

EFFECT OF BENZYLADENINE AND CHEMICAL FERTILIZATION ON GROWTH, FLOWERING AND CHEMICAL COMPOSITION OF *JASMINUM SAMBAC* PLANT

Eman M. Abou El-Ghait*, A.S.M. Youssef*, Y.F. Mohamed*, T.M. Noor El-Deen** and Heba I. Mohamed**

* Hort. Dept., Fac. Agric., Moshtohor, Benha University, Egypt

** Ornamental Plants & Landscape Gardening Res. Dept., Hort. Res. Inst., ARC, Egypt



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ABSTRACT: A pot experimental study was carried out at the Floriculture Nursery of the Horticulture Department, Faculty of Agriculture at Moshtohor, Benha University, Egypt during 2017 and 2018 seasons to study the effect of 16 treatments represented the combination between foliar spraying with four benzyladenine (BA) concentrations (0.0, 20, 40 and 60 ppm) and four chemical fertilization rates (0.0, 2, 4 and 6 g NPK/pot) on the growth, flowering and chemical composition of Arabian jasmine plant (*Jasminum sambac* Ait). The obtained results cleared that the tallest plants, the highest number of branches and leaves, the heaviest leaves fresh weight/plant, the highest number of flowers/plant, the heaviest flowers fresh weight/plant, the highest number and length of roots/plant, the heaviest fresh weight of roots/plant as well as the richest leaf total carbohydrates, nitrogen, phosphorus and potassium percentages were obtained by those treated with BA at 60 ppm + chemical fertilization at 6 g/pot in the two seasons. Conclusively, spraying jasmine plants with BA at 60 ppm and supplying the plants with NPK mineral fertilizer at 6 g/pot, induced prospective effects on vegetative growth and flowering parameters with higher quality of this plant.

Key words: Arabian jasmine, *Jasminum sambac*, benzyladenine, chemical fertilization, growth, flowering and chemical constituents.

INTRODUCTION

Jasminum (Fam: Oleraceae) is a genus of 200 or more species of deciduous, evergreen shrubs and climbers native to Tropical Asia and Africa. *J. sambac* (Arabian jasmine, pikake) is an evergreen, twining climber or scrambler with angular stems and bushy growth, reaches to 2-3 m height. Lustrous, dark green leaves, some in whorls of 3, others opposite, are reduced to one broadly ovate leaflet, to 8 cm long. Bears small cymes of 3-12 salver form, strongly scented white flowers, 2.5 cm across, fading to pink, mainly in summer, but often irregularly throughout the year

(Brickell, 1997). It is cultivated for commercial as a source of perfumes, and ornamentals, nice smell in the garden. In China the flowers are used for perfuming tea, while in India they are made into garlands (Heneidy, 2010).

Many authors demonstrated that growth and flowering of many ornamental plants are greatly influenced by different growth regulators among which kinins group. Benzyladenine (BA) is recognized by its ability to induce cell division in certain plant tissues (Cheema and Sharma, 1982) it can also overcome the apical dominance of many plants and stimulate the lateral buds to

develop into an entire new plant. BA can delay senescence and cause transport of many solutes from older parts of the leaves or even from older leaves into the treated zone (Salisbury and Ross, 1974). In this respect, the beneficial role of BA was reported by many authors e.g. Youssef (2004) on *Pelargonium graveolens*, Currey and Erwin (2012) on 11 *Kalanchoe* species, Carey *et al.* (2013) on *Salvia nemorosa* (L.) "Caradonna", Tandel *et al.* (2018) on *Adhatoda zeylanica*, Singh and Bala (2018) on chrysanthemum. Additionally, Youssef and Mady (2013) cleared that spraying *Aspidistra elatior* plants with BA at 75 ppm improved all tested vegetative and chemical constituents of this plants. Moreover, Abd Al Lateef and Hade (2018) showed that spraying *Viola tricolor* plants with BA at 30 ppm enhanced all vegetative and flowering traits.

Most plants need more than two applications of fertilizers during the growing season. Thus, fertilization must continue for good vegetative growth to produce a good flower and large new mature bulbs (Rees, 1992). For natural plants to grow and thrive they need a number of chemical elements, but the most important are nitrogen, phosphorus and potassium. Most packaged fertilizers contain these three macronutrients. Nitrogen is especially important, and every amino acid in plants contains nitrogen as an essential component for plants to manufacture new cells (Marschner, 1997). Phosphorus which has been called the key to life is essential for cell division and for development of meristematic tissues and it is very important for carbohydrate transformation due to multitude of phosphorylation reaction and to energy rich phosphate bond (Lambers *et al.*, 2008). Potassium is important for growth and elongation probably due to its function as an osmoticum and may react synergistically with IAA. Moreover, it promotes CO₂ assimilation and translocation of carbohydrates from the leaves to storage tissues (Mengel and Kirkby, 1987). In this concern, Mostafa (2018) revealed that

spraying areca palm plants with chemical fertilizer at 6 g/pot produced the highest plant height, stem diameter, stem length, number of leaves/plant and fresh, dry weights of leaf of this plant

Thereupon, this study was undertaken to evaluate the effect of benzyladenine (BA) and mineral fertilization (NPK) on growth, flowering and chemical composition of *Jasminum sambac* plant.

