The Role of Benzyl Amino Purine and Kinetin in Enhancing the Growth and Flowering of three Gaillardia Varieties

Ramy Gaber El-Kinany[1], Atef M. K. Nassar[2] and Ahmed A.A. El-Settawy[3]
[1]Department of Horticulture and [2]Plant Protection Department, Faculty of Agriculture, Damanhour University, Damanhour, El-Beheira, PO Box 59, Egypt, and
[3]Forestry and Wood Technology Department, Faculty of Agriculture (El-Shatby), Alexandira University, Alexandria, Egypt

ABSTRACT

Two pot experiments were carried out during two successive winter seasons of 2015/2016 and 2016/2017 in a private commercial nursery located at Damanhour City, El-Beheira Governorate, Egypt. The objective of this research was to evaluate the effect of two synthetic cytokinins: benzyl amino purine (BAP) at 50 and 100 ppm and 6-furfuryl-aminopurine (kinetin) at 25 and 50 ppm, each alone, on the growth performance, yield and quality of three varieties (pulchella, Mesa Yellow and Lorenziana) of gaillardia (*Gaillardia pulchella*). The experiment was designed as a split-plot design containing three replicates. The obtained results of the two seasons, generally, revealed that *Gaillardia pulchella* var. pulchella had the highest plant and flowering growth parameters, (viz. number of inflorescence per plant and flowering duration). While, Lorenziana variety showed the best diameter, longevity, fresh weight and dry weight of inflorescence per plant. Spraying gaillardia plants with BAP and kinetin significantly enhanced vegetative, root and flowering parameters compared to the control treatment. From that, BAP at 100 ppm or kinetin at 25 ppm recorded the highest mean values of the most recorded data and might be considered as optimal treatment for the production of high yield and quality of gaillardia plants under the environmental conditions of El-Beheira Governorate and other similar regions.

Keywords: Plant growth regulators, Cytokinin, BAP, kinetin, Gaillardia.

INTRODUCTION

Gaillardia (*Gaillardia pulchella*), a member of the family Asteraceae, is native to Florida and Central and Western United States (Anonymous, 2007). Its common name is blanket flower and it may have come from the resemblance of the flowers to brightly patterned Native American. The generic name Gaillardia stands in honor of M. Gaillard, a French patron of botany (Baily, 1947). Gaillardia is a flowering herbaceous annual or short-lived perennial (Helen *et al*., 2007). The annual gaillardia is propagated by seeds. The perennial forms can be propagated by cutting, division or seeds. Gaillardia popularly cultivated for its attractive colour flowers and for varied uses like cut flowers, making garlands, floral decorations and required on weddings, religious occasions, excellent for raising in garden as borders and beds and other ceremonial and social occasions. Gaillardia produces flowers in a wide range of colors such as orange, yellow, scarlet, cream, bronze, red and brick-red and can be grown all around the year (Shreedhar, 1993). Gaillardia flowers are small and numerous; born in solitary, usually showy heads which is stated as capitulam with 4 to 6 cm in diameter. Individual flowers in a capitulam are called florets which range from one to ten according to cultivar or genotype. As a member of Asteraceae it has both ray and disc florets which are pistillate and hermaphrodite, respectively in nature. Flower has a long hairy stalk and single, semi- double and double types with single or multicolored heads (Cox and Klett, 1984). Presently the area under this crop is less and it is likely to be increased in the near future because this is a heavy demand for its flowers. However, the yield of flowers and its quality are low, which need to be increased by adopting improved agro techniques like using plant growth regulators.

The most important types of plant growth regulator classes are grouped into plant growth promoters such as auxins, gibberellins, and cytokinins. In addition, plant growth inhibitors such as abscisic acid and ethylene.

