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RESPONSE OF PEACE LILY (*SPATHIPHYLLUM* WALLISII REGEL) PLANTS TO FOLIAR SPRAY WITH SOME GROWTH REGULATORS AND MICROELEMENTS

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ABSTRACT: A pot experiment was conducted during two successive seasons (2016/2017 and 2017/2018) at the greenhouse of the Ornamental Dept., El-Kassasin Res. Station, Ismailia Governorate, Egypt. This study was carried out to investigate the effect of foliar spraying with some growth regulators (gibberellic acid (GA_3) at 100 and 200 ppm, kinetin (Kin) at 100 and 200 ppm beside the control treatment) and a microelements mixture at (0, 1, 2 and 3 g/l) on vegetative growth, root system and quality of peace lily (*Spathiphyllum wallisii* Regel) plant. Results showed that the interaction treatment between spraying peace lily plants with Kin at 100 ppm in addition to the microelements mixture at 2 g/l gave the highest values regarding number of leaves/plant, stem diameter and leaf area, number of roots/plant in both seasons, fresh weight of roots in the 2nd season and dry weight of root, fresh and dry weight of shoots, number of both shoots and flowers/plant in both seasons. The interaction treatment between spraying plants with GA_3 at 200 ppm and 2 g/l microelements mixture gave the tallest plants in both seasons. However, the interaction treatment between Kin at 100 ppm and spraying plants with 3 g/l microelements mixture was the best interaction treatment for enhancing the concentration of total chlorophyll and total carbohydrates in shoots, in both seasons**.** Generally, the best interaction treatments for increasing growth, flowering and biochemical constituents was obtained with Kin at 100 ppm and 2 g/l microelements.

Key words: *Spathiphyllum wallisii*, gibberellic acid, kinetin, microelements mixture, vegetative growth, chemical composition.

INTRODUCTION

Peace lily (*Spathiphyllum wallisii* Regel) is a member of the family *Araceae* and one of the most popular indoor houseplants (Sardoei 2014a). Interest in peace lily is steadily increasing as it is a shade tolerant indoor plant, easy-care, with dark green foliage and white spathes. The showy white spathes of *Spathiphyllum* enhance its popularity and market niche as a flowering foliage plant (Henny *et al.,* 2004). Although it was initially a plant for containers, in recent years, the culture of this plant has been greatly expanded to the production of cut flowers

Gibberellins form a large family of diterpenoid compounds, some of which are bioactive growth regulators that control such diverse developmental processes as seed germination, stem elongation, leaf expansion, trichome development, in addition to flower and fruit development (Davies, 1995). Moreover, GA_3 application increased petiole length, leaf area and delayed petal abscission and color fading (senescence) by the hydrolysis of starch and sucrose into fructose and glucose (Khan and Chaudhry, 2006).

Kinetin, the most synthetic known cytokinin, has a furfuryl ring at the N6-position of adenine and was identified in both animal cellular DNA and plant tissue extracts. Kinetin is known to be essential to plants and is a necessary growth regulator for these organisms. Although its role for animals is well known, in the case of plants, it needs further investigation. Kinetin in low concentrations influences plants in a positive way but higher concentrations are toxic (Barciszewski *et al*., 2000).

Spraying plants with either kinetin or GA_3 gave the best vegetative growth, both fresh and dry weight of foliage, chemical contents and total chlorophyll than unsprayed plants. In this respect, similar results were obtained elsewhere by Youssef and Ismaeil (2009) on *Clivia miniata*, Ibrahim *et al.* (2010) on croton, Mohammadipour (2012) on peace lily, Youssef and Mady (2013) on *Aspidistra elatior*, Rahbarian *et al.* (2014) on peace lily, Sardoei (2014 b) on *Ficus benjamina*, *Schefflera arboricola* and *Dizigotheeca*, Youssef, and Abd El-Aal (2014) on *Hippeastrum vittatum*, Mohamed (2017) on aster and by Abou-El-Ghait *et al*. (2018) on Chrysanthemum.

Micronutrients play vital roles in the growth and development of plants, due to their stimulatory and catalytic effects on metabolic processes and ultimately on flower yield (Lahijie, 2012). The role of zinc and iron in crop nutrition is well recognized as they are used for bio-synthesis of plant auxins, nitrogen metabolism, and for oxidation-reduction reactions, which are considered to be necessary for plant growth and development. They are also involved in chlorophyll formation, photosynthesis, important enzyme system and respiration in plants. Boron also plays a very important role in vital functions of the plant, including meristem, sugar and hydrocarbon metabolism and their transfer, RNA and cytokinin production and transfer, pollen building and seed formation, (Murthy *et al.*, 2006). Zinc is necessary to activate many enzymes, enzymes that are activated by the zinc are Tryptophan synthetase superoxide dismutase and dehydrogenases. Lack of zinc causes deficiency in formation of RNA and protein. Therefore, the plant with lack of zinc is poor in amount of protein (Praveena *et al.*, 2018).

