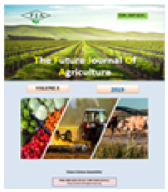
FSA

Available online free at www.futurejournals.org

The Future Journal of Agriculture

Print ISSN: 2687-8151 Online ISSN: 2687-8216

Future Science Association



Future J. Agric., 2 (2021) **1-10** **OPEN ACCES**

DOI: 10.37229/fsa.fja.2021.05.20

EFFECT OF BULB SIZE AND BA ON GROWTH, FLOWERING, BULBS PRODUCTIVITY AND CHEMICAL COMPOSITION OF *Hippeastrum vittatum* PLANT

Abou El-Ghait, E.M.; Goma, A.O.; Youssef, A.S.M.* and Hamoud, M.M.A.

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

***Corresponding author:** ahmed.youssef@fagr.bu.edu.eg **Received:** 20 April 2021 **; Accepted:** 20 May 2021

ABSTRACT: Two field experiments were conducted to evaluate the influence of 12 treatments represented the combination between thee bulb sizes of *Hippeastrum vittatum* (small, medium, and large.) and four concentration of BA (0, 20, 40 and 60 ppm) on the growth, flowering, bulbs productivity and chemical composition of *Hippeastrum vittatum* plant. Results showed that the combined treatment between large bulb size and BA at 60 ppm significantly gave the tallest plant, highest number of leaves / plant and the heaviest fresh and dry weights of leave/plant, followed by the combined treatment between large bulb size and BA at 40 ppm in the two seasons. The earliest flowering, the highest values of inflorescence length, inflorescence stem diameter, inflorescence fresh weight and flowering percentage were recorded by the combined treatment between large bulb size and BA at 60 ppm in the two seasons. The heaviest bulb fresh and dry weights, the highest bulbs number/plant and the thickest bulb and bulblet were scored by the combined treatment between the large bulb and BA at 60 ppm in the two seasons. The highest leaf N, P, K, total carbohydrates and total chlorophylls contents were scored by the combination of large bulb size, especially, those received BA at 60 ppm in the two seasons. Conclusively, spraying *Hippeastrum vittatum* plants with BA at 60 ppm induced prospective effects on vegetative growth and flowering parameters with higher bulbs productivity.

Key words: *Hippeastrum vittatum*, bulb size, BA, growth, flowering, chemical constituents and bulbs productivity**.**

INTRODUCTION

The flowering bulbous plants are considered as a group of the most beautiful adjuncts for garden decoration. They are used particularly in landscape, production of commercial cut-flowers and act as a source of glorious colors and perfumes. *Hippeastrum vittatum*, Herb. (Amaryllidaceae) occupies an important position as one of the most important and economic cut flower crops all over the world and can be planted in beds, in edging and borders along the paths or sides, in pots or indoor, as a foliage and flowering pot plant in a time where is nearly a lack of other flowers. It is a hardy herbaceous perennial growing from bulbs and seeds. It is grown in Egypt for outdoor, as a flower bed impact and in borders, as well as, for cut flowers and indoor, as a pot plant. Amaryllis has no actual rest-period if grown in warm weather as that of Egypt in which it keeps its foliage evergreen all over the year. The inflorescence emerges under Egypt temperature in Mid-April and lasts for a limited short period i.e. 2 -4 weeks (**Everett, 1991**).

Many authors demonstrated that growth and flowering of many ornamental bulbs are greatly influenced by bulb size. In Tuberose, **Ali and Razieh (2012)** concluded that effect of three bulb sizes including 1.5, 2.5 and 3.5 cm in diameter and planting depths of 4, 6 and 10 cm, on vegetative and flowering characteristics which was evaluated under greenhouse condition for producing of desirable flowers economically, the best bulb size for about 3.5 cm in diameter and planting depth 6 cm is advised for cultivation of tuberose flowers. In addition, the bulb yield is changed dependent on the bulb weight and bulb densities (**Khan *et al.*, 2013**). Small bulbs do not give flower or result in products with a low market potential (**Rees, 1986**). In addition, **Hanks (2002)** reported that yields are mainly controlled by the grade of bulbs, bulbs are graded by circumference. For this reason, it is important to determine the bulb size for optimum yield and appropriateness for cut flower and landscape areas. **Kapczyńska (2014)** showed that to obtain plants of the highest quality, it is recommended to cultivate large bulbs of lachenalia (5.1–6.0 cm in circumference) because they produce better quality inflorescences than small bulbs. At the same time, it is worth remembering that bulbs 4.0–5.0 cm in circumference also have the capacity to flower. 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, **Youssef and Ismaeil (2009)** indicated that 200 ppm kinetin-sprayed plants improved all studied vegetative and flowering growth traits of *Clivia miniata* plants. Additionally, **Youssef and Mady (2013)** cleared that spraying *Aspidistra elatior* plants with benzyladenine at 75ppm improved all tested vegetative and chemical constituents of this plants. **Abou El-Ghait *et al.* (2020)** showed that spraying jasmine plants with BA at 60 ppm induced prospective effects on vegetative growth and flowering parameters with higher quality of this plant.