Plant growth regulators at small amounts can adjust plant physiological process and play a vital role in plant growth and development, such as elongation and flower development (Yamaguchi and Kamiya, 2000). Control of flowering is one of the most important practical aspects in application of plant growth regulators. There are numerous examples of utilization of plant growth regulators, which can regulate the flowering in aromatic plant (Shukla and Farooqi, 1990), for example, application of Ethrel (2-Chloroethyl phosphonic acid), kinetin and NAA (Naphthalene acetic acid) improved flowering in *Rosa damascena* and *Jasminum Sambac* (Farooqi and Sharma, 1988; Sharma and Farooqi, 1990; Farooqi *et al*., 1993). Performance of plant growth regulators applied depends on; the application method, amount of active ingredient presents and the time of application. The correct application method will ensure proper coverage of all tissues or targets the responsible tissue. The most common method is a foliar application as it is easy, convenient, cheap and economical.

Plant growth regulators like cytokinins playing a vital role from seed germination to senescence stage, which enable to prolonging the vase life and delaying the onset of senescence (Chatsudthipong and Muanprasat, 2009). Cytokinins can be utilized in variety of applications, from the treatment of seeds (Riedell *et al*., 1985) to applications during flowering (Dyer *et al*., 1986). Synthetic Cytokinins such as 6-furfuryl-aminopurin (kinetin) and benzyl amino purine (BAP) can improve plant growth by increasing cell division, break bud dormancy and promote the growth of the lateral buds (Hossain *et al*., 2006). Application of synthetic cytokinin on shoot increased chlorophyll formation and protein synthesis within tissues (George *et al*., 2008). However, available literature has no reports so far regarding the effect of cytokinins on growth and flowering of Gaillardia particularly in Egypt. Keeping these facts in view, an experiment was conducted with following objectives:

1. Trying to enhancement flower size and quality and increase the flower longevity.
2. To evaluate the effect of two synthetic cytokinin types and levels (BAP and Kin) each alone; on growth performance ,yield and quality of flowers of the three varieties of Gaillardia.

MATERIALS AND METHODS

Greenhouse experimental design

Two pot experiments were carried out during the two successive winter growing seasons, 2015/2016 and 2016/2017. The experiments were accomplished in a private commercial nursery located at Damanhour city in Beheira Governorate, Egypt under greenhouse conditions. Gaillardia varieties used during the study were Pulchella, Mesa Yellow (both varieties have flower head appear single with either a classic daisy form) and Lorenziana (The central disc filled with trumpet-shaped, 5-petaled flowers)". These varieties were chosen because of there fame. Seeds of Gaillardia were obtained from Ontario Seeds Company Ltd. Waterloo, Ont., Canada. Seeds were sown on 15 October in both seasons in 25 cm black plastic pots filled with soil consist of sand, silt, and clay as appeared in Table (1). After seed germination, plants were thinned to one plant per pot.

Soil samples were collected then physically and chemically analyzed according to Black *et al*. (1965). The analyses were carried out at the Natural Resourcse and Engineering Soil Department, Agriculiture Faculty, Damanhour University.

Table 1: Physical and chemical analyses of soil samples of the experiment.

Physical analysis	**First season**	**Second season**
Clay (%)	0.77	0.72
Silt (%)	7.00	8.03
Sand (%)	92.23	91.25
Texture class	sand	sand
Chemical analysis		
EC (dS/m)	0.80	0.87
pH	7.90	7.80
Ca (meq/L)	20.10	20.52
Mg (meq/L)	6.23	6.98
SO_4 (meq/L)	8.21	7.98
K (meq/L)	5.23	5.35

Aqueous solutions of Benzyl amino purine (BAP) and kinetin (manufactured by the Sigma-Aldrich Corporation) were applied as foliar spray at the concentrations of 50, and 100 ppm for (BAP) and 25 and 50 ppm for Kinetin and Distilled water was used as a control. The pot surface was covered with polyethylene before application to avoid falling of spray drips on the growing medium. All cytokinin concentrations were applied using a hand sprayer and non-ionic surfactant tween 80 at 0.05% (v/v) was added to all treatments to reduce the surface tension and increase the contact angle of sprayed droplets. Each plant was sprayed individually, so that, all foliage was moistened until the point of run-off. The spraying volume was 25 ml per plant. The untreated control plants were sprayed with distilled water.

