chrysanthemum indicum*, El-Quesni *et al.* (2010) on *Syngonium podophyllum* and Mahgoub *et al.* (2011) on *Dahlia pinnata*. They found that putrescine with different concentrations increased the number of leaves/plant.

Regarding the effect of uniconazole on the number of leaves/plant, the data revealed that all concentrations significantly increased this character as compared to the control plants. The number of leaves/plant decreased as the concentration of uniconazole was raised, the highest values were found when the plants were treated with 10 ppm uniconazole giving (314.25

and 619.58) in the 1st and the 2nd seasons, respectively, compared with the control plants giving (247.75 and 511.83). These results are in agreement with those obtained by El-Quesni *et al.* (2007) on *Bougainvillea glabra* plants, Bekheta *et al.* (2008) on *Gerbera jamesonii* and El-Sayed (2009) on *Chrysanthemum indicum* plants. The increase in leaf formation due to the application of uniconazole may be attributed to the high level of cytokinins (Singh and Bist, 2003).

For the interaction between putrescine and uniconazole, the data show that the treatment of putrescine at 150 ppm + uniconazole at 10 ppm significantly increased the number of leaves/plant giving 422.67 and 789.00 leaves/plant in the 1st and the 2nd seasons, respectively compared to the other interactions and to the control plants.

3.1.4. Fresh and dry weights of leaves/plant (g)

The results found in Table (2) show that the foliar spray of putrescine at the different concentrations significantly increased the fresh and dry weights of the leaves/plant in the 1st and the 2nd seasons. Treating the plants with 150 ppm putrescine resulted in the highest increase in fresh weight of leaves/plant (68.44 and 134.47 g) in the 1st and the 2nd seasons, respectively, also in dry weight of leaves/plant (19.89 and 36.60 g) in the 1st and the 2nd seasons, respectively. These results are in agreement with those obtained by Youssef *et al.* (2004) on *Matthiola incana* L., Talaat *et al.* (2005) on *Catharanthus roseus* L., Mahgoub *et al.* (2006) on *Dianthus caryophyllus* L., El-Sayed (2009) on *Chrysanthemum indicum* L., El-Quesni *et al.* (2010) on *Syngonium podophyllum* L., and Mahgoub *et al.* (2011) on *Dahlia pinnata* L. Polyamines exhibit their effect on growth through enhancing cell division and expansion (Cohen, 1998) and they can also act as a source of nitrogen, which stimulates growth (Smith, 1982).

Concerning the effect of uniconazole, the data in Table (2) show that the plants treated with 10 ppm and 15 ppm uniconazole had the significant increases in fresh and dry weights of leaves/plant compared to the untreated plants. The obtained values were 57.82 and 114.03 g fresh weight in the 1st and the 2nd seasons, respectively, and 16.42 and 30.19 g dry weight in the 1st and the 2nd seasons, respectively. These results are similar to those obtained by Wang *et al.* (1990) on three bedding plants including *Salvia splendens*, Keever and Foster (1991) on some bedding plants which included *Salvia farinacea*, Kandil and Eleiwa (2008) on *Ammi majus* L. plants, Bekheta *et al.* (2008) on *Gerbera jamesonii* L. plants and El-Sayed (2009) on *Chrysanthemum indicum* L..

plants.

By reference to Table (2), the results indicate that the highest values obtained from the interaction between putrescine and uniconazole were found in the plants treated with 150 ppm putrescine + 10 ppm uniconazole in fresh leaves/plant (93.32 and 167.25 g) and dry weight of leaves/plant (27.99 and 46.83 g) in the 1st and the 2nd seasons, respectively.

3.1.5. Fresh and dry weights of stems/plant (g)

The data presented in Table (2) show that foliar spray of putrescine at different concentrations significantly increased the fresh and dry weight of the stems/plant in the two seasons. Treating the plants with 150 ppm caused the highest increase in fresh weight of stems/plant (92.97 and 227.80 g) and dry weight of stems/plant (31.62 and 71.20 g) in the 1st and the 2nd seasons, respectively. These results are in accordance with those obtained by

Youssef *et al.* (2004) on *Matthiola incana* L., Talaat *et al.* (2005) on *Catharanthus roseus* L., Mahgoub *et al.* (2006) on *Dianthus caryophyllus* L. plants, El-Sayed (2009) on *Chrysanthemum indicum* L. and Mahgoub *et al.* (2011) on *Dahlia pinnata* L. Polyamines have been described showing various roles such as a new class of plant growth regulators, Hormonal Second Messengers (HSM) and one of the reserves of carbon and nitrogen at least in cultured tissue. At cellular pH values, these compounds behave as cations and can interact with anionic macromolecules such as DNA, RNA phospholipids and certain proteins. (Hepy and Persson, 1990).

