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Impact of Foliar Spraying with Boron, Zinc, Salicylic Acid and Their Combinations on Growth and Flowering of *Jasminum sambac* L. Plant

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ABSTRACT

The current study was carried out at a private farm in Al Sananiyah, Damietta Governorate, Egypt during two successive seasons of 2018/19 and 2019/20 on two years-old seedlings of Arabian jasmine plants to investigate the effect of foliar spraying with boron (80 ppm), zinc (120ppm), salicylic acid (200ppm) and their combinations on vegetative growth، flowering, and biochemical characteristics of Arabian jasmine plants. The most important results indicated that foliar spraying with salicylic acid alone or in combination with Zn led to a significant increasing of the most vegetative growth characteristics and biochemical characteristics (tryptophan, polyphenols, total carbohydrates and reducing sugars), while spraying with Zn alone increasing the dry weight of shoots and NPK% during the two seasons. In addition, foliar spraying with zinc or salicylic acid alone or in combination led to a significant improvement in the flowering characteristics (number of total flowers, number of flowering points, number of clusters, number of single flowers, mean number of flowers/cluster). Moreover, foliar spraying with boron alone gave the highest values for flowering characteristics except for the mean number of flowers/clusters. However, gradual decrease in the leaf pigments content (chlorophyll a, b, total chlorophyll and carotenoids) were recorded in all spraying treatment comparing to the control. Accordingly, this study recommends foliar spraying with the combination treatment containing zinc at120 ppm and salicylic acid at 200 ppm to improve the vegetative growth and to increase the flowers number of Grand Duke of Tuscany Jasminum sambac L. plants.

INTRODUCTION

Arabian jasmine (*Jasminum sambac* L.) belongs to the family Oleaceae, under the tribe Jasmineae (USDA, 2013). It is a small evergreen shrub with attractive leaves producing attractive white sweet-scented flowers in great profusion in the hot season **(Rao and Rout, 2003)**. This plant is used in gardens and indoor cultivation" in room balcony" as an ornamental plant, its tall ranged from 0.5 to 3.0 m, it has the most luxurious scent that you will most likely be recognized. It is famous for its beautiful blooming flowers and wonderful aroma, it is of great importance in the perfume industry and its flowers are used in various religions and ceremonies. Egypt produces approximately 70–80% of the world's jasmine absolute alone. Property of jasmine (*Jasminum sambac* L.) oil allows it to be used in food preservation. It also possesses antioxidant activity. The major components of jasmine essential oil are linalool, benzyl acetate, and benzyl benzoate **(Ahmed *et al.*, 2016)**.

Foliar spraying with micro-nutrients and plant growth regulators is a common practice to overcome deficiencies of nutrients to improve the quality of plants. Nutrients are generally available to plants by foliar spraying more quickly than soil **(Phillips and Mullins, 2004)**.

Boron is a micronutrient element, which had a significant impact on plant growth and development. The essential physiological activities of boron are linked to cell elongation and development, RNA metabolism, sugar transport, hormone development, respiration, cell division, Indole acetic acid (IAA) metabolism and as part of the cell membranes **(Goldbach and Wimmer, 2007)**. Boron very important for enzymatic reactions within plants such as the making of RNA and DNA, protein formation, synthesis of the cell wall, occurrence of flowering and fruit formation, important part of growth hormone **(Ullah *et al.*, 2015)**.

Zinc belongs to micro-nutrients, necessary for all types of plants, part of the enzymes involved in protein synthesis and energy processes. Also, it is essential for maintaining the integrity of biofilms and plays an important role in the development of seeds and productive organs **(Sturikova *et al.*, 2018)** and plant physiological function, chlorophyll, vegetative growth, forming phenol, synthesis tryptophan

which is the precursor of IAA **(Camacho *et al.*, 2008 and El-Boraie, 2019)**.