MATERIALS AND METHODS

A pot experimental study was conducted at the Floriculture Nursery of the Horticulture Department, Faculty of Agriculture at Moshtohor, Benha University, during 2017 and 2018 seasons to study the ability of benzyladenine (BA) treatments (0, 20, 40 and 60 ppm) and some chemical fertilization treatments (0, 2, 4 and 6 g/plant) in combining treatments to lump their benefits in producing high quality flowers of *Jasminum sambac* Ait. plants.

Plant material:

Arabian jasmine (*Jasminum sambac* Ait.) plants were used for the present study, for this purpose well established three months old healthy and uniform sized plants having 7-8 leaves and 13-15 cm height were selected for conducting this study. The seedlings were obtained from Floriculture Nursery of the Horticulture Department, Faculty of Agriculture at Moshtohor, Benha University. The plants were repotted in plastic pots of 25 cm diameter (one plant/pot) packed with planting media, containing clay + compost + sand at 1:1:1 by volume, and placed in a partial shade (15000-17000 lux) under lath house condition on March, 1st for the two seasons of this study. Mechanical and chemical analysis of the used medium are shown in Tables (a and b).

Procedure and lay-out of the experiment:

Two factors were involved in the present study, the first was BA treatments and the second was chemical fertilization. The layout of the experiment was designed to provide a

Table a. Mechanical analysis of the experimental soil.

Parameters	Unit	Seasons	
		2017	2018
Coarse sand	%	11.23	12.18
Fine sand	%	34.51	35.82
Silt	%	15.36	13.41
Clay	%	38.90	38.59
Textural class	-	Sandy loam	Sandy loam

Table b. Chemical analysis of the experimental soil.

Parameters	Unit	Seasons	
		2017	2018
CaCO ₃	%	1.21	1.35
Organic matter	%	1.78	1.89
Available nitrogen	%	0.92	0.94
Available phosphorus	%	0.39	0.41
Available potassium	%	0.86	0.82
E.C	ds/m	1.35	1.39
pH	-	7.32	7.41

factorial experiment in randomized complete blocks. The study contained 16 treatments (4 concentration of BA treatments × 4 rates of chemical fertilization) with three replicates. Each replicate contained 4 pots.

Plant growth regulators treatments:

Jasmine plants were subjected to foliar spray with BA at 0.0, 20, 40 and 60 ppm six times at two weeks interval, starting after one month from repotting in the two seasons of this study.

Fertilization treatments:

Jasmine plants received chemical fertilizer by using ammonium nitrate (33% N), calcium superphosphate (15.5% P₂O₅) and potassium sulfate (48% K₂O). A mixture of the three fertilizers, with a ratio of 1:1:1 (N: P₂O₅: K₂O), was prepared and applied to the plants at the rate of 2, 4 and 6 g/pot as top dressing six times at monthly interval, starting after one month from planting time in the two seasons of this study. Common agricultural practices (irrigation, manual weed control, ... etc.) were conducted when needed.

Recorded data:

At the end of this study (end of December during the two seasons) the following data were recorded:

1. Vegetative growth parameters: plant height (cm), number of branches/plant, number of leaves/plant, fresh weight of leaves/plant (g) and dry weight of leaves/plant (g).
2. Flowering growth parameters: number of flowers/plant and fresh weight of flowers/plant (g).
3. Root growth parameters: number of roots/plant, root length/plant (cm) and fresh weight of roots/plant (g).
4. Chemical composition determination: total nitrogen percentage was determined in the dried leaves by using the modified micro-kjeldahl method as described by Pregl (1945), phosphorus was determined colourimetrically in a spectronic (20) spectrophotometer using the method described by Trouge and Meyer (1939), potassium content was determined by a flame photometer according to Brown and Lilleland (1946) and total carbohydrates content was determined in dried leaf powder according to Herbert *et al.* (1971).

Statistical analysis:

All obtained data in both seasons of study were subjected to analysis of variance as factorial experiments in a complete randomized block design. L.S.D. method was used to differentiate between means according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Vegetative growth parameters:

1. Plant height:

Table (1) shows that all tested concentrations of BA succeeded in increasing plant height of *Jasminum sambac* plants as compared with un-sprayed plants in both seasons. In this respect, the highest concentration (60 ppm) gave the highest values in this concern, followed by the medium concentration (40 ppm) in both seasons. On the other hand, there was a positive correlation between the plant height values and fertilization levels, so the values of plant height increased as the level of fertilization increased to reach the maximum increasing at the highest level (6 g/ plant). This trend was true in both seasons.