Manganese is regarded as an activator of many different enzymatic reactions and takes part in photosynthesis. (Sajedi *et al*., 2009).

Many researchers found that spraying floricultural plants with microelements gave the best results for growth and biochemical constituents in plant than untreated plants like what has been reported by Wahba and Ezz EL-Din (2002) on Chrysanthemum; Dashora *et al.* (2004) on marigold; Ahmad *et al*. (2010) on rose; Khalifa *et al*. (2011) on Iris; Khosa *et al.* (2011) on Gerbera; Amuamuha *et al.* (2012) on marigold; Mohammadipour (2012) on peace lily; Amran (2013) on *Pelargonium graveolens*; Bashir *et al*. (2013) on gerbera; Fahad *et al.* (2014) and Chopde *et al*. (2015) on Gladiolus; Soni and Godara (2015) and by Pal *et al.* (2016) on gerbera.

Thus, the aim of this work was to investigate the effect of foliar application with some growth regulators (gibberellic acid, and kinetin) and microelements on vegetative growth, root system and quality of Peace lily (*Spathiphyllum wallisii* Regel) plant.

MATERIALS AND METHODS

The present experiment was conducted during two successive seasons (2016/2017 and 2017/2018) at the greenhouse of the Ornamental Dept., El Kassasin Research Station, Ismailia Governorate, Egypt. This study was designed to investigate the effect of foliar application with some growth regulators (gibberellic acid, and kinetin) and microelements on vegetative growth, root system and quality of peace lily (*Spathiphyllum wallisii* Regel) plant.

Experimental procedure and treatments:

The *Spathiphyllum* plugs (small plants of 8-10 cm long) used in this study were obtained from Pico Modern Agric., private company. On 20th April, 2016, the plants were individually transplanted in 20-cm diameter plastic pots filled with a mixture of peatmoss + perlite + sand, at the ratio of 1:1:1 (v/v/v) and held under greenhouse conditions. After 30 days from transplanting, the plants were sprayed every 4 weeks (from 20 May till 20 August), with the following concentrations of growth regulators treatments gibberellic acid at 100 and 200 ppm, kinetin at 100 and 200 ppm beside, the control treatment, and microelements at 0, 1, 2 and 3 g/l. The plants were sprayed by a hand sprayer until run off point.

Experimental design:

The treatments were arranged in a factorial experiment in complete randomized design with three replicates (each replicate contained 6 pots). The first factor was growth regulators, while the second one was foliar spraying with microelement treatments. So, this study included 20 treatments (including the control).

Gibberellic acid and kinetin were obtained from El-Gomhouria Co. for trading medicines, chemicals and medical appliances, Sharkia Governorate, Zagazig, Egypt, while the source of the microelements mixture was the commercial product Micronate 15, which contains iron at 4%, zinc at 4%, manganese at 3%, magnesium at 1% and cupper at 0.5% and was produced by Al-Qawafel Ind. Agr. Co., Jordan.

Data recorded:

Growth characters:

A sample of six plants from every treatment was taken at 15th of September to investigate the following growth parameters: plant height (cm), stem diameter (cm), number of leaves/plant, leaf area (cm^2), fresh and dry weights of leaves (g/plant), number of roots/plant, root length (cm) for the longest root, fresh and dry weights of roots/plant (g), number of shoots/root, number of flowers and shoots/plant, total chlorophylls and total carbohydrates.

Root system traits:

The roots of peace lily (*Spathiphyllum wallisii* Regel) plants were carefully separated by washing then placed in a flat glass dish containing a little amount of water. Roots were straightened with forceps, to hold them in position, according to Helal and Sauerbesk (1986), and the following data were recorded: root length (cm), fresh and dry weights of roots (g), and number of roots per plant.

Chemical constituents:

Determination of total chlorophyll (SPAD) in fresh leaves was carried out according to A.O.A.C. (1980). Total carbohydrates percentage in dry leaves was determined colorimetrically using the method described by Dubois *et al.* (1956).

Statistical analysis:

Data recorded on both vegetative growth and chemical composition were statistically analyzed. An analysis of variance (ANOVA) was carried out, and the means of the recorded data were compared using the least significant difference (L.S.D.) test at the 5% level, as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Vegetative growth:

1. Effect of growth regulators:

Results presented in Table (1) show the effect of growth regulators on the vegetative growth in both seasons. Spraying peace lily with different growth regulators such as gibberellic (GA_3) or kinetin (Kin) at different rates resulted in a significant effect on plant height, number of leaves/plant, stem diameter and leaf area than in unsprayed plants in both seasons.

Table 1. Effect of foliar spray applications with some growth regulator and microelement treatments on vegetative growth of peace lily during two successive seasons (2016/2017 and 2017/2018).