Therefore, this study was carried out to study the effect of bulb size and BA on growth, flowering, bulbs productivity and chemical composition of *Hippeastrum vittatum* plant.

MATERIALS AND METHODS

This study was carried out in the open field at the Floriculture Nursery of the Horticulture Department Faculty of Agriculture at Moshtohor, Benha University, during 2018/2019 and 2019/2020 seasons to study the effect of bulb size (small, medium and large) and some BA treatments (0, 20, 40 and 60 ppm) in combining treatments to lump their benefits in vegetative growth, flowering, bulb production and chemical composition of *Hippeastrum vittatum* plants.

Plant material

Hippeastrum vittatum, bulbs "local variety" were classified into three sizes i.e., large size (7-8 cm diameter with the weight of 175-189 g), medium size (5-5.5cm diameter with the weight of 120-130 g) and small size (3.5-4 cm with the weight of 75-82 g). The bulbs were obtained freshly from Floriculture Nursery of the Horticulture Department, Faculty of Agriculture at Moshtohor, Benha University.

Planting procedure

Hippeastrum vittatum bulbs were planted in loamy soil "(the analyses of the used soil are presented in Tables (a, b)" on mid-October in beds 1x1m^2 as every bed contain 4 bulbs planted at 50x50 cm in between in both seasons.

Table a. Mechanical analysis of the experimental soil

Parameters	Unit	Seasons	
		2018/2019	2019/2020
Coarse sand	%	5.13	4.86
Fine sand	%	14.74	15.12
Silt	%	27.18	26.31
Clay	%	52.95	53.71
Textural class	---	Loamy	Loamy

Table b. Chemical analysis of the experimental soil

Parameters	Unit	Seasons	
		2018/2019	2019/2020
$CaCo_3$	%	1.04	1.11
Organic matter	%	1.52	1.59
Available nitrogen	%	0.81	0.86
Available phosphorus	%	0.34	0.39
Available potassium	%	0.74	0.78
E.C	ds/m	1.08	1.12
pH	---	7.71	7.78

BA treatments

All planting bulb sizes (small, medium and large) of *Hippeastrum vittatum* bulbs were subjected to foliar spray with BA at the rates of 0, 20, 40 and 60 ppm four times, each at one-month interval, starting at January 1st in the two seasons.

A surfactant (Tween 20) at a concentration of 0.01% was added to all tested solutions including the control.

Experiment layout

The design of this experiment was factorial experiments in a complete randomize block design with 12 treatments represented the combinations between three bulb sizes i.e., small, medium and large and BA at the concentration of 0, 20, 40 and 60 ppm (3 bulb sizes x 4 BA concentration) replicated three times (each replicate consisted of five beds, with four plants/bed). Common agricultural practices (irrigation, manual weed control, … etc.) were carried out when needed.

Recorded data

1- Vegetative growth parameters: Plant height, number of leaves, leaves fresh weight and leaves dry weight.

2- Flowering growth parameters: Flowering start (number of days from planting time to show color of the first flower), inflorescence length, flowering stem diameter and inflorescence fresh weight.

3- Bulb growth parameters: Bulb diameter, fresh and dry weight of bulb, number and diameter of bulblets.

4- Chemical composition measurements: At the flowering stage the chemical composition measurements were recorded:

- Total nitrogen: Total nitrogen was measured in sample solutions by using the modified micro-kjeldahl method as described by **Pregl (1945).**

- Phosphorus content: Phosphorus was determined colourimetrically in spectronic (20) spectrophotometer using the method described by **Trouge and Meyer (1939).**

- Potassium content: Potassium content was measured by flamephotometer according to **Brown and Lilleland (1946).**

- Total carbohydrates content: Total carbohydrates content was determined in dry powder material according to **Herbert *et al.*, (1971).**

- Total chlorophylls contents: Total **chlorophylls** content (mg/100g fw) was determined in fresh leaves according to **AOAC (1990).**

Statistical analysis

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

RESULTS AND DISCUSSION

Vegetative growth parameters

Data in Table (1 and 2) revealed that all studied bulb sizes of *Hippeastrum vittatum* plant significantly affected the vegetative growth parameters /plant in the two seasons. Anyhow, the largest one induced the tallest plant, highest number of leaves as well as the heaviest fresh and dry weights of leaves, followed by using the medium one in the two seasons. While, the small one gave the lowest values in these parameters in the two seasons. On the other hand, there was a positive relationship between the vegetative growth parameters values and BA concentration, hence the vegetative growth parameters values were increased as the BA concentration increased. In this concern, spraying *Hippeastrum vittatum* plants with the highest concentration (60ppm) statistically gave the tallest plant, highest number of leaves / plant and the heaviest fresh and dry weights of leaves, followed by using the medium concentration (40ppm) in the two seasons. Moreover, data in Table (1 and 2) showed that all the interactions between bulb size and BA concentration statistically improved the vegetative growth parameters when compared with control in the two seasons. However, the combined treatment between large bulb size and BA at 60 ppm significantly gave the tallest plant, highest number of leaves / plant and the heaviest fresh and dry weights of leave/plant, followed by the combined treatment between large bulb size and BA at 40 ppm in the two seasons. The lowest values of the tested vegetative growth parameters were gained by the combined treatments between small bulb size and received no BA treatment in the two seasons.