Moreover, data presented in Table (1) indicate that all the interactions between BA concentrations and fertilization levels significantly increased plant height of Arabian jasmine plants as compared with untreated plants in both seasons. However,

the tallest plants (43.4 and 47.8 cm) were recorded by 60 ppm BA combined with NPK fertilization at 6 g/plant treatment in the first and second seasons, respectively.

2. Number of branches/plant:

As presented in Table (1), all studied BA and NPK fertilization treatments as well as their interactions increased the number of branches/plant in both seasons. In this concern, the increment in number of branches were in parallel to applied concentration of BA and fertilization levels, so the highest concentration of BA or the highest level of fertilization significantly scored the highest number of branches/plant when compared with control in both seasons. However, the highest number of branches/plant (8.91 and 8.43) was recorded by 60 ppm BA-sprayed plants combined with NPK fertilization at 6 g/plant in the first and second seasons, respectively.

3. Number of leaves/plant:

Data presented in Table (2) cleared that using BA at 60 ppm was more effective in

Table 1. Effect of benzyladenine (BA) and fertilization treatments on plant height (cm) and number of branches/plant of *Jasminum sambac* during 2017 and 2018 seasons.

BA concentration	Plant height (cm)					Branches number/plant				
	0	2	4	6	Mean	0	2	4	6	Mean
1st season										
0.0	31.7	32.4	34.8	35.2	33.5	4.92	5.36	5.62	5.71	5.40
20 ppm	32.7	35.1	38.2	33.8	34.9	5.68	6.14	6.82	6.94	6.39
40 ppm	34.8	36.7	39.2	32.1	35.7	7.14	7.42	7.94	8.04	7.64
60 ppm	36.1	38.9	42.3	43.4	40.2	8.37	8.49	8.72	8.91	8.62
Mean	33.8	35.8	38.6	36.1		6.53	6.85	7.28	7.40	
L.S.D. at 0.05 for	BA= 1.24					BA= 0.34				
	Fertilization= 1.24					Fertilization= 0.34				
	Interaction= 2.48					Interaction= 0.68				
2nd season										
0.0	32.6	34.7	38.2	39.4	36.2	4.76	5.08	5.39	5.41	5.16
20 ppm	34.2	38.7	42.1	43.2	39.6	5.82	6.14	6.52	6.63	6.28
40 ppm	35.8	33.2	45.3	46.2	40.1	7.18	7.30	7.82	7.91	7.55
60 ppm	33.8	41.5	46.1	47.8	42.3	8.04	8.19	8.38	8.43	8.26
Mean	34.1	37.0	42.9	44.2		6.45	6.68	7.03	7.09	
L.S.D. at 0.05 for	BA= 2.14					BA= 0.41				
	Fertilization= 2.14					Fertilization= 0.41				
	Interaction= 4.28					Interaction= 0.82				

Table 2. Effect of benzyladenine (BA) and fertilization treatments on number of leaves and fresh weight of leaves (g)/plant of *Jasminum sambac* during 2017 and 2018 seasons.

BA concentration	Number of leaves/plant					Fresh weight of leaves (g)/plant				
	Fertilization treatments (g/plant)									
	0	2	4	6	Mean	0	2	4	6	Mean
1st season										
0.0	43.9	46.8	51.8	52.3	48.7	52.6	55.8	76.5	62.4	61.8
20 ppm	51.8	53.7	56.7	57.1	54.8	61.2	63.6	67.2	68.4	65.1
40 ppm	58.2	61.3	64.1	65.3	62.2	69.6	73.2	76.8	78.1	74.4
60 ppm	61.8	63.0	65.2	66.4	64.1	74.2	75.6	78.6	79.2	76.9
Mean	53.9	56.2	59.5	60.3		64.4	67.1	74.8	72.0	
L.S.D. at 0.05 for	BA=4.31					BA=3.04				
	Fertilization=4.31					Fertilization=3.04				
	Interaction=8.62					Interaction=6.08				
2nd season										
0.0	46.2	49.2	53.2	54.1	50.7	59.8	63.7	68.9	70.2	65.7
20 ppm	53.8	54.7	56.9	57.2	55.7	71.0	71.2	74.1	74.6	72.7
40 ppm	58.2	59.6	62.3	63.8	60.9	75.6	76.9	80.6	81.9	78.8
60 ppm	64.2	66.3	69.2	71.4	67.8	83.7	85.9	89.8	92.3	87.9
Mean	55.6	57.5	60.4	61.6		72.5	74.4	78.4	79.8	
L.S.D. at 0.05 for	BA= 3.32					BA= 3.11				
	Fertilization= 3.32					Fertilization= 3.11				
	Interaction= 6.64					Interaction= 6.22				

increasing the number of leaves as it scored 64.1 and 67.8 leaves/plant, followed by using BA at 40 ppm which scored 62.2 and 60.9 leaves/plant, with non-significant differences between themselves in the first season only. In addition, there were positive correlations between the levels of chemical fertilization and the values of number of leaves of Arabian jasmine plants, whereas the rates of chemical fertilization increased the values of number of leaves attained the high levels in the two seasons.