Treatments	Growth characters/plant							
	Plant height (cm)		No. of leaves		Stem diameter (cm)		Leaf area (cm^2)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of growth regulators								
Tap water	39.12	36.44	18.50	16.75	0.81	0.74	118.20	115.50
GA_3 100 ppm	48.90	45.22	32.75	31.50	1.38	1.53	163.50	152.80
GA_3 200 ppm	50.37	49.57	30.75	34.25	1.56	1.64	152.90	139.20
Kin 100 ppm	43.97	42.45	34.00	35.00	1.80	2.00	183.30	180.80
Kin 200 ppm	45.17	45.57	33.25	33.75	1.66	1.88	173.50	170.00
LSD at 0.05 level	0.36	0.53	0.42	0.52	0.67	0.80	4.87	4.06
Effect of microelements								
Tap water	41.82	41.23	26.80	27.00	1.23	1.37	147.70	141.40
1 g/l	45.06	43.14	29.00	29.40	1.38	1.49	156.20	150.70
2 g/l	47.82	46.24	32.20	32.80	1.58	1.71	165.20	158.90
3 g/l	47.34	44.80	31.40	31.80	1.58	1.65	164.00	155.70
LSD at 0.05 level	0.69	0.47	0.67	0.58	N.S	0.03	3.99	3.87

Spraying plants with GA_3 at 200 ppm gave the tallest plants in both seasons, while spraying plants with Kin at 100 ppm gave the highest values of number of leaves/plant, stem diameter and leaf area in both seasons.

The relative increases in leaf area were about 55.07 and 56.53% for the plants which were sprayed with Kin at 100 ppm, followed by 46.78 and 47.18% for Kin at 200 ppm over unsprayed plants in the 1st and 2nd seasons, respectively.

These results agree with those reported by Mohammadipour (2012) on peace lily and Ibrahim *et al*. (2010) on croton plants.

2. Effect of microelements:

Spraying peace lily plants with a microelements mixture at different rates had a significant effect on plant height, number of leaves/plant, stem diameter and leaf area than in unsprayed plants in both seasons, except for stem diameter in the 1st season (Table, 1). However, the highest values of plant height, number of leaves/plant, stem diameter and leaf area were obtained with the plants sprayed with 2 g/l microelements, followed by the plants which were sprayed with 3 g/l in both seasons.

The relative increases in leaf area were 11.84 and 12.37% for the plants which were sprayed with 2 g/l microelements, followed by 11.03 and 10.11% for 3 g/l microelements over unsprayed plants in the 1st and 2nd seasons, respectively.

This increase in vegetative growth characters of peace lily as a result of application of microelements (that contain Zn) might be explained by synthesis of tryptophan, a precursor of indole acetic acid (auxin) which is accelerated by zinc and as such helps the plant to maintain apical dominance, polarity and growth. This is in conformity with other similar observations made by Misra (2001) on chrysanthemum, Khosa *et al*. (2011) and Bashir *et al.* (2013) on gerbera and Fahad *et al*. (2014) on gladiolus.

3. Effect of the interaction between growth regulators and microelements:

Results presented in Table (2) show that the interaction between growth regulators and microelements had significant effects on all vegetative growth parameters of peace lily in both seasons, except that of stem diameter in the 1st season.

The interaction between sprayed plants with GA_3 at 200 ppm and 2 g/l microelements gave the tallest plants in both seasons. While the interaction between sprayed plants with Kin at 100 ppm and 2 g/l microelements gave the highest values of number of leaves/plant, and leaf area in both seasons.

The relative increases in leaf area were about 80.73 and 83.67% for the interaction between Kin at 100 ppm and 2 g/l microelements, followed by 79.13 and 74.39% for the interaction between Kin at 100 ppm and 3 g/l microelements over unsprayed plants in the 1st and 2nd seasons, respectively.

Root system/plant:

1. Effect of growth regulators:

Results presented in Table (3) show that both growth regulators at different rates had significant effects on number of roots/plant, root length, both fresh and dry weights/root than in unsprayed peace lily plants in both seasons.

Number of roots/plant, root length, both fresh and dry weights/plant were at the highest values when plants were treated with Kin than plants treated with GA_3 in both seasons. However, spraying peace lily plants with Kin at 100 ppm gave the highest values in this respect in both seasons.

The relative increases in dry weight of roots/plant were 66.20 and 54.48% for the plants sprayed with Kin at 100 ppm, and 63.31 and 64.88% for Kin at 200 ppm over unsprayed plants in the 1st and 2nd seasons, respectively.

Table 2. Effect of the interaction between foliar spray applications with some growth regulator and microelement treatments on vegetative growth of peace lily during two successive seasons (2016/2017 and 2017/2018).