Spraying plants was applied two times; the first one was carried out at flower initiation phase (Saffari *et al*., 2004 and Khatun *et al*., 2016), almost after five monthes from seed sowing. The second application was done 7 days after the first one.

The reason behind spraying gaillardia plants with cytokinin components when the plants entered flower initiating phase is due to the fact that spraying plants with cytokinins at the beginning of the plant life and the plant still small, leads to elongation in the plant cells and increases number of lateral branches and due to the nature of blanket flower growth where the plant is considered a tall herbaceous annual (more than 1 m long), which is usually subjects to slanting if it was grow alone in pot (Noor El-Deen *et al*., 2014). Also, the yield of flowers and its quality will be low because of the apical dominance which limits the production of flowers and reduces its quality. So the aim of this study was increasing the quality of flowers by increasing flower size and flower longevity or vase life which are the most important characters for commercial value of flowers (Saifuddin *et al*., 2009).

All cultural practices were applied whenever they were necessary and as commonly recommended in the commercial production of gaillardia. Irrigation was done as needed.

The following data were recorded:

Plant growth characters

Three plants from each treatment in each replicate were randomly chosen and tagged for collect vegetative growth traits, notably; plant height (cm) which was recorded from the first week of treatments application (almost five months after sowing of the seeds), number of branches per plant, leaf area (cm^2) according to Zidan (1962), shoot fresh and dry weights per plant (g) were determined without the inflorescences and also for roots by the end of the experiment for all plants. Dry weights were determined by drying the plant samples in the oven at 70 °C till obtaining a constant weight, then left to cool inside the oven and weighed in grams. In all cases, the weight measurements were performed using a digital scale with a precision of 0.001 digits. Also, root growth parameters were measured such as root length, root fresh and dry weights per plant (g).

Flowering growth characters

Flowering growth parameters were measured such as; inflorescence diameter (cm), flowering duration (day), number of inflorescences per plant, inflorescence longevity on the plant and inflorescence fresh weight (g; all fully opened inflorescences per plant before the beginning of fading stage were used), and inflorescence dry weight (g) were estimated according to Elkinany (2016).

The experimental design and statistical analysis

The experiments were designed as a split plots design with three replicates (Snedecor and Cochran, 1967). Where, the three varieties of gaillardia were arranged as the main plots, and the synthetic cytokinins concentrations were considered as sub-plots. Data were analyzed by Statistical Analysis Systems (CoStat, 2008) and the means were compared by Tukey multiple comparison post-hoc test at 0.05 probability.

RESULTS AND DISCUSSION

Vegatative characters

Data in Table (2) showing the main effects of the two studied factors (Three varieties of gaillardia and different levels of synthetic cytokinins) on plant growth parameters of gaillardia plants during the two growing seasons of 2015/2016 and 2016/2017.

Regarding the main effect of three gaillardia varieties on plant growth parameters, data in Table (2) indicated that the three gaillardia varieties significantly differed in their vegetative growth paramaters. Pulchella variety showed the highest mean values of plant height, number of branches per plant, leaf area, shoot fresh weight and dry weights per plant, root length and root fresh and dry weights per plant in both seasons. However, there was no significant difference between the two gaillardia varieties "Pulchella and Mesa yellow" in plant height during the first season, in number of branches per plant in both season and root length in the second season. Moreover, there was no significant difference among the three varieties of gaillardia "Pulchella, Mesa Yellow and Lorenziana" in leaf area, shoot fresh weight per plant and root fresh weight per plant in the second season. The detected differences among the three tested varieties could be attributed to their genetic features.