The obtained results might be due to the role of BA on promoting protein synthesis, increasing cell division and enlargement (**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 BA 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 aforementioned results of kinetin are in conformity with those reported by **El-Malt *et al.* (2006)** on *Hippeastrum vittatum*, **Youssef and Ismaeil (2009)** on *Clivia miniata* and **Youssef and Mady (2013)** on *Aspidistra elatior*, Youssef **and Abd El-Aal (2014)** on *Hippeastrum vittatum* plants, **Ghatas (2015)** on *Hemerocallis aurantiaca*, **El-Shoura and Arafa (2018)** on tuberose bulb (*Polianthes tuberosa* L.) **and Abou El-Ghait *et al.* (2020)** on jasmine plant.

Table 1. Effect of bulb size and BA on plant height and number of leaves of *Hippeastrum vittatum* plant during 2019 and 2020 seasons

BA (b) \ Bulb size(a)	plant height (cm)				number of leaves/plant			
	Small	**Medium**	**Large**	**Mean**	**Small**	**Medium**	**Large**	**Mean**
				1st season				
0	31.2	34.1	36.8	34.0	6.94	7.86	8.91	7.9
20 ppm	34.6	36.8	39.3	36.9	7.42	8.96	9.64	8.67
40 ppm	38.1	39.4	42.6	40.0	8.93	10.32	11.83	10.4
60 ppm	39.3	41.2	46.4	42.3	9.82	10.8	12.91	11.2
Mean	35.8	37.9	41.3		8.28	9.49	10.8	
L.S.D at 0.05	a= 1.34	b =1.54	a*b=2.67		a= 0.82	b =0.94	a*b=1.63	
				2nd season				
0	29.6	32.9	34.8	32.4	7.04	8.13	9.45	8.21
20 ppm	32.8	34.2	37.4	34.8	8.36	9.64	10.62	9.54
40 ppm	36.1	36	42.3	38.1	9.28	11.62	12.18	11.03
60 ppm	37.4	38.9	45.8	40.7	10	12.14	13.26	11.8
Mean	34.0	35.5	40.1		8.67	10.4	11.4	
L.S.D at 0.05	a= 1.26	b =1.45	a*b=2.51		a= 0.91	b =1.05	a*b=1.81	

Table 2. Effect of bulb size and BA on leaves fresh and dry weights of *Hippeastrum vittatum* plant during 2019 and 2020 seasons

BA (b) \ Bulb size(a)	leaves fresh weight (g)				leaves dry weight (g)			
	Small	**Medium**	**Large**	**Mean**	**Small**	**Medium**	**Large**	**Mean**
				1st season				
0	49.6	67.2	102.3	73	5.39	7.73	12.21	8.44
20 ppm	58.2	72.8	114.9	82	6.38	8.82	13.61	9.6
40 ppm	64.3	81.9	138.3	94.8	7.04	9.32	16.5	10.95
60 ppm	69.8	111.4	164.2	115.1	7.68	12.76	19.64	13.4
Mean	60.5	83.3	129.9		6.62	9.66	15.5	
L.S.D at 0.05	a= 12.2	b =14.0	a*b=24.3		a= 0.94	b =1.08	a*b=1.87	
				2nd season				
0	52.8	89.5	121.3	87.9	5.82	10.3	14.52	10.2
20 ppm	64.3	108.2	136.4	103	7.18	12.42	16.32	12
40 ppm	79.2	119	152.4	116.9	8.86	13.68	18.24	13.6
60 ppm	88.4	138.4	169.2	132	9.86	15.87	20.18	15.3
Mean	71.2	113.8	144.8		7.93	13.1	17.3	
L.S.D at 0.05	a= 11.3	b =13.0	a*b=22.5		a= 2.14	b =2.46	a*b=4.26	

Flowering growth measurements

Data in Table (3 and 4) showed that the number of days to start flowering was decreased as the size of bulb increased in the two seasons. Hence, using large bulb size significantly induced earlier flowering, followed by medium size as compared with small size in the two seasons. Moreover, inflorescence length, inflorescence stem diameter, inflorescence fresh weight and flowering percentage were greatly improved with increasing bulb size in the two seasons. In addition, all BA concentration resulted in early flowering of *Hippeastrum vittatum*, plant, especially the high concentration (60 ppm), followed by the medium rate in the two seasons. Besides, all studied concentrations of BA increased inflorescence length, inflorescence stem diameter, inflorescence fresh weight and flowering percentage, particularly the high concentration in the two seasons.