Treatments		Growth characters/plant							
		Plant height (cm)		No. of leaves		Stem diameter (cm)		Leaf area (cm^2)	
Growth regulators	Microelements	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Tap water	Tap water	35.30	35.20	15.00	13.00	0.70	0.65	106.40	103.50
	1 g/l	38.50	35.75	17.00	16.00	0.80	0.75	118.70	115.70
	2 g/l	40.60	38.30	20.00	20.00	0.85	0.75	122.40	120.70
	3 g/l	42.10	36.50	22.00	18.00	0.90	0.80	125.30	122.30
GA_3 100 ppm	Tap water	45.30	42.30	30.00	27.00	1.10	1.20	150.30	140.50
	1 g/l	48.70	44.70	32.00	30.00	1.30	1.40	160.70	150.30
	2 g/l	51.20	47.50	35.00	35.00	1.60	1.80	170.30	162.30
	3 g/l	50.40	46.40	34.00	34.00	1.50	1.70	172.50	158.20
GA_3 200 ppm	Tap water	46.80	45.60	28.00	31.00	1.25	1.50	145.30	130.30
	1 g/l	49.30	48.75	30.00	33.00	1.50	1.60	150.50	136.70
	2 g/l	53.10	51.65	33.00	37.00	1.70	1.70	160.50	144.80
	3 g/l	52.30	52.25	32.00	36.00	1.80	1.75	155.30	145.20
Kin 100 ppm	Tap water	40.10	40.50	31.00	32.00	1.60	1.80	170.10	172.30
	1 g/l	43.50	41.80	33.00	34.00	1.70	1.90	180.30	180.30
	2 g/l	46.70	45.50	37.00	38.00	2.00	2.20	192.30	190.10
	3 g/l	45.60	42.00	35.00	36.00	1.90	2.10	190.60	180.50
Kin 200 ppm	Tap water	41.60	42.60	30.00	32.00	1.50	1.70	166.30	160.30
	1 g/l	45.30	44.70	33.00	34.00	1.60	1.80	170.70	170.70
	2 g/l	47.50	48.25	36.00	34.00	1.75	2.10	180.60	176.60
	3 g/l	46.30	46.80	34.00	35.00	1.80	1.90	176.30	172.40
LSD at 0.05 level		1.54	1.05	1.49	1.29	NS	0.07	8.92	8.64

Table 3. Effect of foliar spray applications with some growth regulator and microelement treatments on root system/plant of peace lily during two successive seasons (2016/2017 and 2017/2018).

Treatments	Root system/plant							
	Number of roots/ plant		Root length (cm)		Fresh weight of root (/plant)		Dry weight of root (/plant)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
	Effect of growth regulators							
Tap water	13.25	11.25	29.50	30.35	26.11	27.29	7.25	7.69
GA_3 100 ppm	18.00	16.00	35.00	41.13	34.93	35.45	9.94	9.79
GA_3 200 ppm	16.00	17.75	31.00	38.15	33.98	34.09	11.11	10.29
Kin 100 ppm	19.25	21.25	35.75	46.30	43.00	48.40	12.05	11.88
Kin 200 ppm	18.75	21.00	34.25	42.30	42.75	46.28	11.84	12.68
LSD at 0.05 level	0.77	0.67	0.79	0.42	0.22	0.82	0.82	0.79
	Effect of microelements							
Tap water	14.40	15.20	30.80	35.30	31.63	34.08	9.06	9.31
1 g/l	16.20	16.80	32.60	38.28	34.60	37.38	10.18	10.24
2 g/l	18.80	19.20	35.80	43.08	39.06	40.75	11.34	10.88
3 g/l	18.80	18.60	33.60	41.92	39.32	40.99	11.17	11.43
LSD at 0.05 level	0.68	0.69	0.61	0.33	0.20	0.51	0.51	0.61

These results are in agreement with those reported by Sardoei (2014a) on *Ficus benjamina*, *Schefflera arboricola* and *Dizigotheeca elegantissima*.

2. Effect of microelements:

Number of roots/plant, root length, both fresh and dry weights/plant of peace lily have been affected by microelements as foliar spray than in unsprayed plants in both seasons (Table, 3).

Spraying plants with 2 g/l significantly increased number of roots/plant, root length, both fresh and dry weights/plant with non-significant differences with 3 g/l in most cases in both seasons.

The obtained results here were alike those reported by Mohammadipour (2012) on *Aglaonema, Dieffenbachia, Spathiphyllum, Epipremnum,* and *Syngonium*.

3. Effect of the interaction between growth regulators and microelements:

The interaction between growth regulators and microelements had significant effect on root system/plant than unsprayed plants in both seasons (Table, 4).

The interaction between spraying plant with Kin at 100 ppm and microelements at 2 g/l gave the highest values of number of roots/plant in both seasons, fresh weight of roots in the 2^{nd} season and dry weight of roots in the 1^{st} season, while the interaction between 100 ppm Kin and 3 g/l microelements gave the highest values of root length in the 2^{nd} season and fresh weight of roots in the 1^{st} season. The interaction between Kin at 200 ppm and microelements at 3 g/l gave the highest values of dry weight of roots in the 2^{nd} season.