Salicylic acid (SA) is a phenolic phytohormone and plays an important role on plant growth and development, photosynthesis, ion uptake and transport. SA also induces specific modifications and changes in leaf and chloroplast structure **(Hayat and Ahmad, 2007)**. SA is considered a plant growth stimulator that is known as an endogenous signaling molecule, which is involved in different plant physiological processes like regulation growth, stomatal conductance, photosynthesis, plant water relations, nutrient uptake, and mechanisms of plant tolerance and resistance and abiotic stresses **(Hayat *et al.*, 2010)**.

Therefore, the current investigation aimed to evaluate the effect of foliar application with boron, zinc, salicylic acid alone or in combinations on vegetative growth, root parameters, flowering characteristics, photosynthetic pigment contents, biochemical changes and macro elements in leaves of *Jasminum sambac* L. Shrubs.

MATERIALS AND METHODS

This current study was carried out at a private farm in Al Sananiyah, Damietta Governorate and laboratory of the horticulture department, Faculty of Agriculture, Damietta University, Egypt during two successive seasons of 2018/19 and 2019/20 on Arabian jasmine (*Jasminum sambac* L. "Grand Duke of Tuscany") plants.

Plant material and cultivation

Cutting of Jasminum sambac L. plants were purchased from Egypt Green farm, Cairo Governorate, Egypt and then they used in propagation for producing the required seedlings. Each seedling was transplanted in plastic pot size (40 cm) filled beforehand with soil mixture consists of clay: sand: peat moss (2:2:1 v/v/v). Then the plants were pruning at a height of 15 cm in March of 2018 and 2019 years.

The experimental design

This experiment was carried out in complete randomized block design involved 8 treatments each of them includes Nine plants in three replicates (3 plants for each replicate). All the studied treatments were applied as foliar spraying as follows: Con: Distilled water (control).

B: Boron at 80 ppm (boric acid).

Zn: Zinc at 120 ppm (zinc sulfate).

SA: Salicylic acid at 200 ppm.

B + Zn: Boron at 80 ppm and Zinc at 120 ppm.

B +SA: Boron at 80 ppm and Salicylic acid at 200 ppm.

Zn + SA: Zinc at 120 ppm and Salicylic acid at 200 ppm.

B+ Zn + SA: Boron at 80 ppm, Zinc at 120 ppm and Salicylic acid 200 ppm.

Arabian jasmine plants under study

All treatments were sprayed 6 times starting from April to October during the two seasons of study.

Data recorded

A) The vegetative growth parameters

At the end of the experiment (November) three plants were randomly collected from each treatment (one plant from each replicate) and the following characters were recorded:

- Plant height (cm)
- Number of branches/plant
- Number of leaves/plants
- Number of leaves/ branch

The leaves number per branch was calculated using the following equation:

$$No.\ Leaves/Branch = \frac{Total\ Leaves\ No.}{Total\ Branches\ No.}$$

- Dry weight of shoots/plant (g)

The above mentioned plants were cut, air-dried, placed in paper bags and then dried at 75 °C for 3 days in the oven until weight stability **(Bo et al., 2018)**.

B) The flowering characteristics

1- Number of total flowers /plant

It was calculated by applying the following equation:

Total flowers No./plant = Number of single flowers + (Average of flowers No./cluster x clusters No.)

2- Number of total flowering points/plant

All flowering points whether, a single or cluster, opening or not, were counted for each plant through the following equation: Number of flowering points/plant = Number of single flower points + Number of cluster points

3 - Number of clusters/plant (cluster)

4 - Number of single flowers/plant (flower)

5 - Mean of flowers number/cluster / plant (NFC)

It was calculated by using the following equation:

NFC = (NFC1 + NFC2 + NFC3 +..... + NFCy) / Number of clusters. Whereas, NFC1 represent flowers No. in cluster 1, NFC2 represent flowers No. in cluster 2 …… etc.

C) Chemical analysis

At the end of the experiment (November) random leaves sample was taken from each treatment in two seasons for the following measurements:

1. photosynthetic pigments content

Chlorophyll a, chlorophyll b, total chlorophyll, and carotenoids (µg/cm^2) were determined in fresh leaves samples according to **Moran (1982)**.