Regarding the interaction effect between chemical fertilization and BA, data in the same Table referred that all interactions of chemical fertilization increased number of leaves/plant as compared with the control plants in the two seasons. However, the interaction of chemical fertilization at 6 g/pot showed to be the most pronounced one for producing the highest values, especially those received BA at 60 ppm as it registered 66.4 and 71.4 leaves / plant, in the first and second seasons, respectively.

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

It was interest to notice that there was a positive relationship between the fresh and dry weights of leaves/plant and BA or fertilization treatments. Hence, as the levels of BA or fertilization were increased the fresh and dry weights of leaves increased up to the maximum increasing at the highest level of BA or fertilization in both seasons (Tables, 2 and 3). However, the heaviest fresh and dry weights of leaves/plant were recorded by 60 ppm BA + spraying plants with NPK fertilization at 6 g/ plant in both seasons.

The abovementioned results regarding the effect of BA was reported by many authors e.g. Youssef (2004) on *Pelargonium graveolens*, Currey and Erwin (2012) on 11 *Kalanchoe* species, Carey *et al.* (2013) on *Salvia nemorosa* (L.) “Caradonna”, Tandel *et al.* (2018) on *Adhatoda zeylanica*, Singh and Bala (2018) on chrysanthemum. Additionally, Youssef and Mady (2013) cleared that spraying *Aspidistra elatior* plants with BA at 75 ppm improved all tested vegetative traits.

Table 3. Effect of benzyladenine (BA) and fertilization treatments on dry weight of leaves (g)/plant and number of flowers/plant of *Jasminum sambac* during 2017 and 2018 seasons.

BA concentration	Dry weight of leaves (g)/plant					Number of flowers/plant				
	Fertilization treatments (g/plant)									
	0	2	4	6	Mean	0	2	4	6	Mean
1st season										
0.0	7.36	7.81	10.72	8.74	8.66	43.8	45.1	49.3	51.2	47.4
20 ppm	8.81	9.12	9.67	9.84	9.36	53.7	56.2	61.2	61.9	58.3
40 ppm	10.11	10.61	10.69	11.32	10.68	62.4	65.0	68.3	69.2	66.2
60 ppm	11.12	11.32	11.78	11.86	11.52	68.7	72.1	76.4	78.1	73.8
Mean	9.35	9.72	10.72	10.44		57.2	59.6	63.8	65.1	
L.S.D. at 0.05 for	BA= 0.82					BA= 4.02				
	Fertilization= 0.82					Fertilization= 4.02				
	Interaction= 1.64					Interaction= 8.04				
2nd season										
0.0	8.97	9.65	10.36	10.57	9.89	46.1	48.3	52.0	53.2	49.9
20 ppm	11.00	11.11	11.48	11.56	11.29	54.6	56.2	59.4	61.3	57.9
40 ppm	11.74	11.99	12.57	12.77	12.27	64.2	66.3	69.8	71.8	68.0
60 ppm	13.37	13.71	14.32	14.71	14.3	71.4	73.2	76.2	78.1	74.7
Mean	11.27	11.62	12.18	12.40		59.1	61.0	64.35	66.1	
L.S.D. at 0.05 for	BA= 1.25					BA= 4.19				
	Fertilization= 1.25					Fertilization= 4.19				
	Interaction= 2.50					Interaction= 8.38				

Moreover, Abd Al Lateef and Hade (2018) showed that spraying *Viola tricolor* plants with BA at 30 ppm enhanced all studied vegetative traits.

The obtained results might be due to the role of benzyladenine on promoting protein synthesis, increasing cell division and enlargement (Cheema and Sharma, 1982). Moreover, these results might be explained according to the role of benzyladenine on promoting proteins, soluble and non-soluble sugars synthesis, or may be due to the ability of benzyladenine 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).

The results respecting chemical fertilization are in conformity with those reported by Hunmili and Paswan (2003) on gerbera, El-Malt *et al.* (2006) on *Hippeastrum vittatum*, Youssef and Gomaa (2007) on *Iris tingitana*, Abou El-Ella (2007) on *Acanthus mollis*, Kolodziej (2007) on goldenrod, Biswas and Parya (2008) on *Solidago canadensis*, Nath *et al.* (2008) on

Peperomia, El-Naggar and El-Nasharty (2009) on *Hippeastrum vittatum*, Hussein (2009) on *Cryptostegia grandiflora* and Abd El-All (2011) on *Aspidistra elatior*.