The relative increases in dry weight of roots/plant were about 113.07 and 91.16% for the interaction between Kin at 100 ppm and 2 g/l microelements and 107.69 and 118.60% for the interaction between Kin at 200 ppm and 3 g/l microelements over unsprayed plants in the 1^{st} and 2^{nd} seasons, respectively.

Shoot and flowering characteristics:

1. Effect of growth regulators:

Results presented in Table (5) show that spraying peace lily plants by both GA_3 and Kin at different concentrations had significant effects on both fresh and dry weights of shoot, number of both shoots and flowers/plant than in unsprayed plants in both seasons.

The best treatment for increasing fresh and dry weight of shoot and number of shoots/plant was obtained with the plants sprayed with Kin at 100 ppm in both seasons, with no significant differences at the same time with Kin at 200 ppm for fresh weight of shoot and with either Kin or GA_3 at 200 ppm regarding dry weight of shoot in the 1^{st} season.

Concerning number of flowers/plant, the same result data show that, in general, all sprayed treatments recorded increases in number of flowers/plant more than in unsprayed plants in both seasons. However, GA_3 at 200 ppm was effective in a better manner in this concern.

The relative increases in fresh weight of shoot/plant were 41.22 and 42.74%, for plants sprayed with Kin at 100 ppm, and 39.92 and 33.73% for Kin at 200 ppm over unsprayed plants in the 1^{st} and 2^{nd} seasons, respectively.

The increases in number of flowers/plant were about 116.66 and 160% for the plants sprayed with GA_3 at 200 ppm over unsprayed plants in the 1^{st} and 2^{nd} seasons, respectively.

The obtained results might be due to the role of kinetin on promoting protein synthesis, increasing cell division and enlargement (Cheema and Sharma, 1982). Moreover, these results might be explained by the role of kinetin in promoting proteins, soluble and non-soluble sugars synthesis, or may be due to the ability of kinetin for making the treated area to act as a sink in which nutrients from other parts of the plant are drawn (Salisbury and Ross, 1974).

Table 4. Effect of the interaction between foliar spray applications with some growth regulator and microelement treatments on root system/plant of peace lily during two successive seasons (2016/2017 and 2017/2018).

Treatments		Root system/plant							
		Number of roots/ plant		Root length (cm)		Fresh weight of root (/plant)		Dry weight of root (/plant)	
Growth regulators	Microelements	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Tap water	**Tap water**	11.00	9.00	27.00	25.10	23.15	24.30	6.50	6.45
	1 g/l	13.00	11.00	29.00	28.20	25.50	26.50	7.10	7.50
	2 g/l	14.00	12.00	31.00	32.60	27.30	28.20	7.50	8.30
	3 g/l	15.00	13.00	31.00	35.50	28.50	30.15	7.90	8.50
GA_3 100 ppm	**Tap water**	16.00	14.00	33.00	37.50	31.00	31.90	8.50	9.10
	1 g/l	17.00	15.00	34.00	41.30	34.20	34.30	9.25	9.60
	2 g/l	20.00	18.00	37.00	45.50	38.20	38.50	10.35	10.70
	3 g/l	19.00	17.00	36.00	40.20	36.30	37.10	11.65	9.74
GA_3 200 ppm	**Tap water**	14.00	16.00	28.00	34.30	30.20	30.20	11.30	9.50
	1 g/l	16.00	17.00	31.00	36.50	33.50	33.50	11.50	10.10
	2 g/l	18.00	20.00	35.00	42.50	37.50	35.45	12.15	10.25
	3 g/l	16.00	18.00	32.00	39.30	34.70	37.20	10.50	11.30
Kin 100 ppm	**Tap water**	15.00	19.00	33.00	41.30	35.50	43.20	10.30	10.20
	1 g/l	17.00	20.00	35.00	45.30	39.40	47.30	11.75	11.50
	2 g/l	22.00	24.00	40.00	48.50	46.50	52.50	13.85	12.33
	3 g/l	23.00	22.00	35.00	50.10	50.60	50.30	12.30	13.50
Kin 200 ppm	**Tap water**	16.00	18.00	33.00	38.30	38.30	40.50	9.70	11.30
	1 g/l	18.00	21.00	34.00	40.10	40.40	45.30	11.30	12.50
	2 g/l	20.00	22.00	36.00	46.30	45.80	49.10	12.85	12.80
	3 g/l	21.00	23.00	34.00	44.50	46.50	50.20	13.50	14.10
LSD at 0.05 level		1.74	1.55	1.36	0.75	0.51	1.14	1.14	1.36

Table 5. Effect of foliar spray applications with some growth regulator and microelement treatments on shoot characters and number of flowers/plant of peace lily during two successive seasons (2016/2017 and 2017/2018).