Concerning the main effect of different rates of synthetic cytokinins (BAP and kinetin) on plant growth parameters, data in Table (2) indicated that, spraying gaillardia plants with benzyl amino purine (BAP) and kinetin in general significantly increased vegetative growth parameters compared to control treatment. Spraying plants with BAP at 100 ppm gave the highest mean values of plant height, number of branches per plant, leaf area, shoot fresh and dry weights per plant during both seasons compared to the control treatments. However, there was no significant difference between the two concentrations of BAP (50, and 100 ppm) in number of branches per plant and leaf area in both seasons. On the other hand, spraying with kinetin significantly increased root growth parameters i.e. root length, root fresh weight per plant and root dry weight per plant in both seasons compared to the control treatment.

Results also indicated that the low concentration of kinetin (25 ppm) was more effective than the high concentration of kinetin (50 ppm) in increasing root growth parameters. However, there was no significant difference between the two concentrations of kinetin (25 and 50 ppm) for leaf area in the first season, shoot dry weight per plant in the second season and root fresh and dry weights per plant in the second season.

Generally, the superior influence of benzyl amino purine (BAP) treatments on stimulating the vegetative growth parameters may be due to the role of BAP in stimulating cell division and elongation (Krug *et al*., 2006, Mazher *et al*. 2011, and Sadak *et al*., 2013), which leads to stimulation of primordial production and partially intermodal elongation on the apex (Kumari, 2017), which reflected in the increase of plant height. Cytokinins play an important role in counteracting or eliminating the apical dominance and stimulating the release of axillary buds from apical dominance (Sachs and Thimann, 1964, 1967; Tamas, 1995; Arteca, 1996 and Menaka *et al*., 2018) which lead to increment in number of branches per plant.

Table 2: The main effect of G. varieties and Kin. and BAP on plant growth parameters of gaillardia plants during 2015/2016 and 2016/2017 seasons.

Treatments	Plant height (cm)		N. of Branches /plant		Leaf area (cm^2)		Shoot fresh weight/plant (g)		Shoot dry weight/plant (g)		Root length (cm)		Root fresh weight/plant (g)		Root dry weight/plant (g)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Gaillardia varieties																
Mesa Yellow	84.93 AB	85.27 B	12.93 A	13.33 A	36.80 B	35.33 A	72.93 AB	76.00 A	13.15 C	12.83 C	27.10 B	28.18 A	25.82 B	24.91 A	5.01 B	5.38 AB
Pulchella	86.80 A	87.40 A	13.53 A	13.27 A	37.93 A	37.27 A	75.47 A	76.53 A	15.69 A	16.06 A	28.00 A	28.89 A	27.03 A	27.32 A	5.52 A	5.76 A
Lorenziana	83.07 B	83.60 C	8.20 B	9.00 B	35.97 B	36.53 A	71.07 B	75.33 A	14.60 B	14.63 B	25.29 C	27.17 B	24.24 C	26.29 A	4.63 B	4.95 B
Different levels of Kin. and BAP																
Control	66.44 E	66.56 E	9.00 C	8.33 C	34.11 C	33.00 D	59.22 E	63.78 E	10.60 E	9.714 D	20.89 E	22.34 D	21.28 D	21.07 D	3.24 D	3.45 C
25 ppm kinetin	90.44 C	91.56 C	11.56 B	12.89 A	36.33 B	36.89 B	71.00 C	74.11 C	12.66 D	13.24 C	33.56 A	34.99 A	30.78 A	30.55 A	7.67 A	7.48 A
50 ppm kinetin	76.33 D	78.33D	10.22 C	10.56 B	35.47 B	34.89 C	68.33 D	68.89 D	14.02 C	13.94 C	30.21 B	31.01 B	28.04 B	30.76 A	6.51 B	6.60 A
50 ppm BAP	93.89 B	93.44 B	13.00 A	13.33 A	39.36 A	38.44 AB	79.22 B	84.22 B	16.73 B	17.18 B	26.00 C	28.16 C	25.59 C	25.99 B	4.18 C	5.50 B
100 ppm BAP	97.56 A	97.22A	14.00 A	14.22 A	39.22 A	38.67 A	88.00 A	88.78 A	18.39 A	18.46 A	23.34 D	23.89 D	22.77 D	22.48 C	3.66CD	3.77 C

1st and 2nd; first season and second season. Values marked with the same alphabetical letters, do not differe significantly, using Tukey's Honest Significant Difference test at 0.05 level of probability.