Flowering growth parameters:

1. Number of flowers/plant:

It is clear from data presented in Table (3) that using the high concentration of BA was more effective in increasing number of flowers/plant as it gave 73.8 and 74.7, followed by using the medium concentration which recorded 66.2 and 68.0 flowers per plant, with significant differences between themselves in the first and second seasons, respectively. Also, data in the same Table revealed that there were positive relationships between the values of flower number and the used rates of chemical fertilization, hence as the chemical fertilization rates increased the values of flower number increased to reach the greatest increment at 6 g/pot-fertilized plants as it gave 65.1 and 66.1 flowers per plant in the first and second seasons, respectively.

As for the interaction effect between BA and chemical fertilization, data presented in Table (3) showed that sprayed jasmine plants with BA at 60 ppm and supplemented with chemical fertilizer at 6 g/pot is being the most effective one for producing the highest number of flowers per plant (78.1 and 78.1) in the first and second seasons, respectively.

2. Fresh weight of flowers/plant (g):

Data presented in Table (4) showed that the heaviest fresh weight of flowers per plant was recorded by using the high concentration of BA as it scored 33.8 and 41.9 g/plant, followed in a descending order by the medium concentration which scored 29.7 and 37.8 g/plant in the first and second seasons, respectively. Moreover, all tested rates of chemical fertilization increased this character, especially the high rate as it scored 28.7 and 36.3 g/plant when compared with un-fertilized plants in the two seasons. As for the interaction effect between BA and chemical fertilization, data in the same Table, showed that all resulted interactions increased the fresh weight of flowers in the two seasons. However, the heaviest flowers fresh weight (35.8 and 43.9 g) was obtained by those received BA at 60 ppm and fertilized with chemical fertilization at 6 g/pot, in the first and second seasons, respectively.

The abovementioned results regarding the effect of BA was reported by many authors e.g. Carey *et al.* (2013) on *Salvia nemorosa* (L.) "Caradonna" and Singh and Bala (2018) on chrysanthemum. Moreover, Abd Al Lateef and Hade (2018) showed that spraying *Viola tricolor* plants with BA at 30 ppm enhanced all studied flowering traits.

The results of chemical fertilization are in harmony with those attained by El-Malt *et al.* (2006) on *Hippeastrum vittatum*, Youssef and Gomaa (2007) on *Iris tingitana*, Abou El-Ella (2007) on *Acanthus mollis*, El-Naggar and El-Nasharty (2009) on *Hippeastrum vittatum*, Hussein (2009) on *Cryptostegia grandiflora* and Abd El-All (2011) on *Aspidistra elatior*.

Root growth parameters:

1. Number of roots/plant:

Data presented in Table (4) revealed that 60 ppm BA-sprayed plants was more promising in increasing the root number of jasmine plant as it scored 18.3 and 21.8 roots/plant, followed by using the medium concentration which scored 16.0 and 20.0 roots/plant, with significant differences between themselves in the first and second seasons, respectively. In addition, there were positive relationships between the rates of chemical fertilization and the values of root number of jasmine plants, whereas the rates of chemical fertilization were increased the values of root number increased till reached the highest rate in the two seasons. With regard to the interaction between chemical fertilization and BA data in the same Table referred that all combinations of chemical fertilization increased number of roots/plant when compared with the combination of control plants in the two seasons. However, the combination of chemical fertilization at 6 g/pot proved to be the most pronounced one for inducing the highest values, particularly those received BA at 60 ppm as it registered 19.4 and 23.2 roots/plant in the first and second seasons, respectively.

2. Root length (cm):

Using the high concentration of BA was more effective on increasing the root length per plant (47.3 and 48.4 cm), followed by the medium concentration which scored 44.0 and 44.7 cm, with significant differences between them in the first and second seasons, respectively (Table, 5).

Referring to the effect of chemical fertilization data presented in Table (5) indicated the all tested rates of chemical fertilization increased root length/plant with superiority for the highest rate (6 g/pot) as it scored 44.4 and 32.3 cm, in the first and second seasons, respectively. As for the interaction effect between BA and chemical fertilization data presented in Table (5) showed that the combination of BA at the high concentration showed to be the most effective one for producing the

Table 4. Effect of benzyladenine (BA) and fertilization treatments on fresh weight of flowers (g)/plant and number of roots/plant of *Jasminum sambac* during 2017 and 2018 seasons.