In regarding to using uniconazole, the data in Table (2) show that the plants treated with 10 and 15 ppm uniconazole had the significant increases in fresh and dry weight of stems/plant compared to untreated plants. The highest values of the fresh

Table (2): Effect of putrescine and uniconazole on the vegetative growth of *Salvia splendens* F. plant during 2006/2007 and 2007/2008 seasons.

Measurements	F.W leaves/plant (g)		F.W. stems/plant (g)		D.W. leaves/plant (g)		D.W. stems/plant (g)	
	1 st season	2 nd season						
Effect of Putrescine								
Put. 0	29.51	63.70	29.32	93.79	7.12	14.80	8.70	24.50
Put. 50 ppm	35.91	86.80	53.63	138.97	9.34	21.47	16.87	38.31
Put. 100 ppm	58.68	117.14	83.76	207.49	16.59	31.11	27.97	62.48
Put. 150 ppm	68.44	134.47	92.97	227.80	19.89	36.60	31.62	71.20
LSD_{0.05}	2.40	3.65	1.93	2.74	0.43	0.31	0.21	0.09
Effect of Uniconazole								
Uni. 0	41.14	90.54	59.81	158.24	10.82	22.85	19.11	45.26
Uni. 10 ppm	57.82	114.03	77.35	192.66	16.42	30.19	26.06	59.67
Uni. 15 ppm	51.62	106.74	64.37	169.20	14.45	28.00	21.09	50.00
Uni. 20 ppm	41.96	90.80	58.15	147.95	11.25	22.95	18.89	41.57
LSD_{0.05}	2.40	3.65	1.93	2.74	0.43	0.31	0.21	0.09
Effect of interaction								
Put. 0 + Uni. 0	28.39	60.25	25.20	90.56	6.70	12.87	7.28	23.55
Put. 0 + Uni. 10 ppm	31.82	70.53	34.23	110.27	7.86	16.79	10.41	29.33
Put. 0 + Uni. 15 ppm	29.03	67.09	30.02	97.12	7.03	15.70	8.95	25.45
Put. 0 + Uni. 20 ppm	28.79	56.93	27.82	77.20	6.88	13.85	8.15	19.69
Put. 50 ppm + Uni. 0	43.18	77.38	66.32	121.76	11.44	24.67	21.22	32.88
Put. 50 ppm + Uni. 10 ppm	33.17	82.92	58.34	142.87	8.59	20.32	18.38	39.57
Put. 50 ppm + Uni. 15 ppm	34.63	89.00	49.38	130.69	9.07	22.25	15.36	35.68
Put. 50 ppm + Uni. 20 ppm	32.65	97.90	40.46	160.56	8.26	18.65	12.50	45.12
Put. 100 ppm + Uni. 0	45.62	110.71	70.33	195.82	12.27	26.20	22.65	57.18
Put. 100 ppm + Uni. 10 ppm	72.98	135.41	103.12	250.07	21.24	36.83	35.68	81.52
Put. 100 ppm + Uni. 15 ppm	65.65	120.47	83.27	210.91	18.84	32.53	27.73	62.22
Put. 100 ppm + Uni. 20 ppm	50.48	101.95	78.31	173.16	14.03	28.90	25.84	49.00
Put. 150 ppm + Uni. 0	47.36	113.81	77.38	224.80	12.88	27.66	25.30	67.44
Put. 150 ppm + Uni. 10 ppm	93.32	167.25	113.68	267.42	27.99	46.83	39.79	88.25
Put. 150 ppm + Uni. 15 ppm	77.19	150.41	94.81	238.09	22.85	41.51	32.33	76.66
Put. 150 ppm + Uni. 20 ppm	55.90	106.42	86.01	180.89	15.82	30.39	29.07	52.45
LSD_{0.05}	4.79	7.30	3.85	5.49	0.86	0.62	0.42	0.18

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

weight of stems/plant were 77.35 and 192.66 g and the dry weight of stems/plant were 26.06 and 59.67 g in the 1st and the 2nd seasons, respectively, when the plants were treated with 10 ppm uniconazole. These results are similar to those obtained by Keever and Foster (1991) on some bedding plants which included *Salvia farinacea*, Kandil and Eleiwa (2008) on *Ammi majus* L. and El-Sayed (2009) on *Chrysanthemum indicum* L.