Treatments	Shoot characters and number of flowers/plant							
	Fresh weight of shoot (g/ plant)		Dry weight of shoot (g/ plant)		Number of shoots/ plant		Number of flowers/ plant	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of growth regulators								
Tap water	62.70	65.43	8.51	9.09	2.04	1.50	1.50	1.25
GA_3 100 ppm	81.10	81.70	11.31	11.91	3.25	3.75	3.00	3.00
GA_3 200 ppm	78.06	82.70	12.95	12.94	3.00	3.25	3.25	3.25
Kin 100 ppm	88.55	93.40	12.89	14.25	4.50	4.50	3.33	2.50
Kin 200 ppm	87.73	87.50	12.88	12.80	3.50	3.25	3.00	2.00
LSD at 0.05 level	2.61	4.10	0.52	0.52	0.86	0.84	0.88	0.67
Effect of microelements								
Tap water	72.20	72.84	10.06	10.59	1.83	2.40	1.80	1.60
1 g/l	78.86	79.64	11.38	11.73	2.80	2.80	2.40	2.20
2 g/l	83.70	87.76	12.66	13.06	4.40	4.20	3.87	3.20
3 g/l	83.74	88.34	12.73	13.41	4.00	3.60	3.20	2.60
LSD at 0.05 level	3.00	3.29	0.47	0.47	0.74	0.55	0.62	0.69

The results are in conformity with those reported by El-Malt *et al*. (2006), Youssef, and Abd El-Aal (2014) on *Hippeastrum vittatum*, Mohamed (2017) on aster and Abou-El-Ghait *et al*. (2018) on Chrysanthemum.

2. **Effect of microelements:**

Foliar sprayed microelements had significant effects on both fresh and dry weights of shoot, number of shoots and flowers/plant more than in unsprayed plants in both seasons (Table, 5).

Spraying peace lily plants with microelements at 2 g/l significantly increased fresh and dry weight of shoots, both number of shoots and flowers/plant in both seasons, with no significant differences with 3 g/l microelements for fresh and dry weight of shoot/plant in both seasons and both number of shoots and flowers/plant in the 1^{st} season.

The relative increases in fresh weight of shoot/plant were 15.92 and 20.48% and in number of flowers/plant were about 115 and 100% over unsprayed plants in 1^{st} and 2^{nd} seasons, respectively.

These results are in harmony with those stated by Bashir *et al*. (2013), Soni *et al.* (2015) and Pal *et al*. (2016) on gerbera, Fahad *et al.* (2014) and Chopde *et al.* (2015) on Gladiolus.

3. Effect of the interaction between growth regulators and microelements:

The interaction between growth regulators and microelements exhibited positive effects on fresh and dry weight of shoots, number of both shoots and flowers/plant than in unsprayed plants in both seasons (Table, 6).

The maximum values of fresh and dry weight of shoots, number of both shoots and flowers/plant were obtained with the interaction between spraying with Kin at 100 ppm and 2 g/l microelements in both seasons.

The relative increases in fresh weight of shoot/plant were 70.93 and 63.90% for the interaction between Kin at 100 ppm and 2 g/l microelements and 68.73 and 53.49% for the interaction between Kin at 200 ppm and 3 g/l over unsprayed plants in the 1^{st} and 2^{nd} seasons, respectively.

Chemical composition:

1. Effect of growth regulators:

Results presented in Table (7) show that there were significant differences between both growth regulators at the different concentrations and unsprayed plants concerning total chlorophylls and total carbohydrates in leaves of peace lily in both seasons.

Spraying plants with Kin at 100 ppm had significant effects on total chlorophyll and total carbohydrates in leaves with no significant differences between Kin at 200 ppm for total chlorophyll in both seasons and total carbohydrates in the 1^{st} season.

The increases in total chlorophyll in shoots were 27.5 and 63.29%, total carbohydrates were 13.68 and 17.60% for the plants sprayed with Kin at 100 ppm, and 32.91 and 63.82% for total chlorophyll and 11.64 and 12.61% for total carbohydrates with plants sprayed with Kin at 200 ppm over unsprayed plants in the 1^{st} and 2^{nd} seasons, respectively.

As for the explanation of the incremental effect of kinetin on chemical constituents of peace lily content, it could be interpreted here by the fact that kinetin treatments stimulated the endogenous cytokinins synthesis. Also, there is an intimate relationship between cytokinins and chlorophylls metabolism in both excised or detached leaf disks and intact plants,i.e. cytokinins retard chlorophylls degradation, preserve it and increase its synthesis (Devlin and Witham, 1983).

Results in this research study agree with those of Youssef, and Abd El-Aal (2014) on

Table 6. Effect of the interaction between foliar spray applications with some growth regulator and microelement treatments on shoot characters and number of flowers/plant of peace lily during two successive seasons (2016/2017 and 2017/2018).