The obtained results are comparable with those obtained by Eid and Abou-Leila (2006) on Coroton plant, Mara (2017) on *Echinacea Hybrids* and Mazher *et al*., (2011) on *Codiaeum variegatum* L., Sharief and El-hamady (2017) on *Broad Bean* and Khandaker *et al*. (2018) on stevia plants.

Cytokinins are considered a growth control hormones, which promote protein synthesis, cell division, enlargement, cell number and nutrient mobilization (Zhao *et al.*, 2010 and Bairwa and Mishra, 2017). When exogenous applications of Cytokinins are made, they promote cell expansion (Miller, 1956) which leads to increasing the leaf area. The general increase in leaf area as a result of BAP treatments is in agreement with the findings of Reda *et al.,* (2010) on chamomile plant, Henschke *et al*., (2015) on *Helleborus Orientalislam* 'Red Hybrids', Mansour *et al*., (2016) on *Conocarpus erectus* L. Plants, Mara (2017) on *Echinacea Hybrids* and Mohamed (2017) on aster plant.

The increment in the shoot fresh weight could be explained through the role of cytokinin in stimulating xylem differentiation and vascular strand development, which lead to more absorption of water and nutrients from the soil, which was reflected in more growth, as mentioned by Sorokin and Thimann (1964). These results are in harmony with those obtained by Eid and Abou-Leila (2006) on Coroton plant, Abdel El-Aziz (2007) on *Codiaeum variegatum* L., Ghatas (2015) on *Hemerocallis aurantiaca* and Neetu and Singh (2016) on gladiolus. Similar increases in the dry weight of shoot as a result of BAP treatments have been reported by Mazrou (1992) on *Datura innoxia* plants, Zaghloul (1998) on *Codiaeum variegatum* and *Cordyline terminalis* and Mansour *et al*., (2016) on *Conocarpus erectus* L. plants.

The positive effect of kinetin on stimulating the root growth parameters may be due to accumulation of greater photosynthates which leading to better growth parameters (El-Keltawi and Croteau, 1987) and the role of kinetin in stimulation of the cell division, enlargement and number (Schmulling, 2002 and Khalighi *et al*., 2005) which leading to increase root length and number of offsets and then increasing root growth parameters. Our results are in harmony with those of Sardoei *et al*., (2013) on *Aloe barbadensis*, Aier *et al*., (2015) on Gladiolus Cv. Red Candyman, Hembrom and Singh (2015) on Lilium, Ghatas (2015) on *Hemerocallis aurantiaca* and El-Bably and Rashed (2017) on *Clivia miniata*.

The interaction effect between the three gaillardia varieties and different levels of BAP and kinetin on plant growth parameters were significant during both seasons (Table 3). The statistical analysis revealed that the highest mean values of plant height recorded at the combined treatment of the three gaillardia varieties "Pulchella, Mesa Yellow and Lorenziana" with 100 ppm BAP treatment. The combined treatment of Pulchella variety with 100 ppm BAP treatment recorded, generally, the highest mean values of number of branches per plant, leaf area, shoot fresh and dry weights in both seasons compared to the control treatment. However, the highest mean values of root length were obtained when Lorenziana cultivar sprayed with 25 ppm kinetin in both seasons. On the other hand the combined treatment which included Pulchella variety with 25 ppm kinetin recorded the highest mean values of root fresh and dry weights, in the both seasons. The 100 ppm BAP level increased number of branches per plant, leaf area , shoot fresh weight and shoot dry weight of Pulchella variety by (62.14 and 81.11%) , (15.85 and 20.12 %), (35.3% and 38%) and (78.38% and 86.67%) over than the control treatment for the first and second seasons, respectively. Also, 25 ppm kinetin level, increased root fresh and dry weights of Pulchella variety by (48.8% and 56.52%) and (94.6% and 119.44%) over than the control treatment for the first and second seasons, respectively.