In Table (2), the results show that the highest values obtained from the interaction between putrescine and uniconazole were found in the plants treated with 150 ppm putrescine + 10 ppm uniconazole in fresh weight of stems/plant (113.68 and 267.42 g) and dry weight of stems/plant (39.79 and 88.25 g) in the 1st and the 2nd seasons, respectively.

3.2. Flowering characteristics

3.2.1. Number of spikes/plant

Data presented in Table (1) indicate that foliar spraying of *Salvia splendens* F. with putrescine at the concentrations of 50, 100 and 150 ppm caused significant increase in the number of spikes/plant in both seasons than the control. The highest values were found when the plants were treated with 150 ppm putrescine giving 29.50 and 100 ppm putrescine giving 33.92 compared to the control (11.83 and 16.17) in the 1st and the 2nd seasons, respectively. These findings are in accordance with some investigators *i.e.*, Youssef *et al.* (2004) on *Matthiola incana*, Mahgoub *et al.* (2006) on *Dianthus caryophyllus*, Abd El-Aziz *et al.* (2009) on gladiolus and Mahgoub *et al.* (2011) on dahlia. This may be explained that the conjugated polyamines are known to be associated with the physiology of flowering (Solcum and Galston, 1985).

With regard to the effect of uniconazole, the data indicate that in the 1st season the application of 10 and 15 ppm uniconazole increased the number of spikes/plant than the untreated plants, while the application of 10, 15 and 20 ppm uniconazole treatments increased the number of spikes/plant in the second season than the control plants. The highest values were obtained when the plants treated with 10 ppm which recorded 26.58 and 32.25 compared to the control plants giving 20.25 and 22.25 in the 1st and the 2nd seasons, respectively. In support of these results significant influence of uniconazole increasing the number of spikes/plant has been experimentally sustained by Yoo *et al.* (1999) on *Chrysanthemum*, Jung *et al.* (2000) on *Chrysanthemum*, Mahgoub *et al.* (2006) on *Calendula officinalis*, Bekheta *et al.* on *Gerbera jamesonii* and El-Sayed (2009) on

Chrysanthemum indicum. It may be due that paclobutrazol, an inhibitor of gibberellins biosynthesis or action significantly accelerate flowering at certain doses in woody, perennial and annual plants, (Karagusel and Ortacesme, 2002).

Regarding the effect of interaction between putrescine and uniconazole, data show that the highest values were found when the plants were treated with 150 ppm putrescine + 10 ppm uniconazole in the 1st season, while the plants treated with 100 ppm putrescine + 10 ppm uniconazole gave the highest values in the 2nd season.