BA concentration	Fresh weight of flowers (g)/plant					Number of roots/plant				
	Fertilization treatments (g/plant)					Fertilization treatments (g/plant)				
	0	2	4	6	Mean	0	2	4	6	Mean
1st season										
0.0	17.2	18.6	19.6	20.4	19.0	11.3	12.1	13.4	13.9	12.7
20 ppm	23.3	24.7	26.8	27.2	25.5	12.8	13.4	14.2	14.8	13.8
40 ppm	27.9	29.2	30.6	31.1	29.7	14.7	15.6	16.5	17.1	16.0
60 ppm	31.2	33.1	34.9	35.8	33.8	16.8	17.8	19.1	19.4	18.3
Mean	24.9	26.4	28.0	28.7		13.9	14.7	15.8	16.3	
L.S.D. at 0.05 for	BA= 2.89 Fertilization= 2.89 Interaction= 5.78					BA= 0.83 Fertilization= 0.83 Interaction= 1.66				
2nd season										
0.0	23.2	24.6	26.9	27.8	25.6	12.5	13.7	14.8	15.1	14.0
20 ppm	29.7	30.9	32.4	33.6	31.6	14.9	16.1	17.2	17.8	16.5
40 ppm	35.8	36.9	38.6	39.8	37.8	17.6	19.2	21.2	21.9	20.0
60 ppm	39.9	41.0	42.8	43.9	41.9	19.8	21.8	22.4	23.2	21.8
Mean	32.2	33.4	35.2	36.3		16.2	17.7	18.9	19.5	
L.S.D. at 0.05 for	BA= 1.52 Fertilization= 1.52 Interaction= 3.04					BA= 1.71 Fertilization= 1.71 Interaction= 3.42				

Table 5. Effect of benzyladenine (BA) and fertilization treatments on root length (cm) and fresh weight of roots (g)/plant of *Jasminum sambac* during 2017 and 2018 seasons.

BA concentration	Root length (cm)					Fresh weight of roots (g)/plant				
	Fertilization treatments (g/plant)					Fertilization treatments (g/plant)				
	0	2	4	6	Mean	0	2	4	6	Mean
1st season										
0.0	36.1	38.4	39.7	40.0	38.6	6.78	7.26	8.04	8.34	7.61
20 ppm	39.4	41.3	42.6	43.1	41.6	8.44	8.81	9.37	9.76	9.10
40 ppm	42.9	43.7	44.5	45.0	44.0	9.84	10.45	11.11	11.45	10.71
60 ppm	44.2	46.3	49.1	49.6	47.3	11.42	12.10	12.98	13.19	12.42
Mean	40.7	42.4	43.9	44.4		9.12	9.66	9.99	10.69	
L.S.D. at 0.05 for	BA= 2.19 Fertilization= 2.19 Interaction= 4.38					BA= 0.57 Fertilization= 0.57 Interaction= 1.14				
2nd season										
0.0	34.2	35.6	38.1	38.7	36.7	7.51	8.63	9.32	9.51	8.74
20 ppm	38.4	39.8	41.6	42.2	40.5	9.83	10.62	11.35	11.71	10.88
40 ppm	42.1	43.4	45.0	48.3	44.7	11.61	12.67	13.99	14.45	13.18
60 ppm	45.3	46.8	49.9	51.4	48.4	13.46	14.83	15.23	15.77	14.82
Mean	40.0	41.4	43.7	43.3		10.60	11.69	12.47	12.86	
L.S.D. at 0.05 for	BA= 2.27 Fertilization= 2.27 Interaction= 4.54					BA= 1.22 Fertilization= 1.22 Interaction= 2.44				

highest values in this concern, especially those fertilized with chemical fertilization at the high level as it recorded 49.6 and 51.4 cm, in the first and second seasons respectively.

3. Fresh weight of roots/plant (g):

Data presented in Table (5) indicated that the heaviest fresh weight of roots was recorded by using BA at 60 ppm, followed in a descending order by BA at 40 ppm in the two seasons. However, the lowest fresh weight of roots was gained by un-treated plants, followed in an ascending order by using BA at 20 ppm in the two seasons. Moreover, roots fresh weight of jasmine plants was increased by increasing chemical fertilization rates in the two seasons. In general, all resulted combinations between BA and chemical fertilization increased the fresh weight of roots/plant with significant differences in most cases when compared with un-fertilized plants in the two seasons of this study. However, the heaviest fresh weight of roots/plant was obtained by those sprayed with BA at 60 ppm and fertilized with chemical fertilization at 6 g/pot in the two seasons.

The aforementioned results regarding chemical fertilization are in conformity with those reported by Hunmili and Paswan (2003) on gerbera, El-Malt *et al.* (2006) on *Hippeastrum vittatum*, Youssef and Gomaa (2007) on *Iris tingitana*, Abou El-Ella (2007) on *Acanthus mollis*, Kolodziej (2007) on goldenrod, Biswas and Parya (2008) on *Solidago canadensis*, Nath *et al.* (2008) on peperomia, El-Naggar and El-Nasharty (2009) on *Hippeastrum vittatum*, Hussein (2009) on *Cryptostegia grandiflora* and Abd El-All (2011) on *Aspidistra elatior*.

Chemical composition determinations:

1. Leaf total carbohydrates %:

Data presented in Table (6) showed that BA at the high concentration was more effective on increasing leaf total carbohydrates percentage of jasmine plant in the two seasons of this study. In addition, data in the same Table revealed that leaf total carbohydrates percentage increased by the

used all rates of chemical fertilization, with superiority for 6 g/pot-fertilized plants which scored 20.70 and 18.65% in the first and second seasons, respectively. As for the interaction effect between BA and chemical fertilization, data in Table, 6 cleared that sprayed jasmine plants with BA at 60 ppm and enriched with chemical fertilization at 6 g/pot is being the most promising one for producing the greatest values as it scored 21.90 and 19.80% in the first and second seasons, respectively.