On the other hand, all combinations between bulb size and BA concentration induced a remarkable enhancement in these parameters, especially the combinations of large bulb size in both seasons. In this regard, the earliest flowering, the highest values of inflorescence length, inflorescence stem diameter, inflorescence fresh weight and flowering percentage were recorded by the combined treatment between large bulb size and BA at 60 ppm, followed by the combined treatment between large size and BA at 40 ppm in the two seasons. On the reverse, the highest flowering delaying as well as the lowest values of inflorescence length, inflorescence stem diameter, inflorescence fresh weight and flowering percentage were recorded by the combined treatments between small bulb size and received no BA in the two seasons.

Table 3. Effect of bulb size and BA on flowering start and inflorescence length of *Hippeastrum vittatum* plant during 2019 and 2020 seasons

Bulb size(a) / BA (b)	Flowering start (days)				Inflorescence length (cm)			
	Small	**Medium**	**Large**	**Mean**	**Small**	**Medium**	**Large**	**Mean**
1st season								
0	224	217	209	217	34.2	39.3	43.7	39.1
20 ppm	221	216	204	214	36.8	41	43.8	40.5
40 ppm	218	214	202	211	39.1	43.2	46.2	42.8
60 ppm	216	221	201	213	40.2	44.6	49.4	44.7
Mean	220	217	204		37.6	42.00	45.8	
L.S.D at 0.05	a= 6.27	b =7.21	a*b=12.47		a= 1.45	b =1.67	a*b=2.88	
2nd season								
0	232	224	204	220	32.4	36.7	41.8	37.0
20 ppm	226	221	201	216	34.1	38.4	43.4	38.6
40 ppm	218	216	198	211	36.8	41.6	46.2	41.5
60 ppm	219	215	196	210	37.2	43.2	48.4	42.9
Mean	224	219	200		35.1	40.0	45.0	
L.S.D at 0.05	a= 5.91	b =6.80	a*b=11.76		a= 2.18	b =2.51	a*b=4.38	

Table 4. Effect of bulb size and BA on inflorescence stem diameter, inflorescence fresh weight and flowering (%) of *Hippeastrum vittatum* plant during 2019 and 2020 seasons

Bulb size(a) / BA (b)	Inflorescence stem diameter (cm)				Inflorescence fresh weight (g)				Flowering (%)			
	Small	**Medium**	**Large**	**Mean**	**Small**	**Medium**	**Large**	**Mean**	**Small**	**Medium**	**Large**	**Mean**
1st season												
0	1.25	1.49	1.68	1.47	124.9	141.6	168.8	145.1	25.8	69.6	96.2	63.9
20 ppm	1.34	1.58	1.78	1.57	128.4	147.2	173.8	149.8	29	74.2	100	67.7
40 ppm	1.41	1.67	1.89	1.66	136.1	159.2	182.4	159.2	38.2	79.4	100	72.5
60 ppm	1.43	1.72	1.92	1.69	139.2	161.4	189.6	163.4	43.1	83.2	100	75.4
Mean	1.36	1.62	1.82		132.2	152.4	178.7		34	76.6	99.1	
L.S.D at 0.05	a=0.14	b= 0.16	a*b=0.78		a=8.14	b=9.36	a*b= 16.2		a=3.15	b=4.02	a*b=6.96	
2nd season												
0	1.27	1.48	1.65	1.47	121.2	138.4	164.3	141.3	28.3	68.7	98.3	65.1
20 ppm	1.3	1.53	1.71	1.51	126.4	141.2	168.2	145.3	31.4	73	100	68.1
40 ppm	1.39	1.61	1.82	1.61	131.6	146	180.1	152.6	36.9	78.2	100	71.7
60 ppm	1.42	1.64	1.86	1.64	134.2	148.2	182.4	154.9	41	81.4	100	74.1
Mean	1.35	1.57	1.76		128.4	143.5	173.8		34.4	75.3	99.6	
L.S.D at 0.05	a=0.16	b=0.18	a*b=0.32		a=7.17	b=8.25	a*b=14.3		a=4.02	b= 4.62	a*b= 8.00	

The obtained results might be due to the role of BA 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 BA on 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**).

The aforementioned results of kinetin 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*, **Youssef and Abd El-Aal (2014)** on *Hippeastrum vittatum* plants, **Ghatas (2015)** on *Hemerocallis aurantiaca*, **El-Shoura and Arafa (2018)** on tuberose bulb (*Polianthes tuberosa* L.) **and Abou El-Ghait *et al.* (2020)** on jasmine plant.