3.3. Mineral content

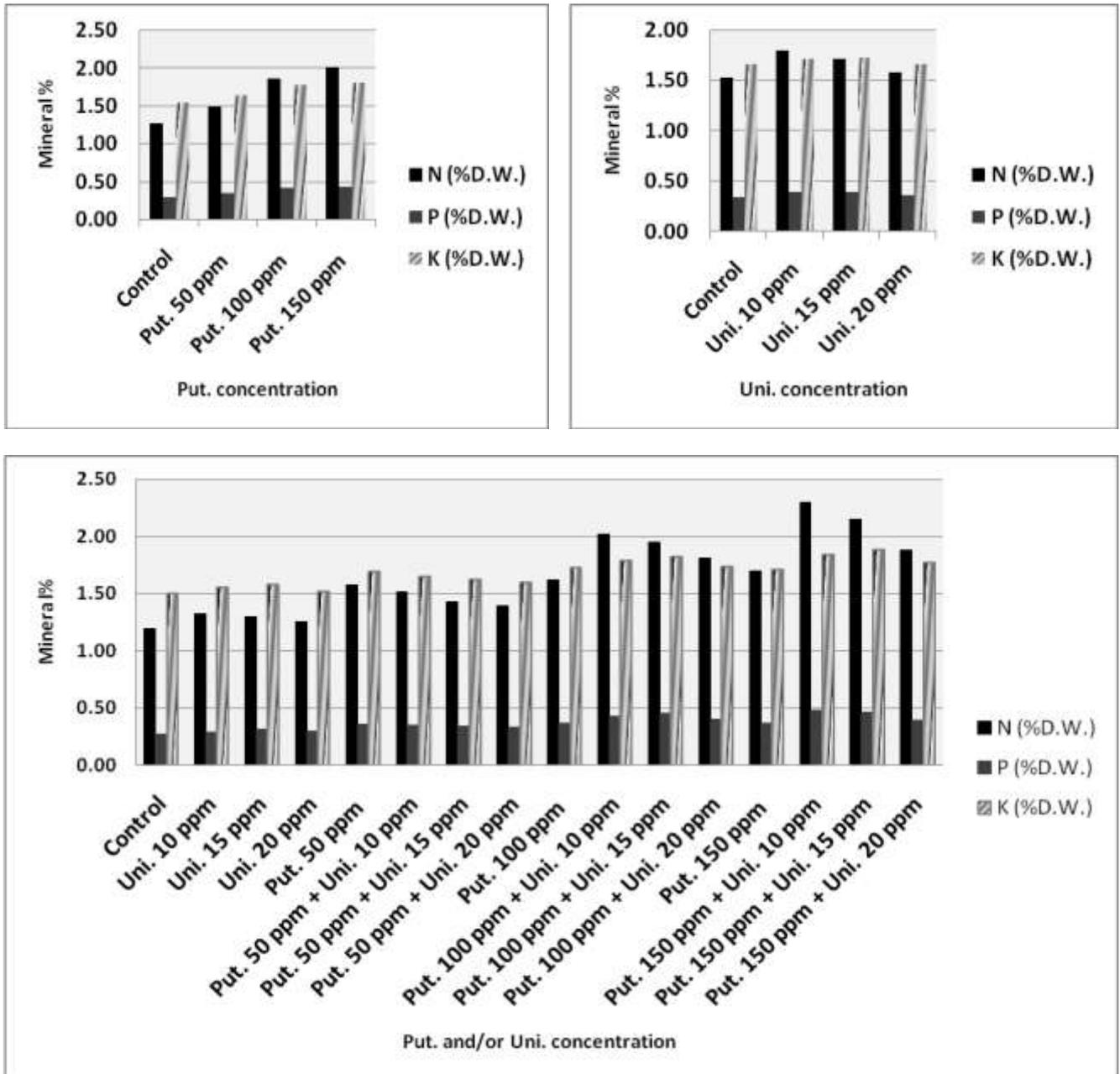
3.3.1. Nitrogen percentage in shoot

The data illustrated in Figs. (1) and (2) indicate significant effect of putrescine and uniconazole on the percentage of nitrogen in *Salvia splendens* F. It was noticed that the N% in the shoots increased by all the tested concentrations of the two used bio-regulators than in the untreated plants.

Concerning the effect of putrescine, the results indicated that treating plants with 150 ppm gave the highest significant values (2.01 and 2.29% D.W.) in the 1st and the 2nd seasons, respectively, than the untreated plants which recorded (1.27 and 1.55% D.W.) in the 1st and the 2nd seasons, respectively, followed by 100 ppm putrescine, then 50 ppm putrescine. These results agree with those obtained by El-Quesni *et al.* (2007) on *Bougainvillea glabra* plants, El-Sayed (2009) on *Chrysanthemum indicum*, El-Quesni *et al.* (2010) on *Syngonium podophyllum* and Youssef (2011) on *Populus* sp. They found that the using of putrescine at different concentrations increased N% content in the treated plants than in the untreated ones.