2. Leaf nitrogen %:

Data in Table (6) indicated that using BA at the high concentration exhibited to be the most promising one for detecting the highest leaves nitrogen percentage in the two seasons. Also, all tested applications of chemical fertilization increased the values of this parameter, especially using the highest rate (6 g/pot) as it recorded 1.65 and 1.68%, when compared with un-fertilized plants in the first and second seasons, respectively. As for the interaction effect between BA and chemical fertilization, data presented in Table (6) showed that all resulted combinations between BA concentration and chemical fertilization succeeded in increasing the values of this parameter, with superiority for the combination of chemical fertilization at 6 g/pot in both seasons. However, the highest leaf nitrogen percentage (1.81 and 1.92%) was recorded by the plants treated with benzyladenine at the high concentration and fertilized with chemical fertilization at 6 g/pot in the two seasons of this experiment.

3. Leaf phosphorus %:

Data outlined in Table (7) reported that the richest leaf phosphorus percentage was scored by using the high concentration of BA as it scored 0.265 and 0.262% in the first and second seasons, respectively. Moreover, all tested rates of chemical fertilization increased this character, especially the high level (0.255 and 0.251%) when compared with un-fertilized plants in the two seasons. Referring to the interaction effect between

Table 6. Effect of benzyladenine (BA) and fertilization treatments on total carbohydrates (%) and nitrogen percentage of *Jasminum sambac* during 2017 and 2018 seasons.

BA concentration	Total carbohydrates (%)					N (%)				
	Fertilization treatments (g/plant)									
	0	2	4	6	Mean	0	2	4	6	Mean
1st season										
0.0	14.60	16.80	18.70	19.20	17.33	1.34	1.39	1.46	1.48	1.42
20 ppm	15.40	17.90	19.10	20.00	18.10	1.41	1.46	1.52	1.59	1.50
40 ppm	16.90	18.00	19.60	21.70	19.05	1.51	1.69	1.68	1.73	1.65
60 ppm	18.10	19.70	21.80	21.90	20.38	1.67	1.72	1.79	1.81	1.75
Mean	16.25	18.10	19.80	20.70		1.48	1.57	1.61	1.65	
L.S.D. at 0.05 for	BA= 1.04 Fertilization= 1.04 Interaction= 2.08					BA= 0.12 Fertilization= 0.12 Interaction= 0.24				
2nd season										
0.0	13.40	14.90	16.20	17.90	15.60	1.28	1.31	1.41	1.39	1.35
20 ppm	14.10	15.80	16.90	18.20	16.25	1.38	1.49	1.58	1.61	1.52
40 ppm	14.90	16.20	17.80	18.70	16.90	1.51	1.62	1.74	1.79	1.67
60 ppm	16.20	17.30	19.30	19.80	18.15	1.72	1.81	1.89	1.92	1.84
Mean	14.65	16.05	17.55	18.65		1.47	1.56	1.66	1.68	
L.S.D. at 0.05 for	BA= 0.86 Fertilization= 0.86 Interaction= 1.72					BA= 0.11 Fertilization= 0.11 Interaction= 0.22				

Table 7. Effect of benzyladenine (BA) and fertilization treatments on P and K percentage of *Jasminum sambac* during 2017 and 2018 seasons.

BA concentration	P (%)					K (%)				
	Fertilization treatments (g/plant)									
	0	2	4	6	Mean	0	2	4	6	Mean
1st season										
0.0	0.214	0.226	0.231	0.239	0.228	1.12	1.19	1.28	1.31	1.23
20 ppm	0.228	0.237	0.240	0.246	0.238	1.24	1.31	1.39	1.42	1.34
40 ppm	0.241	0.249	0.258	0.264	0.253	1.36	1.42	1.56	1.59	1.48
60 ppm	0.251	0.263	0.274	0.270	0.265	1.45	1.5	1.63	1.68	1.57
Mean	0.234	0.244	0.251	0.255		1.29	1.36	1.47	1.50	
L.S.D. at 0.05 for	BA=0.013 Fertilization= 0.013 Interaction=0.026					BA=0.14 Fertilization=0.14 Interaction=0.28				
2nd season										
0.0	0.204	0.216	0.224	0.228	0.218	1.17	1.21	1.29	1.34	1.25
20 ppm	0.219	0.232	0.241	0.243	0.234	1.21	1.32	1.38	1.41	1.33
40 ppm	0.238	0.246	0.257	0.261	0.251	1.37	1.46	1.52	1.54	1.47
60 ppm	0.247	0.259	0.268	0.272	0.262	1.42	1.51	1.62	1.65	1.55
Mean	0.227	0.238	0.248	0.251		1.29	1.38	1.45	1.49	
L.S.D. at 0.05 for	BA= 0.024 Fertilization= 0.024 Interaction= 0.048					BA= 0.12 Fertilization= 0.12 Interaction= 0.24				

BA and chemical fertilization, data in the same Table declared that all resulted interactions increased leaf phosphorus percentage in both seasons. However, the highest leaf phosphorus percentage (0.270 and 0.272%) was registered by those received BA at the high concentration and fertilized with chemical fertilization at 6 g/pot in the two seasons.