Bulb growth parameters

Data presented in Table (5 and 6) showed that planted the largest bulb significantly produced the heaviest bulb fresh and dry weights, the highest bulbs number/plant and the thickest bulb and bulblet, followed by the medium size with significant differences between them in the two seasons. However, the small one gave the lowest values of these parameters the two seasons. Furthermore, it was of interest to observe that (from Tables, 5 and 6) there was a positive relationship between the values of bulb growth parameters and BA concentration. Since, as the concentration of BA increased, the values of bulb growth parameters increased until reach to the maximum increment at the high concentration in the two seasons. Additionally, all interactions between bulb size and BA concentration increased the bulb growth parameters in both seasons. In this concern, the heaviest bulb fresh and dry weights, the highest bulbs number/plant and the thickest bulb and bulblet were scored by the combined treatment between the large bulb and BA at 60 ppm, followed by the combined treatment between the large bulb and BA at 40 ppm in the two seasons. On contrary, the lowest values of these parameters were scored by the combined treatments between small bulb and received no BA concentration in the two seasons.

Table 5. Effect of bulb size and BA on bulb fresh and dry weights of *Hippeastrum vittatum* plant during 2019 and 2020 seasons

Bulb size(a) / BA (b)	Bulb fresh weight (g)				Bulb dry weight (g)			
	Small	**Medium**	**Large**	**Mean**	**Small**	**Medium**	**Large**	**Mean**
1st season								
0	74.8	121.3	178.2	124.8	12.58	20.61	30.26	21.2
20 ppm	81.6	129.6	187.4	132.9	13.77	21.91	31.79	22.5
40 ppm	96.2	138.4	198.3	144.3	16.32	23.46	33.66	24.5
60 ppm	102	146.2	206.5	151.6	17.34	24.82	35.02	25.7
20 ppm	88.7	133.9	192.6		15.0	22.7	32.7	
L.S.D at 0.05	a= 11.4	b =13.1	a*b=22.7		a= 1.21	b =2.54	a*b=4.40	
2nd season								
0	78.3	132.4	183.6	131	14.04	23.76	32.94	23.6
20 ppm	84.3	141.6	194.2	140	15.12	25.38	34.92	25.1
40 ppm	102.4	151.8	204.3	153	18.36	27.18	36.72	27.4
60 ppm	110.8	159.4	214.2	161	19.8	28.62	38.52	29
Mean	94.0	146.0	199.0		16.8	26.2	35.8	
L.S.D at 0.05	a= 9.32	b =10.7	a*b=18.5		a= 1.17	b =1.35	a*b=2.33	

Table 6. Effect of bulb size and BA on number of bulbs, diameter of bulb and diameter of bulblet of *Hippeastrum vittatum* plant during 2019and 2020 seasons

Bulb size(a) / BA (b)	Number of bulbs				Diameter of bulb (cm)				Diameter of bulblet (cm)			
	Small	Medium	Large	Mean	Small	Medium	Large	Mean	Small	Medium	Large	Mean
1st season												
0	3.94	4.82	6.94	5.23	3.92	5.86	7.67	5.82	2.34	2.52	2.83	2.56
20 ppm	4.68	5.02	7.3	5.67	4.12	5.98	7.84	5.98	2.41	2.51	2.92	2.61
40 ppm	5.04	6.14	8.24	6.47	4.39	6.13	8.06	6.19	2.5	2.63	3.03	2.72
60 ppm	5.18	6.21	8.85	6.75	4.76	6.8	8.47	6.68	2.49	2.72	3.12	2.78
Mean	4.71	5.55	7.83		4.27	6.19	8.01		2.44	2.6	2.98	
L.S.D at 0.05	a=0.24	b=0.28	a*b=0.78		a=0.52	b=0.60	a*b=1.03		a= 0.12	b=0.14	a*b=0.24	
2nd season												
0	3.85	4.72	6.8	5.12	4.09	5.96	7.34	5.71	2.29	2.46	2.81	2.52
20 ppm	4.36	4.9	7.08	5.45	4.14	6.08	7.48	5.9	2.34	2.53	2.94	2.6
40 ppm	4.92	5.45	7.93	6.1	4.68	6.24	7.92	6.28	2.41	2.68	3.1	2.73
60 ppm	5.04	5.93	8.1	6.36	4.92	6.74	8.23	6.63	2.42	2.65	3.18	2.75
Mean	4.54	5.25	7.48		4.46	6.26	7.74		2.37	2.58	3.01	
L.S.D at 0.05	a=0.19	b= 0.22	a*b=0.38		a=0.47	b=0.54	a*b=0.94		a=0.13	b=0.15	a*b=0.26	

These results might be explained according to the role of BA on promoting proteins synthesis, soluble and non-soluble sugars synthesis, or may be due to the ability of BA for making the treated area to act as a sink into which nutrients from other parts of the plant are drawn. Additionally, these results may explain the role of cytokinins in promoting proteins and pigments synthesis and their ability to delay senescence and withdraw sugars and other solutes from older parts of a plant to the new organs (**Salisbury and Ross, 1974**). In the same line, **Leopol and Kawase (1964)** stated that cytokinins stimulate the movement of sugars, starch, amino acids and many other solutes from mature organs to primary tissues of other ones. Furthermore, may be due to the role of BA on increasing the promoters in the plant tissues at the expense of the inhibitors to increase roots growth. Moreover, it is well established that cytokinins stimulate lateral roots initiation, absorption and thus increasing the size (number, thickness, fresh and dry weights) (**Devlin and Witham, 1983**).