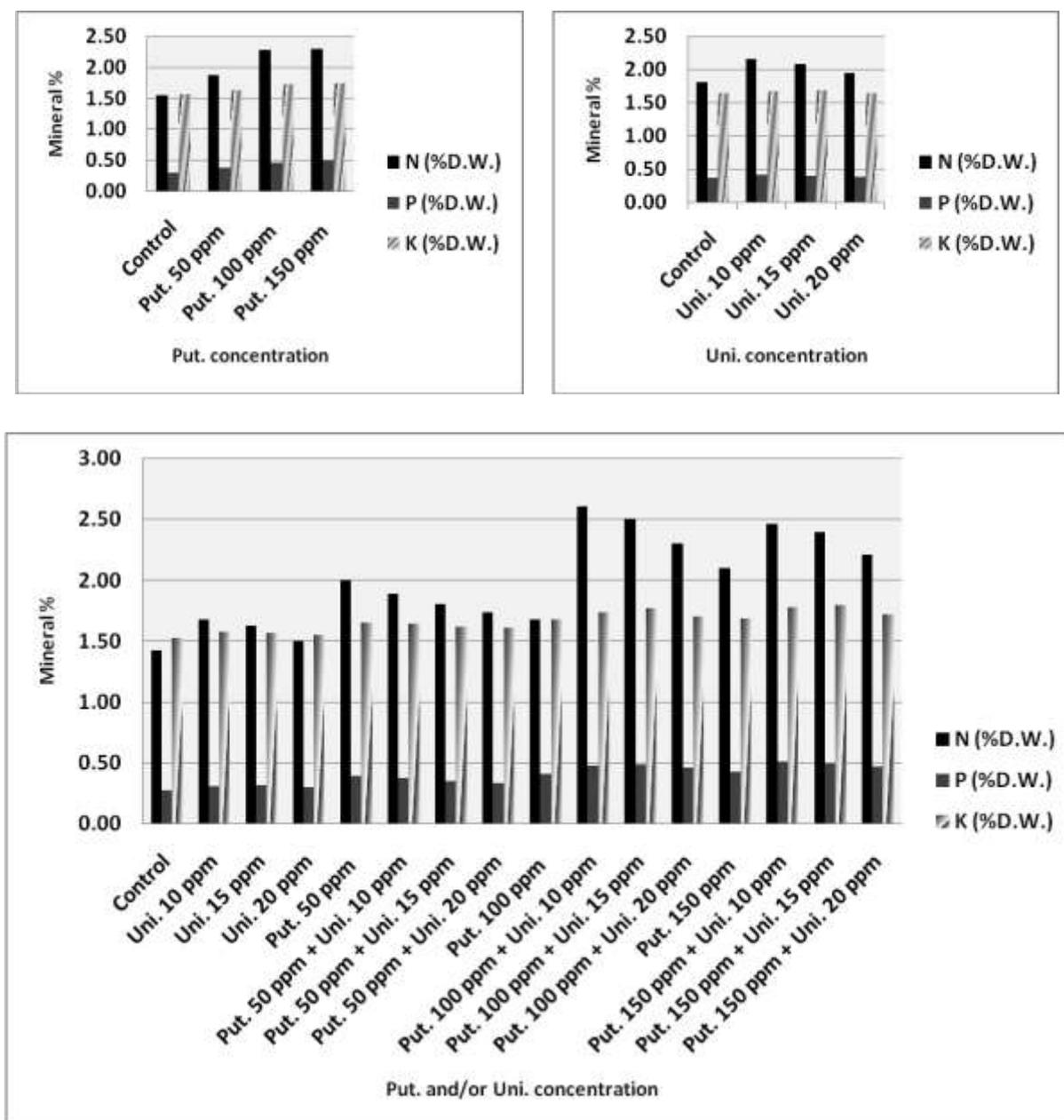
In the case of uniconazole, it was found that all tested concentrations increased N content compared to untreated plants. Plants treated with 10 ppm uniconazole produced the highest values (1.79 and 2.16% D.W.) compared to the control plants (1.53 and 1.80% D.W.) in the 1st and the 2nd seasons, respectively. These results are similar to those obtained by El-Quesni *et al.* (2007) on *Bougainvillea glabra*, Kandil and Eleiwa (2008) on *Ammi majus*, Abd-El-Aziz *et al.* (2009) on *gladiolus* and El-Sayed (2009) on *Chrysanthemum indicum*.

Regarding the effect of interaction between putrescine and uniconazole it was found that spraying the plants with 150 ppm putrescine + 10 ppm uniconazole recorded the highest N% content (2.30 and 2.60% D.W.) than the control plants (1.19 and 1.42% D.W.) in the 1st and the 2nd (1.19



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

Fig. (1): Effect of putrescine and uniconazole on nitrogen, phosphorus and potassium in the shoots of *Salvia splendens* F. during 2006/2007 (first season).