2. Biochemical changes analysis

were performed in dried leaves at the end of the experiment for the two seasons (November).

2.1. Tryptophan (µg/g)

Tryptophan was determined as described by **Sastry and Tummuru (1985)**.

2.2. Polyphenols (mg/100g)

The phenolic components were extracted as described by **Stabell *et al.* (1996)** and measured using Folin-Ciocalteau reagent **(Sadasivam & Manickam, 1996)** with catechol as standard. Total phenolic contents were expressed as mg gallic acid equivalent (mg GAE)/g DW.

2.3. Total carbohydrates (mg/100 mg)

Total carbohydrates content was determined according to **Hedge and Hofreiter (1962)**.

2.4. Reducing sugars (mg/100 mg)

Reducing sugars (RS) content was determined according to the method described by **Somogyi (1952)**.

3. Macro elements content (Nitrogen, phosphorous, and potassium (N, P, K)

Oven-dried leaves sample at 70^{o}C till constant weight, was grinded in a mill until it turned into a fine powder. A weight of 0.5 g from powder was wet digested in 6 ml H_2SO_4 concentrated and $HClO_4$ according to **Piper (1950)**. The digested samples were transferred quantitatively to a standard flask (100 ml its size) and were completed solution with distilled water and were filtered and transferred to brown glass bottles and kept for determining the percentages of total nitrogen, phosphorus and potassium as following:

3.1. Nitrogen percentage (N %)

Nitrogen percentage was determined using Keldahl methods as described by **Jones *et al.* (1991)**.

3.2. Phosphorus percentage (P %)

Total phosphorus content was determined spectrophotometrically using the chlorostannus reduce molybdo phosphoric blue colors method in the sulphuric system according to **Jackson (1973)**.

3.3. Potassium percentage (K %)

Potassium was determined by flame photometry according to **Gustav (1961)**.

D) Statistical analyses

Experimental data were subjected to one-way analysis of variance (ANOVA) and the differences between means compared by Duncan's Multiple Range Test at a 5% level of probability as found by Waller and **Duncan's (1969)** using statistical software of SPSS according to **Snedecor and Cochran, (1982)**.

RESULTS AND DISCUSSION

1- Vegetative growth parameters: Data in **Table (1)** shows the effect of foliar spraying treatments with boron at 80 ppm, zinc at 120 ppm and salicylic acid at 200 ppm alone or in combinations on plant height, number of branches/plant, number of leaves/plant, number of leaves/ branch and dry weight of shoots/plant of the *Jasminum sambac* L. plant. The results indicated that the foliar spraying with zinc at 120ppm caused a significant improving in the plant height and the dry weight of shoots compared to the control in the two seasons except salicylic acid at 200 ppm treatment for plant height in the second season. In addition, spraying with salicylic acid at 200 ppm gave a positive effect for improving number of branches in the two seasons and leaves/branch in the first season, while B + Zn recorded the highest leaves/branch in the second one. These results are in accordance with results obtained by **Ramtin *et al.* (2015), Faraji-Mehmany *et al.* (2016), Elbohy *et al.* (2018), Abd El-Hady and Shehata (2019), El-Boraie (2019), and Hamaiel *et al.* (2021).** The foliar application of B+ Zn+ SA combination treatment led to decrease in most of the vegetative growth in both seasons. This may be due to harmful physiological interactions that led to a slowdown in vegetative growth. The reduction of vegetative growth with B application may be due to decreased leaf area **(Roessner *et al.*, 2006)**, inhibition of root growth and decrease plant dry weight **(Turan *et al.*, 2009).** These results are in harmony with results obtained by **Miwa *et al.* (2007).**

2- Flowering characteristics: From **Table (2)** a significant increase in all flowering characteristics with boron foliar spraying could be noticed in the two seasons except for mean of flowers number/cluster, the Zn + SA +B combination treatment gave significant increasing in the first season and the Zn + SA combination treatment recorded a significant increasing in the second one for mean of flowers number/cluster. The Zn+ SA combination treatment came in the second order in all flowering characteristics except number of total clusters/plant in the first season and mean of flowers number/cluster in the second season. These results are in accordance with **Zuhair *et al.* (2010), Al-Qubaie (2013), Al-Abbasi *et al.* (2015), Choudhary *et al.* (2016), Neha *et al.* (2016) and Elbohy *et al.* (2018).**