Treatments		Shoot characters and number of flowers/plant							
		Fresh weight of shoot (g/plant)		Dry weight of shoot (g/plant)		Number of shoots/ plant		Number of flowers/plant	
Growth regulators	Microelements	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Tap water	**Tap water**	54.70	61.50	7.65	8.35	1.00	1.00	1.00	1.00
	1 g/l	61.30	65.40	8.10	8.75	2.00	1.00	1.00	1.00
	2 g/l	64.50	66.30	8.70	9.50	2.00	2.00	2.00	1.00
	3 g/l	70.30	68.50	9.60	9.75	3.00	2.00	2.00	2.00
GA_3 100 ppm	**Tap water**	72.50	71.30	9.75	10.50	2.00	3.00	2.00	2.00
	1 g/l	80.40	77.60	10.50	11.20	3.00	3.00	3.00	3.00
	2 g/l	86.30	90.50	11.70	12.85	5.00	5.00	4.00	4.00
	3 g/l	85.20	87.40	13.30	13.10	3.00	4.00	3.00	3.00
GA_3 200 ppm	**Tap water**	70.60	73.50	11.30	11.10	2.00	3.00	2.00	2.00
	1 g/l	78.50	79.60	13.30	12.50	2.00	3.00	2.00	3.00
	2 g/l	82.70	88.60	14.50	13.65	4.00	4.00	5.00	4.00
	3 g/l	80.43	89.10	12.70	14.50	4.00	3.00	4.00	4.00
Kin 100 ppm	**Tap water**	82.70	80.20	10.30	12.50	2.00	3.00	2.00	2.00
	1 g/l	87.50	90.30	12.50	13.70	4.00	4.00	3.00	2.00
	2 g/l	93.50	100.80	14.85	15.60	6.00	6.00	4.00	4.00
	3 g/l	90.50	102.30	13.90	15.20	6.00	5.00	4.00	2.00
Kin 200 ppm	**Tap water**	80.50	77.70	11.30	10.50	2.00	2.00	2.00	1.00
	1 g/l	86.60	85.30	12.50	12.50	3.00	3.00	3.00	2.00
	2 g/l	91.50	92.60	13.57	13.69	5.00	4.00	4.00	3.00
	3 g/l	92.30	94.40	14.15	14.50	4.00	4.00	3.00	2.00
LSD at 0.05 level		6.71	7.36	1.05	1.05	1.66	1.14	1.88	1.55

Table 7. Effect of foliar spray applications with some growth regulator and microelement treatments on total chlorophyll and total carbohydrates in leaves of peace lily during two successive seasons (2016/2017 and 2017/2018).

Treatments	Total chlorophyll (spad)		Total carbohydrate (%)	
	1st season	2nd season	1st season	2nd season
		Effect of growth regulators		
Tap water	2.40	1.88	21.55	20.45
GA_3 100 ppm	2.77	2.71	23.13	23.03
GA_3 200 ppm	2.75	2.70	23.23	22.05
Kin. 100 ppm	3.06	3.07	24.50	24.05
Kin. 200 ppm	3.19	3.08	24.06	23.03
LSD at 0.05 level	0.17	1.20	0.67	0.52
		Effect of microelements		
Tap water	2.70	2.40	21.90	20.96
1 g/l	2.83	2.74	22.92	22.26
2 g/l	2.91	2.72	23.90	23.62
3 g/l	2.90	3.88	24.44	23.24
LSD at 0.05 level	0.10	0.48	0.69	0.55

Hippeastrum vittatum and Sardoei (2014b) on peace lily, who found that sprayed plant with GA_3 or BA gave higher concentrations of total chlorophyll and total carbohydrates in leaves than in unsprayed plants

2. **Effect of microelements:**

The obtained results in Table (7) indicate that spraying peace lily with different microelements reflected significant effects on total chlorophyll and total carbohydrates in leaves more than in unsprayed plants in both seasons.

Total chlorophyll and total carbohydrates were significantly increased with plants sprayed with 3 g/l microelements without significant differences with 2 g/l microelements regarding total carbohydrates in both seasons and with 2 or 1 g/l microelements concerning total chlorophyll in the 1^{st} season.

The increases in total chlorophyll in leaves were 7.77 and 13.33%, total carbohydrates were 9.13 and 12.69% for plants sprayed with microelements at 2 g/l and 7.40 and 61.66% for total chlorophyll and 11.59 and 10.87% for total carbohydrates with plants sprayed with Kin at 200 ppm over unsprayed plants in the 1^{st} and 2^{nd} seasons, respectively.

These results here are in harmony with those revealed by Ahmad *et al.* (2010), who found that leaf chlorophyll contents were significantly increased in rose cultivars in response to foliar application of B (0.5%), Zn (1.5%) and Fe (1.0%), applied either alone or in different combinations when compared with unsprayed plants.

3. Effect of the interaction between growth regulators and microelements:

Data presented in Table (8) show that the interaction between growth regulators and microelements had significant effects on total chlorophyll and total carbohydrates in leaves than in unsprayed plants in both seasons.