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

Fig. (2): Effect of putrescine and uniconazole on nitrogen, phosphorus and potassium in the shoots of *Salvia splendens* F. during 2007/2008 (second season).

and 1.42% D.W.) in the 1st and the 2nd seasons, respectively, while the lowest N% was obtained with 0 ppm + 15 ppm uniconazole which recorded (2.15 and 2.50% D.W.) in the 1st and the 2nd seasons, respectively.

3.3.2. Phosphorus percentage in shoots

The data illustrated in Figs. (1) and (2) showed that the application of putrescine at three concentrations produced significant increase in P% in shoots than the control plants in the two seasons. The highest values were found when the plants were treated with 150 ppm putrescine giving 0.43 and 0.48% D.W. in the 1st and the 2nd seasons, respectively.

In the case of uniconazole treatment, the data also showed significant increase in P% in the plants were treated with different concentrations of uniconazole. The highest values were found when the plants treated with 10 ppm uniconazole in the 1st and the 2nd seasons, which recorded 0.39 and 0.42% respectively, than the control plants (0.34 and 0.38% D.W.) in the 1st and the 2nd seasons, respectively.

The plants treated with putrescine at the concentration of 150 ppm + uniconazole at the concentration of 10 ppm produced the highest P% values (0.48 and 0.51% D.W.) followed by putrescine 150 ppm + uniconazole 15 ppm which gave 0.46 and 0.50% D.W. in the 1st and the 2nd seasons, respectively. Whereas the untreated plants gave 0.27 and 0.28% D.W. in the 1st and the 2nd seasons, respectively.

These results are similar to those obtained by El-Quesni *et al.* (2007) on *Bougainvillea glabra*, Kandil and Eleiwa (2008) on *Ammi majus*, Abd-El-Aziz *et al.* (2009) on *gladiolus* plants, El-Sayed (2009) on *Chrysanthemum indicum*, El-Quesni *et al.* (2010) on *Syngonium podophyllum* and Youssef (2011) on *Populus* sp. They found that foliar application of putrescine and triazole compounds increased P% content of the plants.

3.3.3. Potassium percentage in shoots

The data illustrated in Figs. (1) and (2) showed significant increase when the plants treated by the three concentrations of putrescine and the best results were found by using 150 ppm putrescine than the untreated plants which recorded 1.80 and 1.75% D.W. in the 1st and the 2nd seasons, respectively. These results are in agreement with El-Quesni *et al.* (2007) on *Bougainvillea glabra*, El-Sayed (2009) on *Chrysanthemum indicum*, El-Quesni *et al.* (2010) on *Syngonium podophyllum* and Youssef (2011) on *populus*. They found that putrescine with different concentrations increased the content of K% in the plants.

In the case of the effect of uniconazole, the data revealed that all concentrations gave significant increase in K% content. The highest values were found by using 15 ppm uniconazole giving 1.72 and 1.69% D.W. in the 1st and the 2nd seasons, respectively than the untreated plants (1.66 and 1.64% D.W.) in the 1st and the 2nd seasons, respectively. These results are similar to those obtained by El-Quesni *et al.* (2007) on *Bougainvillea glabra*, Kandil and Eleiwa (2008) on *Ammi majus*, Abd-El-Aziz *et al.* (2009) on *gladiolus* and El-Sayed (2009) on *Chrysanthemum*.

The combination of putrescine (150 ppm) and uniconazole (15 ppm) resulted in the greatest increase of K concentration in the shoots in both seasons compared to the control. The recorded values were 1.88% D.W. in the 1st season compared to 1.50% D.W. in the control plants and of the 1.80% D.W. in the 2nd season compared to 1.53% in the control plants.

The positive obtained results may be due to the main role of bioregulators on growth of roots and consequently increased the absorbing area of the plants (Hanafy *et al.*, 2002). Salama (1999) recorded that polyamines (PAs) as spray increased some nutrient elements particularly K, which was found to serve a vital role in photosynthesis by directly increase growth and photosynthetic pigments, and hence CO₂ assimilation. Shawky (2003) reported that the increment in minerals uptake (N, P and K) by PAs treatment, the promotive effect of PAs treatment on plant growth productivity as well as on plant chemical composition may be due to the effect on many metabolic and physiological processes. Youssef (2007) noticed that PAs have possibly increased activities on metabolic processes in plant. Accordingly, physiological performance of such plants was improved, as manifested by the increased efficiency of roots in absorbing macronutrients from the soil.