3 - Photosynthetic pigment contents: Data in **Table (3)** showed that foliar spraying with boron, zinc, salicylic acid and different combination of them led to decrease in the leaf content of photosynthetic pigments of the *Jasminum sambac* L. plant in the two seasons except for Chlorophyll a in the first season. Foliar spraying with SA recorded the highest one as comparing with the control. The highest deficient in chlorophyll obtained from B + Zn + SA combination treatment. From data above mentioned it seems that the level of pigment concentrations in the treatments except for the triple interaction was sufficient to complete the photosynthesis process need to grow. The reduction in photosynthetic content may be due to decreased electron transport rate and reduced activity of some enzymes involved in CO_2 assimilation **(Han *et al.*, 2009).**

4 - Biochemical content: Data in **Table (4**) regarding the effect of foliar spraying treatments with boron, zinc, salicylic

acid alone or in combination on biochemical contents of *Jasminum sambac* L., show that all foliar spraying treatments were significantly superior in the leaves content of tryptophan compared to the control except the triple combination treatment (B + Zn + SA) in the second season. Foliar spraying plants with Zn + SA recorded the highest content of tryptophan, polyphenols, total carbohydrates and reducing sugars in the leaves compared to the other treatments and the control in the two seasons except for the reducing sugars in the first season, where the combination of B + Zn + SA recorded the highest one. These results are in agreement with **Al-Qubaie (2013), Elbohy *et al.* (2018) and El-Boraie (2019).**

5 - Macro elements content: Data in **Table (5)** showed that foliar spraying using zinc at 120 ppm and salicylic acid at 200 ppm have not significant differences between them in most cases and indicated the highest nitrogen, phosphorous and potassium% compared to the control in the two seasons, while the combination treatment of B + Zn + SA recorded the lowest nitrogen, phosphorous and potassium% in the two seasons except for K% in the first season the least significant one was the control. These results are in harmony with **Elbohy etal. (2018), Abd El-Hady and Shehata (2019), Nada and Abd El-Hady (2019) and Hamaiel *et al.* (2021).**

CONCLUSION

Based on the previous results, it can be concluded that mixture of foliar spraying treatment containing zinc (120 ppm) and salicylic acid (200ppm) was the best treatment for improving the vegetative growth, flowering characteristics as well as the biochemical characteristics, followed by the treatment of foliar spraying with zinc (120ppm), while foliar application with boron (80 ppm) increased flowering characteristics only. Therefore, the study recommends foliar spraying with mixture treatment containing zinc (120 ppm) and salicylic acid (200ppm) for Arabian Jasmine (*Jasminum sambac* L. "Grand Duke of Tuscany") plants in order to improve vegetative growth and to increase the number of flowers per the plant.

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CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest.

AUTHORS CONTRIBUTION

Hamaiel, A. F.; El-Boraie, E. A. and EL-Habashi Norhan F.A. developed the concept of the manuscript. EL-Habashi wrote the manuscript. All authors checked and confirmed the final revised manuscript.

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Table 1. Effect of foliar spraying with boron، zinc, salicylic acid and their mixture on vegetative growth of *Jasminum sambac* (L.) plants during 2018/2019 and 2019/2020 seasons.