4. Leaf potassium %:

Data presented in Table (7) revealed that BA at the high concentration was more effective in increasing leaf potassium percentage of jasmine plant in the two seasons of this study. In addition, data in the same Table showed that leaf potassium percentage increased by all used rates of chemical fertilization, with superiority for 6 g/pot-fertilized plants which gave 1.50 and 1.49% in the first and second seasons, respectively. As for the interaction effect between BA and chemical fertilization, data presented in Table (7) cleared that sprayed jasmine plants with BA at the high concentration and enriched with chemical fertilization at 6 g/pot is being the most effective one for producing the highest values as it scored 1.68 and 1.65% in the first and second seasons, respectively.

The aforementioned results of BA concerning chemical constituents are in conformity with those reported by Runkova (1985) on *Dhalia pinnata*, Auda (1992) on *Hippeastrum vittatum*, Maximoos (1993) on *Gerbera jamesonii*, El-Malt *et al.* (2006) on *Hippeastrum vittatum* and Youssef and Ismaeil (2009) on *Clivia miniata*.

However, the abovementioned results of chemical fertilization are in harmony with those attained by Hunmili and Paswan (2003) on gerbera, El-Malt *et al.* (2006) on *Hippeastrum vittatum*, Youssef and Gomaa (2007) on *Iris tingitana*, Abou El-Ella (2007) on *Acanthus mollis*, Kolodziej (2007) on goldenrod, Biswas and Parya (2008) on *Solidago canadensis*, Nath *et al.* (2008) on Peperomia, El-Naggar and El-Nasharty (2009) on *Hippeastrum vittatum*, Hussein

(2009) on *Cryptostegia grandiflora* and Abd El-All (2011) on *Aspidistra elatior*.

The obtained results might be due to the role of benzyladenine on promoting protein synthesis, increasing cell division, enlargement and chlorophyll synthesis (Cheema and Sharma, 1982). Moreover, these results might be explained according to the role of kinetin on promoting proteins, soluble and non-soluble sugars synthesis, or may be due to the ability of benzyladenine 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).

In conclusion, in order to produce good quality *Jasminum sambac* plants with more flowers, it is preferable to spray the plants with benzyladenine at 60 ppm four times supplemented with mineral fertilization at 6 g/plant ten times a year.

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تأثير البنزاييل آدينين والتسميد الكيماوي على النمو، الإزهار والمحتوى الكيماوي لنبات الفل

إيمان مختار أبو الغيط*، أحمد سعيد محمد يوسف*، يسري فهمي سعودي*، طارق محمد نور الدين**، هبة إبراهيم محمد**

* قسم البساتين، كلية الزراعة بمشتر، جامعة بنها، مصر
** قسم بحوث الزينة وتنسيق الحدائق، معهد بحوث البساتين، مركز البحوث الزراعية، مصر

تم اجراء تجربة أصص لدراسة تأثير ١٦ معاملة مثلت التداخل بين الرش الورقي بـ ٤ تركيزات من البنزاييل آدينين (صفر، ٢٠، ٤٠ و ٦٠ جزء في المليون) و ٤ معدلات تسميد كيماوي (صفر، ٢، ٤ و ٦ جرام سماد مركب NPK/أصيص) على النمو، التزهير، التركيب الكيماوي لنبات الفل. النتائج المتحصل عليها أظهرت أن أطول النباتات وأعلى قيم لعدد الأفرع والأوراق والوزن الطازج للأوراق وأكبر عدد للأزهار كما أن أثقل الأزهار وزناً طازجاً، أكبر عدد وطول للجزور/نبات وأثقل الجذور وزناً وأغنى محتوى للأوراق من الكربوهيدرات الكلية والنيتروجين والفوسفور والبيوتاسيوم (%) لكل نبات قد تم الحصول عليها بالمعاملة بالبنزاييل آدينين بتركيز ٦٠ جزء في المليون مع التسميد الكيماوي بمعدل ٦ جم/أصيص لكلا الموسمين. في الخلاصة، أظهرت النتائج السابقة بشكل كبير أن معاملة النباتات بالبنزاييل آدينين بتركيز ٦٠ جزء في المليون بالإضافة إلى إمدادها بالسماد الكيماوي (NPK) بمعدل ٦ جم/أصيص أدت إلى إحداث تأثيرات مرغوبة على النمو الخضري ومواصفات التزهير مع جودة عالية لنباتات الفل.