The abovementioned results of kinetin are in harmony with those attained by **Auda (1992)** on *Hippeastrum vittatum*, **Shahin (1998)** on Crinum and Hemerocallis plants, **El-Malt *et al.* (2006)** on *Hippeastrum vittatum* and **Youssef and Ismaeil (2009)** on *Clivia miniata*. **Youssef and Abd El-Aal (2014)** on *Hippeastrum vittatum* plants, **Ghatas (2015)** on *Hemerocallis aurantiaca* and **El-Shoura and Arafa (2018)** on tuberose bulb (*Polianthes tuberosa* L.).

Chemical composition determination

Data in Table (7 and 8) pointed out that all studied bulb sizes affected leaf N, P, K, total carbohydrates and total chlorophylls contents of *Hippeastrum vittatum* in both seasons of this study. In this concern, the greatest leaf N, P, K, total carbohydrates and total chlorophylls contents were scored by using the large bulb, followed in descending order by medium bulb in the two seasons. Moreover, all tested application of BA concentration succeeded in increasing leaf N, P, K, total carbohydrates and total chlorophylls contents, followed by the medium level in the two seasons. Moreover, all resulted interactions between bulb size and chemical fertilizer rates increased leaf N, P, K, total carbohydrates and total chlorophylls contents in both seasons. Anyhow, the highest leaf N, P, K, total carbohydrates and total chlorophylls contents were scored by the combination of large bulb size, especially those received BA at 60 ppm in the two seasons. On contrast, the lowest leaf N, P, K, total carbohydrates and total chlorophylls contents were scored by the combination of small bulbs, particularly those un-sprayed in the two seasons.

As for the explanation of the incremental effect of BA on chemical constituents of Hippeastrum content, it could be illustrated here on the basis that

BA treatments stimulated the endogenous cytokinins synthesis and there is an intimate relationship between cytokinins and chlorophylls metabolism in both excided or detached leaf disks and intact plants i.e., cytokinins retard chlorophylls degradation, preserve it and increase its synthesis **(Devlin and Witham, 1983**). Besides, cytokinins activate a number of enzymes participating in a wide range of metabolic reactions in the leaves. These reactions included the maturation of proplastid into chloroplasts. These enzymes could be divided into two groups according to their response to cytokinins. The first group of enzymes could be said to relate to chloroplast differentiation, while the second one could be related to cytokinin stimulated group (**Kulaeva, 1979**). Also, these results may explain the role of cytokinins on promoting proteins and pigments synthesis and their ability to delay senescence and withdraw sugars and other solutes from older parts of a plant to the new organs (**Salisbury and Ross, 1974)**. In the same line **Leopol and Kawase (1964)** stated that cytokinins stimulate the movement of sugars, starch, amino acids and many other solutes from mature organs to primary tissues of other ones. Furthermore, it may be due to the role of BA on increasing the growth promoters in the plant tissues at the expense of the inhibitors. In this concern, **Kenneth (1979)** reported that total control of plant growth is vested not in a single hormonal type – that of auxin – but is shared by several specially auxins, cytokinins, gibberellins and ethylene and this further subjected to namely the phenols, flavons and absicsic acid. The aforementioned results of BA are in conformity with those obtained by **Maximoos (1993)** on *Gerbera jamesonii*, **Shahin (1998)** on Crinum and Hemerocallis plants, **El-Malt *et al.* (2006) on *Hippeastrum vittatum,* Youssef and Ismaeil (2009) on *Clivia miniata* and Youssef and Mady (2013**) on *Aspidistra elatior*, **Youssef and Abd El-Aal (2014)** on *Hippeastrum vittatum* plants, **Ghatas (2015)** on *Hemerocallis aurantiaca*, **El-Shoura and Arafa (2018)** on tuberose bulb (*Polianthes tuberosa* L.) **and Abou El-Ghait *et al.* (2020)** on jasmine plant.

Consequently, in order to produce good quality *Hippeastrum vittatum* plants with higher bulbs productivity, it is preferable to spray the plants with BA at 60 ppm. Additionally, spray the medium bulb size with BA at 60 ppm could give the previously mentioned prospective traits.