Parameters / Treatments	Plant height (cm)		No. of branches/plant		No. of leaves/plant		leaves number of the branch (leaf/branch)		Dry weight of shoots/plant (g)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	82.33^{ab}	101.00^{c}	20.33^{bc}	15.00^{b}	338.33^{b}	380.67^{c}	16.54^{b}	28.24^{bc}	75.65^{b}	75.53^{b}
B	73.33^{b}	97.50^{d}	20.00^{bc}	17.33^{a}	221.67^{cd}	327.67^{d}	11.16^{cde}	18.98^{d}	50.86^{e}	50.80^{e}
Zn	84.33^{ab}	137.67^{a}	20.33^{bc}	15.00^{b}	288.00^{bc}	394.00^{b}	14.20^{bc}	26.36^{c}	85.49^{a}	85.38^{a}
SA	92.33^{a}	133.00^{a}	24.67^{a}	18.5^{a}	220.33^{cd}	389.67^{b}	20.26^{a}	31.63^{ab}	52.35^{de}	52.48^{de}
B+Zn	81.67^{ab}	110.67^{b}	18.00^{c}	14.00^{bc}	184.00^{d}	339.33^{d}	10.20^{de}	24.31^{a}	62.60^{c}	62.49^{c}
B+SA	73.17^{b}	113.33^{b}	19.33^{bc}	10.67^{d}	254.00^{cd}	354.67^{d}	13.11^{cd}	33.74^{c}	61.18^{cd}	61.05^{cd}
Zn+SA	85.67^{ab}	114.67^{b}	22.00^{b}	17.67^{a}	436.33^{a}	494.33^{a}	19.84^{a}	28.01^{bc}	77.54^{ab}	76.02^{b}
B+Zn+SA	75.33^{b}	70.67^{e}	22.00^{b}	13.67^{bc}	276.00^{bc}	261.67^{e}	12.53^{cd}	19.29^{d}	48.76^{e}	36.33^{f}

The means per column with similar letters are not significant at 0.05 of probability according to Duncan's Multiple Range Tests. B; Boron (80 ppm), Zn; Zinc (120 ppm), SA; salicylic acid (200 ppm).

Table 2. Effect of foliar spraying with boron, zinc, salicylic acid and their mixture on flowering characteristics of *Jasminum sambac* (L.) plants during 2018/2019 and 2019/2020 seasons.

Parameters / Treatments	No. of total flowers/plant		No. of total flower points/plant		No. of total clusters/plant		No. of total single flowers/plant		Mean of flowers number in cluster/plant	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	8.17^{f}	8.18^{f}	4.33^{e}	4.67^{f}	2.00^{bc}	1.67^{f}	2.50^{f}	2.83^{f}	2.83^{b}	3.03^{bc}
B	20.67^{a}	20.33^{a}	12.33^{a}	11.67^{a}	4.17^{a}	4.17^{a}	8.33^{a}	7.67^{a}	2.96^{b}	3.28^{b}
Zn	13.00^{d}	12.50^{d}	8.33^{c}	8.50^{c}	2.50^{b}	2.16^{de}	5.67^{c}	6.50^{b}	2.9ه^{b}	2.85^{c}
SA	14.33^{c}	14.00^{c}	8.17^{c}	7.50^{d}	3.75^{a}	2.92^{bc}	4.33^{d}	4.67^{d}	2.6ٍ^{b}	3.27^{b}
B+Zn	10.17^{e}	10.50^{e}	6.50^{d}	6.00^{e}	2.42^{bc}	2.58^{cd}	3.33^{e}	3.67^{e}	2.8ٍ^{b}	2.66^{d}
B+SA	7.00^{g}	7.00^{g}	4.67^{e}	4.33^{f}	1.83^{c}	1.83^{ef}	2.67^{f}	2.67^{f}	2.39^{c}	2.39^{e}
Zn+SA	19.00^{b}	17.67^{b}	10.50^{b}	10.17^{b}	4.17^{a}	3.17^{b}	6.67^{b}	6.67^{b}	2.97^{b}	3.50^{a}
B+Zn+SA	13.50^{d}	13.83^{c}	8.17^{c}	8.83^{c}	2.17^{bc}	2.50^{cd}	5.83^{c}	5.83^{c}	3.53^{a}	3.20^{b}

The means per column with similar letters are not significant at 0.05 of probability according to Duncan's Multiple Range Tests. B; Boron (80 ppm), Zn; Zinc (120 ppm), SA; salicylic acid (200 ppm).