Concerning the effect of uniconazole concentrations on the content of N, P and K; Kuchenbuch and Jung (1988), Bekheta (1993) and El-Kadey (2002), found that using different concentrations of uniconazole increased the content of mineral ions in the treated plants (Davies, 1995). Also, the positive obtained results of uniconazole may be due to its main role on the growth of roots and consequently increased the absorbing area for plants.

Recommendation: From this study it may be recommended spraying salvia plants twine with putrescine 150 ppm and Uniconazole 10 ppm to enhance the vegetative growth and the content of NPK as compared with the untreated plants.

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تأثير مادتي البوتريسين والبيونيكونازول على بعض الصفات الخضريّة
والزهريّة والمكونات الكيماويّة لنبات *Salvia splendens*

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كان الهدف من هذا العمل دراسة تأثير الرش الورقي بمنظمين للنمو هـ م أ البوتريسين بتركيزات (0 و 50 و 100 و 150 جزء في المليون) والبيونيكونازول بتركيزات (0، 10، 15 و 20 جزء في المليون)، وكذلك تأثير الرش بكليهما معاً على بعض الصفات الخضريّة والمكونات الكيماويّة لنبات السلفيا الحمراء خلال مواسم النمو 2007/2006 و 2008/2007. وقد أظهرت النتائج ما يلي:

تأثرت معظم الصفات الخضريّة مثل طول النبات، وقطر الساق، وعدد الأوراق لكل نبات، وعدد الأفرع لكل نبات، والوزن الطازج والجاف للأوراق والسيقان، وكذلك الصفات الزهرية الممثلة في عدد النورات لكل نبات، بشكل معنوي، بإضافة منظمي النمو المستخدمان في هذه الدراسة.

أدى رش النباتات بالبوتريسين بتركيز 150 جزء في المليون إلى أعلى زيادة في طول النبات، وقطر الساق، وعدد الأوراق لكل نبات، والوزن الطازج والجاف للأوراق والسيقان، وعدد النورات لكل نبات.

تسببت معاملة نباتات السلفيا الحمراء بمادة اليونيكونازول، بتركيز 10 جزء في المليون في زيادة كل الصفات الخضريّة والزهرية سائلة الذكر بشكل معنوي، ما عدا قطر الساق الذي زاد عند الرش باليونيكونازول بتركيز 20 جزء في المليون. وعند استخدام المادتين معاً بتركيزاتهما المذكورة أعلاه، فكانت أفضل النتائج عند استخدام البوتريسين بتركيز 150 جزء في المليون مع اليونيكونازول بتركيز 10 جزء في المليون وذلك مع عدد الأوراق لكل نبات، والوزن الطازج والجاف للأوراق والسيقان. أما بالنسبة لقطر الساق فكانت أعلى القيم عند رش النباتات بالبوتريسين بتركيز 150 جزء في المليون مع اليونيكونازول بتركيز 20 جزء في المليون. وسجلت عدد النورات لكل نبات أعلى زيادة عند استخدام البوتريسين بتركيز 150 جزء في المليون واليونيكونازول بتركيز 10 جزء في المليون في الموسم الأول بينما كانت أعلى زيادة في الموسم الثاني في النباتات التي عوملت بالبوتريسين بتركيز 100 جزء في المليون مع اليونيكونازول بتركيز 10 جزء في المليون. وأخيراً عند تقدير بعض المكونات الكيماوية لنباتات السلفيا الحمراء تحت الدراسة فقد وجدت أعلى القيم لمحتوى النبات من النيتروجين والفوسفور والبوتاسيوم في الأوراق والسيقان عند رش النباتات بالبوتريسين بتركيز 150 جزء في المليون. أما عند استخدام اليونيكونازول فقد أعطى أعلى القيم في محتوى النبات من النيتروجين والفوسفور برشه بتركيز 20 جزء في المليون، وسجلت أعلى القيم في محتوى النبات من البوتاسيوم عند رشه بتركيز 10 جزء في المليون. وعند استخدام المادتين معاً كانت أعلى القيم في محتوى النبات من النيتروجين والفوسفور عند الرش بالبوتريسين بتركيز 150 جزء في المليون مع اليونيكونازول بتركيز 10 جزء في المليون، بينما كانت أعلى القيم لمحتوى النبات من البوتاسيوم عند رش البوتريسين بتركيز 150 جزء في المليون مع اليونيكونازول بتركيز 15 جزء في المليون.