Table 7. Effect of bulb size and BA on leaf N and P (%) of *Hippeastrum vittatum* plant during 2019 and 2020 seasons

Bulb size(a) / BA (b)	Leaf N (%)				Leaf P (%)			
	Small	**Medium**	**Large**	**Mean**	**Small**	**Medium**	**Large**	**Mean**
				1st season				
0	1.41	1.5	1.71	1.54	0.214	0.23	0.246	0.23
20 ppm	1.53	1.59	1.74	1.62	0.219	0.229	0.245	0.23
40 ppm	1.6	1.58	1.89	1.69	0.231	0.241	0.258	0.24
60 ppm	1.58	1.67	1.97	1.74	0.229	0.24	0.263	0.24
Mean	1.53	1.59	1.83		0.22	0.24	0.25	
L.S.D at 0.05	a=0.07	b = 0.08	a*b= 0.14		a=0.008	b =0.009	a*b=0.02	
				2nd season				
0	1.48	1.56	1.78	1.61	0.221	0.24	0.254	0.24
20 ppm	1.58	1.61	1.84	1.68	0.234	0.246	0.256	0.25
40 ppm	1.56	1.73	1.93	1.74	0.232	0.247	0.267	0.25
60 ppm	1.59	1.72	1.96	1.76	0.234	0.251	0.271	0.25
Mean	1.55	1.66	1.88		0.23	0.246	0.262	
L.S.D at 0.05	a=0.09	b = 0.10	a*b=0.18		a=0.009	b = 0.010	a*b=0.017	

Table 8. Effect of bulb size and BA on leaf K (%), leaf total carbohydrates (%) and leaf total chlorophylls (mg/100g fw) of *Hippeastrum vittatum* plant during 2019 and 2020 seasons

Bulb size(a) / BA (b)	Leaf K (%)				Leaf total carbohydrate (%)				Leaf total chlorophylls (mg/100g fw)			
	Small	Medium	Large	Mean	Small	Medium	Large	Mean	Small	Medium	Large	Mean
1st season												
0	1.28	1.36	1.47	1.37	13.7	18.4	19.8	17.3	145.2	156.8	178.7	160.2
20 ppm	1.37	1.35	1.46	1.39	14.2	18.2	21.6	18	151.3	167	192.3	170.2
40 ppm	1.36	1.49	1.52	1.46	16.8	20.3	24.2	20.4	168.2	181.7	212.4	187.4
60 ppm	1.4	1.48	1.61	1.5	16.6	21.4	25.3	21.1	167	180.5	218.3	188.6
Mean	1.35	1.42	1.52		15.3	19.6	22.7		157.9	171.5	200.4	
L.S.D at 0.05	a= 0.09	b=0.10	a*b= 0.18		a= .92	b=1.06	a*b= 1.83		a=9.32	b=10.72	a*b= 18.544	
2nd season												
0	1.27	1.42	1.51	1.4	14.8	17.9	21	17.9	151.8	168.4	189.4	169.9
20 ppm	1.31	1.48	1.59	1.46	15.6	19.8	22.3	19.2	162.4	173.2	198.2	177.9
40 ppm	1.49	1.52	1.68	1.56	15.4	19.7	24.6	19.9	171.2	172.8	218	187.3
60 ppm	1.47	1.53	1.73	1.58	16.8	20.8	26.2	21.3	169.8	184.3	226.5	193.5
Mean	1.39	1.49	1.63		15.7	19.6	23.5		163.8	174.7	208	
L.S.D at 0.05	a=0.07	b=0.08	a*b= 0.139		a=0.96	b=1.10	a*b= 1.91		a=8.34	b=9.59	a*b= 16.6	

REFERENCES

A.O.A.C. (1990). Official Methods of Analysis of Association of Official Analytical Chemists. Pub. A.O.A.C. INC. Suite 400, 22201 USA Fifteenth Ed. 1990; pp: 62-63, 236 and 877-878.

Abou El-Ghait, E.M.; Youssef, A.S.M., Mohamed, Y.F. Noor El-Deen, T.M. and Heba I. Mohamed (2020). Effect of benzyladenine and chemical fertilization on growth, flowering and chemical composition of Jasmine sambac plant. Scientific J. Flowers & Ornamental Plants, 7(4): 1-13.

Ali, T. and Razieh, A. (2012). Effect bulb sizes and planting depths of planting on growth and development of tuberose under greenhouse condition. J. Ornamental. Hort., 4(1): 50-52.

Auda, M.S. (1992). Physiological studies on Amaryllis bulbs. Ph.D. Thesis, Fac. Agric., Ain Shams Univ. Egypt.

Brown, J.D. and Lilleland, O. (1946). Rapid determination of potassium and sodium in plant material and soil extract by flame photometry. Proc. Amer. Soc., Hort., Sci., 48: 341-346.