Table 3. Effect of foliar spraying with boron, zinc, salicylic acid and their mixture on photosynthetic pigments of *Jasminum sambac* (L.) during 2018/2019 and 2019/2020 seasons.

Parameters / Treatments	Chlorophyll a µg/cm^2		Chlorophyll b µg /cm^2		Total chlorophyll µg /cm^2		Carotenoids µg /cm^2	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	44.23^{b}	45.60^{a}	16.58^{a}	16.35^{a}	64.48^{a}	64.95^{a}	9.59^{a}	10.11^{a}
B	40.30^{d}	38.08^{f}	12.69^{e}	11.69^{d}	52.98^{d}	53.09^{e}	8.62^{c}	8.38^{e}
Zn	41.45^{c}	40.73^{d}	13.90^{cd}	13.83^{bc}	55.35^{c}	54.55^{d}	9.23^{b}	8.53^{cd}
SA	46.57^{a}	43.38^{b}	15.14^{b}	16.31^{a}	61.04^{b}	60.35^{b}	8.62^{c}	9.75^{b}
B+Zn	41.48^{c}	39.60^{e}	13.37^{de}	14.06^{b}	53.51^{d}	54.99^{d}	8.65^{c}	8.49^{cd}
B+SA	38.85^{e}	41.04^{d}	12.80^{e}	13.44^{c}	51.32^{e}	54.81^{d}	8.63^{c}	8.77^{c}
Zn+SA	41.05^{cd}	42.37^{c}	14.19^{c}	13.80^{bc}	55.24^{c}	59.51^{c}	9.51^{a}	10.03^{ab}
B+Zn+SA	36.29^{f}	39.56^{e}	10.66^{f}	11.65^{d}	45.28^{f}	45.54^{f}	7.35^{d}	7.98^{e}

The means per column with similar letters are not significant at 0.05 of probability according to Duncan's Multiple Range Tests. B; Boron (80 ppm), Zn; Zinc (120 ppm), SA; salicylic acid (200 ppm).

Table 4. Effect of foliar spraying with boron, zinc, salicylic acid and their mixture on biochemical content of *Jasminum sambac* (L.) during 2018/2019 and 2019/2020 seasons.

Parameters / Treatments	tryptophan µg/g		Polyphenols mg/100 g		Total Carbohydrate mg/100 mg		Reducing Sugars mg/100 mg	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	39.50^{e}	38.93^{d}	4.176^{ab}	4.570^{b}	55.560^{a}	52.832^{bc}	9.170^{b}	7.699^{c}
B	40.10^{d}	43.94^{b}	3.864^{b}	3.218^{d}	57.161^{a}	44.273^{d}	9.845^{a}	8.055^{bc}
Zn	44.55^{b}	42.24^{bc}	4.405^{a}	4.762^{bc}	55.750^{a}	50.644^{bcd}	7.771^{c}	6.302^{d}
SA	41.24^{cd}	43.09^{b}	3.792^{b}	4.376^{c}	53.367^{a}	53.659^{bc}	9.309^{b}	7.450^{cd}
B+Zn	43.20^{bc}	40.71^{cd}	4.154^{ab}	4.424^{c}	43.981^{b}	47.726^{cd}	9.751^{a}	6.86 ^{d}
B+SA	40.90^{d}	44.58^{b}	3.915^{b}	4.464^{b}	44.710^{b}	51.568^{bc}	7.734^{c}	8.394^{b}
Zn+SA	52.94^{a}	48.00^{a}	4.438^{a}	5.398^{a}	57.650^{a}	61.538^{a}	9.426^{b}	9.797^{a}
B+Zn+SA	39.52^{e}	43.24^{b}	4.594^{a}	4.781^{bc}	54.000^{a}	56.869^{ab}	9.900^{a}	8.698^{b}

The means per column with similar letters are not significant at 0.05 of probability according to Duncan's Multiple Range Tests. B; Boron (80 ppm), Zn; Zinc (120 ppm), SA; salicylic acid (200 ppm).