The interaction between spraying plants with Kin at 100 ppm and 3 g/l microelements was the best interaction treatments for enhancing the concentration of total chlorophyll and total carbohydrates in leaves

Table 8. Effect of the interaction between foliar spray applications with some growth regulator and microelement treatments on total chlorophyll and total carbohydrates in leaves of peace lily during two successive seasons (2016/2017 and 2017/2018).

Treatments		Total chlorophyll (spad)		Total carbohydrate (%)	
Growth regulators	Microelements	1st season	2nd season	1st season	2nd season
Tap water	**Tap water**	2.10	1.75	20.50	18.70
	1 g/l	2.40	1.80	21.30	20.50
	2 g/l	2.45	1.85	22.10	21.10
	3 g/l	2.66	2.10	22.30	21.50
GA_3 100 ppm	**Tap water**	2.70	2.20	22.10	21.60
	1 g/l	2.79	3.35	23.10	22.50
	2 g/l	2.90	2.70	23.20	24.70
	3 g/l	2.70	2.60	24.10	23.30
GA_3 200 ppm	**Tap water**	2.68	2.50	21.50	20.30
	1 g/l	2.75	2.65	22.50	21.60
	2 g/l	2.80	2.75	24.30	23.50
	3 g/l	2.75	2.90	24.60	22.80
Kin. 100 ppm	**Tap water**	2.90	2.85	22.60	22.50
	1 g/l	3.00	2.90	24.10	24.40
	2 g/l	3.10	3.00	25.60	25.20
	3 g/l	3.25	3.53	25.70	24.10
Kin. 200 ppm	**Tap water**	3.10	2.85	22.80	21.70
	1 g/l	3.20	3.00	23.60	22.30
	2 g/l	3.30	3.30	24.30	23.60
	3 g/l	3.15	3.15	25.50	24.50
LSD at 0.05 level		0.22	1.08	1.55	1.24

in both seasons, followed by Kin at 200 ppm and 2 g/l microelements regarding total chlorophyll in both seasons or with Kin at 100 ppm and 2 g/l microelements for total carbohydrates in leaves in both seasons.

The relative increases in total chlorophyll in leaves were 54.76 and 101.71%, whereas total carbohydrates were 25.36 and 28.87% for the interaction between Kin at 100 ppm and 3 g/l microelements over unsprayed plants in the 1st and 2nd seasons, respectively.

Finally, the best interaction treatment for increasing growth, flowering and biochemical constituents was obtained with Kin at 100 ppm and 2 g/l microelements.

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استجابة نبات الاسباثيفيللم للرش الورقى ببعض منظمات النمو والعناصر الصغرى

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تم اجراء تجربة أصص خلال موسمين متتاليين (٢٠١٦/٢٠١٧ و ٢٠١٧/٢٠١٨) بصوبة قسم الزينة، بمحطة بحوث البساتين بالقصاصين، محافظة الإسماعيلية، مصر. تم اجراء هذه التجربة لدراسة تأثير الرش الورقي ببعض منظمات النمو (حمض الجبريلليك والكينتين بتركيز ١٠٠ و ٢٠٠ جزء في المليون لكل منهما بالاضافة الى معاملة المقارنة) و كذلك الرش بمخلوط العناصر الصغرى بتركيز صفر، ١، ٢ و ٣ جرام/لتر على النمو الخضري والمجموع الجذري وجودة نبات الاسباثيفيللم.

أظهرت النتائج أن معاملة التفاعل بين الرش الورقي بالكينتين بتركيز ١٠٠ جزء في المليون بالاضافة الى مخلوط العناصر الصغرى بتركيز ٢ جم/لتر أعطت أعلى القيم فيما يتعلق بعدد الأوراق/نبات، مساحة الورقه وعدد الجذور/نبات بكلا الموسمين، الوزن الطازج للجذورفي الموسم الثاني والوزن الجاف للجذور والوزن الطازج والجاف للأفرع وعدد كل من الأفرع والأزهار/نبات. معاملة التفاعل بين الرش الورقي بحمض الجبريلليك بتركيز ٢٠٠ جزء في المليون و مخلوط العناصر الصغرى بتركيز ٢ جم/لتر أعطى أطول النباتات بكلا الموسمين. بينما معاملة التفاعل بين الكينتين بتركيز ١٠٠ جزء في المليون ورش النباتات بمخلوط العناصر الصغرى بتركيز ٣ جم/لتر كانت أفضل معاملات التفاعل لتحسين النسبة المئوية للكلورفيلات والكربوهيدرات الكلية بكلا الموسمين.

من النتائج السابقة يتضح أنه كانت أفضل معاملات التفاعل والتى أدت إلى زيادة فى النمو والتزهير والمحتوى الكيماوي هي معاملة التفاعل بين الرش بالكينيتين بتركيز ١٠٠ جزء في المليون مع العناصر الصغرى بتركيز ٢جم/لتر.