Flowering growth characters

Concerning the main effect of the three gaillardia varieties on flower parameters, the gained results presented in Table (4) showed that the three gaillardia varieties significantly differed in inflorescence characters. Lorenziana variety showed highest mean values of the most data recorded i.e. inflorescence diameter, inflorescence fresh and dry weight per plant and inflorescence longevity in both seasons. While, Pulchella variety showed highest mean values of number of inflorescences per plant and flowering duration in both seasons. However, there was no significant difference between the two gaillardia varieties "Lorenziana and Pulchella" in inflorescence diameter in both seasons and "Pulchella and Mesa Yellow" varieties in number of inflorescence per plant in the first season only. The detected difference among three gaillardia varieties could be attributed to their genetic features.

Regarding the main effect of different rates of BAP and kinetin on flowering growth parameters, data in Table (4) indicated in general that, spraying gaillardia plants with kinetin and benzyl amino purine (BAP) significantly increased flowering growth parameters compared to control treatment. The obtained data indicated that spray plants with kinetin gave the highest mean values of inflorescence diameter, number of inflorescence per plant, inflorescence fresh and dry weight per plant, inflorescence longevity and flowering duration.

Table 3: the interaction effect between G. varieties and Kin. and BAP on vegetative traits of G. varieties in during 2015/2016 and 2016/2017 seasons.

Treatments		Plant height (cm)		N. of branches /plant		Leaf area (cm^2)		Shoot fresh weight/plant (g)		Shoot dry weight/plant (g)		Root length (cm)		Root fresh weight/plant (g)		Root dry weight/plant (g)	
varieties	cytokinins	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mesa Yellow	Control	63.3 f	65.3h	9. 7 fgh	9.0 de	34.7 fg	33.3 de	56.0 c	65.7 fg	10.5 gh	10.3 gh	21.0 i	23.3 ef	23.3 ef	22.3 fgh	3.1 f	3.8 def
	25 ppm kinetin	93.7 b	93.3 bc	13.3 bcd	13.3 abc	36.3def	34.7cde	75.3 bc	71.0 def	12.97 def	13.3 ef	32.0bc	33.6 ab	32.0 a	28.5 bcd	7.8 a	7.2 ab
	50 ppm kinetin	75.7 d	76.7f	11.0 defg	11.7 bcd	34.3 fg	34.7cde	69.7 d	67.7 efg	11.4fgh	9.9 gh	31.0cd	28.3 d	27.5 bcd	28.1 cd	6.97 ab	5.6 bcde
	50 ppm BAP	93.3 b	93.0bc	15.0abc	16.0 a	39.6 ab	36.3bcd	78.0 b	87.3 ab	14.9 bcd	14.9 cdef	26.7fg	29.5cd	24.3 def	23.8 ef	3.6 ef	5.95abcd
	100 ppm BAP	98.7 a	98.0a	15. 7 ab	16.7 a	39.1 abc	37.7abc	85.7 a	88.3 ab	15.9 bc	15.7 cde	24.9gh	26.3 de	22.0 fg	21.8 fgh	3.6 ef	4.4 def
Pulchella	Control	71.0 e	69.0 g	10.3 efg	9.0 de	34.7 fg	33.3 de	66.0 d	65.0 fg	11.1 fgh	10.5 gh	24.0 h	23.1 ef	20.9 fg	20.7 gh	3.7 def	3.6 ef
	25 ppm kinetin	92.0 b	92.7bc	13.0 bcde	14.7 ab	37.0 cde	37.3abc	70.7 cd	74.7 cde	12.5 ef	13.8 ef	34.0ab	35.5 ab	31.1a	32.4 a	7.2 a	7.9 a
	50 ppm kinetin	78.00d	82.0e	12.3cdef	11.7 bcd	37.7bcde	36.3bcd	67.0 d	68.7 ef	16.4 b	17.2bcd	30.3cd	32.7abc	30.3 ab	31.6ab	6.9 ab	7.5 ab
	50 ppm BAP	94.67b	95.3abc	15.3ab	14.7ab	40.0 a	39.3 ab	84.3 a	84.7 ab	18.7 a	19.1 ab	27.7 ef	28.5 d	28.7 abc	28.4 cd	5.2 cd	5.9 abcd
	100 ppm BAP	98.3 a	98.0a	16.7 a	16.3 a	40.2 a	40.0 a	89.3 a	89.7 a	19.8 a	19.6 ab	24.0 h	24.7 e	24.0ef	23.6 efg	4.6 cde	3.9 def
Lorenziana	Control	65.0f	65.3h	7.0 h	7.0 c	33.0 g	32.3 c	55.7 c	60.7 g	10.2 h	8.3 h	17.7 j	20.7 f	19.7 g	20.3 h	2.9 f	3.003 f
	25 ppm kinetin	85.7 c	88.7 d	8.3 gh	107 cd	35.7 ef	38.7 ab	67.0 d	76.7 cd	12.5 efg	12.6 fg	34.7 a	35.8 a	29.2abc	30.8 abc	8.1 a	7.4 ab
	50 ppm kinetin	75.3d	76.3 f	7.3h	8.3 de	34.3 fg	33.7 de	68.3 d	70.3def	14.2 cde	14.7 def	29.3 de	32.1 bc	26.3 cde	32.6 a	5.7bc	6.7 abc
	50 ppm BAP	93.7 b	92.0 c	8.7 gh	9.3 de	38.5 abc	39.7ab	75.3 bc	80.7 bc	16.6 b	17.5 abc	23.7 h	26.5 de	23.7ef	25.8 de	3.8 def	4.7 cdef
	100 ppm BAP	95.7ab	95.7ab	9.7 fgh	9.7 de	38.3abcd	38.3 ab	89.0 a	88.3 ab	19.4 a	20.1 a	21.1 i	20.7 f	22.3 fg	22.0 fgh	2.8 f	3.0 f