Table 5. Effect of foliar spraying with boron, zinc, salicylic acid and their mixture on N, P and K% of Jasminum sambac (L.) during 2018/2019 and 2019/2020 seasons.

Parameters / Treatments	N %		P %		K%	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	2.27^{bc}	2.05^{c}	0.154^{c}	0.223^{c}	3.38^{c}	3.87^{d}
B	2.15^{c}	2.18^{b}	0.152^{c}	0.216^{cd}	3.33^{c}	4.10^{c}
Zn	2.65^{a}	2.29^{a}	0.261^{a}	0.272^{a}	3.96^{a}	4.74^{a}
SA	2.52^{a}	2.24^{a}	0.222^{b}	0.280^{a}	4.11^{a}	4.63^{ab}
B+Zn	2.46^{ab}	2.15^{bc}	0.156^{c}	0.246^{b}	3.75^{b}	4.22^{c}
B+SA	2.64^{a}	2.26^{a}	0.166^{c}	0.221^{cd}	3.70^{b}	4.35^{bc}
Zn+SA	2.52^{a}	2.24^{a}	0.133^{c}	0.195^{d}	4.00^{a}	4.52^{b}
B+Zn+SA	2.21^{bc}	2.04^{c}	0.132^{c}	0.148^{e}	4.03^{a}	4.26^{c}

The means per column with similar letters are not significant at 0.05 of probability according to Duncan's Multiple Range Tests. B; Boron (80 ppm), Zn; Zinc (120 ppm), SA; salicylic acid (200 ppm).

تأثير الرش الورقي بالبورون والزنك وحمض السالسيلك وتوليفاتهم علي نمو وإزهار نبات الفل

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أجريت تجربتان حقليتان خلال موسم ٢٠١٩/٢٠١٨ و٢٠٢٠/٢٠١٩ بمزرعة خاصة بقرية السنانية، محافظة دمياط، مصر، وذلك لدراسة تأثير بعض معاملات الرش الورقي بالبورون في صورة حمض البوريك بتركيز (٨٠ جزء في المليون) والزنك في صورة سلفات الزنك بتركيز (١٢٠ جزء في المليون) وحمض السالسيلك (٢٠٠ جزء في المليون) منفردة أو فى توليفات على بعض صفات النمو والازهاروكذلك بعض الصبغات والصفات الكيميائية ونسبة بعض العناصر الكبري في الأوراق لنبات الفل المكبس. وأشارت أهم النتائج إلى أن:

- الرش الورقي بحمض الساليسيليك وحده أو مع الزنك أدى إلى زيادة معنوية في خصائص النمو الخضري والخصائص البيوكيميائية (التربتوفان، والفينولات، والكربوهيدرات الكلية، والسكريات المختزلة).
- أدى الرش بالزنك منفردا إلى زيادة الوزن الجاف للمجموع الخضري ومحتوي الأوراق من النيتروجين والفسفور والبوتاسيوم في النبات في الموسمين.
- أدي الرش الورقي بالزنك أو حمض السالسيلك منفردين أو في تداخل تحسناً معنوياً في الصفات الزهرية محل الدراسة والتي تمثلت في (عدد الازهار الكلية،عدد النقاط الزهرية، عدد النورات الزهرية، عدد الازهار المفردة، عدد الازهار لكل نورة)، كما أعطي الرش الورقي بالبورون بمفردة أعلي القيم للصفات الزهرية المدروسة ماعداعدد الأزهارللنورة.
- أدت معظم المعاملات الي حدوث نقص في محتوي الأوراق من الكلوروفيل والكاروتينات مقارنة بالكنترول في الموسمين.

وعليه توصي هذه الدراسة: بالرش الورقي بخليط الزنك بتركيز ١٢٠ جزء في المليون وحمض السالسيلك بتركيز ٢٠٠ جزء في المليون، وذلك للحصول على أفضل صفات للمجموع الخضري وزيادة عدد الأزهار لنبات الفل المكبس المنزرع تحت ظروف قرية السنانية، محافظة دمياط.

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