Cheema, G.S. and Sharma, D.P. (1982). *In vitro* propagation of apple rootstocks. Int. Hort. Congr XXI. Hamburg, German Federal Republic, Int. Soc. Hort. Sci., 1: 1035 (Chem. Abst., 52: 7692).

Devlin, M. and Witham, H. (1983). Plant Physiology, 4th Ed. Publishers Willard, Grant Press, Boston.

El-Malt, A.A.T.; El-Maadawy, E.E.; El-Khateeb, M.A. and El-Sadak, Z.H. (2006). Physiological studies on *Hippeastrum vittatum* L. plants.2- Effect of NPK, CCC and BA on growth, bulblet production and flowering. Egypt. J. Appl. Sci., (6B): 724-742.

El-Shoura, H.A.S. and Arafa, F.F. (2018). Effect of soaking tuberose bulb (*Polianthes tuberosa* L.) in growth regulators and thiorea on growth and flowering. Middle East J. Appl. Sci., 08(01): 79-82.

Everett, T.H. (1991). The New York Botanical Garden Illustrated Encyclopedia of Horticulture. Garland Publishing, Inc. New York & London.

Ghatas, Y.A.A. (2015). Response of *Hemerocallis aurantiaca* Plants to Kinetin and Chemical Fertilization Treatments. Middle East J. Agric. Res., 4(4): 650-659.

Hanks, G.R. (2002). Commercial Production of Narcissus Bulbs. In: Narcissus and Daffodil, Hanks, G.R. (Ed.). Taylor and Francis Limited, pp: 53-131.

Herbert, D.; Phipps, P.J. and Strange, R.E. (1971). Determination of total carbohydrates, Methods in Microbiology, 5(8): 290-344.

Kapczyńska, A. (2014). Effect of bulb size on growth, flowering and bulb formation in lachenalia cultivars. Hort. Sci., 41(2): 89–94.

Kenneth, V.T. (1979). Physiology of Plant Growth and Development. Nalcolm. B. Wilkins TATA McGraw-Hill Publishing Co. Ltd. New-Delhi.

Khan, I.M.; Khan, F.U.; Salmani, M.; Khan, M. H.; Mir, M.A. and Amir, H. (2013). Effect of bulb density, nitrogen application time and deheading on growth, yield and relative economics of daffodil cv. Tunis (Narcissus sp.). African J. Agric. Res., 8(31): 4189-4193.

Kulaeva, O.N. (1979). Cytokinin action on enzyme activities in plants. In plant growth substances. (Ed.) F. Skoog, Springer-verlage Berlin, Heidelberg. New York (1980), pp. 119-128.

Leopol, A.C. and Kawase, M. (1964). Senescence of a trifoliate bean leaf caused by treating the primary leaves of cuttings with benzyladenine. Amer. J. Bot., 51: 294-298.

Maximoos, S.L. (1993). Physiological and hormonal studies on the growth and flowering of Gerbera Plant. Ph.D. Thesis, Fac. Agric., Ain Shams Univ.

Pregl, F. (1945). Quantitative organic micro analysis. 4th ED. J. & Achurnil, London. Regul., 4: 111-122.

Rees, A.R. (1986). Narcissus: Flowers per tonne of bulbs. ISHS Acta Horticulturae 177: IV International Symposium on Flower Bulbs, R.J. Bogers, B.H.H. Bergman (Eds.), Vol. 1, pp: 261- 266.

Runkova, L.V. (1985). Cytokinin's effect on some ornamental plants. Acta-Horticulturae, 167: 69-77.

Salisbury, F.B. and Ross, C.W. (1974). Plant Physiology. Publishing Inc. Belmont. California, 2nd ed., pp. 422.

Shahin, S.M.E. (1998). Physiological studies on Crinum and Hemerocallis bulbs. Ph.D. Thesis, Fac. Agric., Tanta Univ.

Snedecor, G.W. and Cochran, W.G. (1989). Statistical methods. 7th Ed. Iowa State Univ. Press. Ames Iowa, USA.

Trouge, E. and Meyer, A.H. (1939). Improvement in deiness calorimetric for phosphorus and arsenic. Ind. Eng. Chem. Anal. Ed., 1: 136-139.

Youssef, A.S.M and Ismaeil, F.H.M. (2009). Response of *Clivia miniata* plant to light intensity and kinetin treatments. Annals of Agric. Sc., Moshtohor, 47(1): 149-164.

Youssef, A.S.M. and Mady, M.A. (2013). Influence of light intensity and benzyladenine on growth performance of *Aspidistra elatior* Blume plant. Res. J. Agric. and Biol. Sci, 9(5): 248-257.

Youssef, A.S.M. and Abd El-Aal, M.M.M. (2014). Effect of kinetin and mineral fertilization on growth, flowering, bulbs productivity, chemical compositions and histological features of *Hippeastrum vittatum* plant. J. Plant Production, Mansoura Univ., 5(3): 357 – 381.