1st and 2nd: first season and second season. Values marked with the same alphabetical letters, do not differe significantly, using Tukey's Honest Significant Difference test at 0.05 level of probability.

Table 4: The main effect of G. varieties and Kin. and BAP on flowering parameters of gaillardia plants during 2015/2016 and 2016/2017 seasons.

Treatments	Inflorescence diameter (cm)		N. of inflorescences / plant		Inflorescence fresh weight/plant (g)		Inflorescence dry weight/plant (g)		Inflorescence longevity (day)		Flowering duration (day)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Gaillardia varieties												
Mesa Yellow	5.05 B	5.43 B	24.33 A	23.67 B	2.12 C	2.25 C	0.94 C	0.903 C	5.53 C	5.67 B	73.53 C	71.07 C
Pulchella	5.91 A	5.79 A	24.40 A	25.60 A	2.38 B	2.57 B	1.17 B	1.18 B	6.20 B	6.07 B	91.07 A	92.67 A
Lorenziana	5.70 A	5.87 A	15.00 B	14.47 C	3.6 A	3.88 A	1.80 A	1.93 A	13.8 A	13.93 A	81.13 B	82.47 B
Different levels of Kin. and BAP												
Control	4.47 C	4.48 C	17.56 C	16.44 C	2.45 C	2.46 C	0.91 D	1.05 C	6.44 C	6.44 C	70.00 C	74.44 D
25 ppm kinetin	6.29 A	6.58 A	25.22 A	25.00 A	2.94 A	3.15 A	1.71 A	1.54 A	10.00 A	9.78 A	89.89 A	89.67 A
50 ppm kinetin	6.16 A	6.52 A	23.56 AB	24.33 A	2.89 A	3.10 A	1.42 B	1.47 A	9.56 A	9.33 A	89.22 A	86.11 AB
50 ppm BAP	5.79 A	5.31 B	21.56 B	21.89 AB	2.63 B	3.05 A	1.37 B	1.41 AB	8.44 B	9.11 A	84.00 AB	82.67 BC
100 ppm BAP	5.08 B	5.62 B	18.33 C	18.56 BC	2.59 BC	2.75 B	1.11 C	1.21 BC	8.11 B	8.11 B	76.44 BC	77.44 CD

1st and 2nd; first season and second season. Values marked with the same alphabetical letters, do not differe significantly, using Tukey's Honest Significant Difference test at 0.05 level of probability.

Also, there was no significant difference between the two concentrations of kinetin (25, and 50 ppm) in inflorescence diameter, number of inflorescences per plant, inflorescence fresh weight per plant, inflorescence longevity, flowering duration in both seasons, and inflorescence dry weight per plant in the second season.

Generally, the greater influence of kinetin treatments on stimulating the flowering growth parameters may be due to the role of kinetin in promoting protein synthesis, increasing cell division, enlargement and chlorophyll synthesis (Cheema and Sharma, 1982). Which lead to an increase in flower diameter. These results are comparable with those obtained by El-Bably and Rashed (2017) on *Clivia miniata*. L. plants, Bairwa and Mishra (2017) on African Marigold (*Tagetes erecta* Linn.) and Abou-El-Ghait *et al*., (2018) on *Dendranthema grandiflorium* cv. Art Queen plants.

The increment in number of inflorescences per plant with kinetin treatment could be due to delay of senescence which enhanced the translocation of photosynthesis from source to sink (Salisbury and Ross, 1974 and Hugar and Nalawadi, 1999). The obtained results of number of inflorescence per plant are in harmony with those reported by Bairwa and Mishra (2017) on African Marigold (*Tagetes erecta* Linn.), El-Bably and Rashed (2017) on *Clivia miniata*. L. plants, Mara (2017) on *Echinacea Hybrids* and Mohamed (2017) on aster plant.

Kinetin playing a vital role in promoting protein synthesis, increasing cell division and enlargement and chlorophyll synthesis (Cheema and Sharma, 1982) which lead to an increase in inflorescence diameter and, then increment of inflorescence fresh and dry weights. Results of inflorescence fresh weight and flower dry weight per plant are comparable with those obtained by Youssef (2004) on *Strelitzia reginae*, Youssef and Ismaeil (2009) on *Livia minister* plant, Ghatas (2015) on *Hemerocallis aurantiaca* and El-Bably and Rashed (2017) on *Clivia miniata*. L.

The increased longevity of kinetin-treated inflorescence may be due to its effect on ethylene synthesis processes in the tissue of flowers and decreases the ethylene production within the flowers (Bosse and Van Staden, 1989) and decreasing of protein hydrolytic enzymes activity lipooxygenase (Leshem *et al*., 1979). Also, it may attributed to its role in decreaseing the respiration rate of kinetin-treated flowers (MacLean and Dedolph, 1962). The superior influence of kinetin on increasing flowering duration may be due to the increasing of inflorescence number and inflorescence longevity.

Table 5: The interaction effect between G. varieties and Kin. and BAP on flowering traits during 2015/2016 and 2016/2017 seasons

Treatments		Inflorescence diameter (cm)		N. of inflorescence / plant		Inflorescence fresh weight/plant (g)		Inflorescence dry weight/plant (g)		Inflorescence longevity (day)		Flowering duration (day)	
varieties	Cytokinins	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mesa Yellow variety	Control	4.0 h	4.3 g	19.3 cde	17.7 efg	1.97 fg	1.9 g	0.5 i	0.6 f	4.7 gh	4.3 f	60.7 d	66.3 fg
	25 ppm kinetin	5.8 abcdef	6.7 abc	27.7 a	27.3 abc	2.4 cde	2.4 def	1.4 cde	1.237 cd	6.7 def	7.0 d	84.0 abc	80.7 cde
	50 ppm kinetin	5.6 abcdefg	6.3 ab	27.7 a	27.0 abc	2.2 def	2.4 def	1.0 fgh	0.99 def	6.0 defg	6.0 de	81.0 abc	76.3 def
	50 ppm BAP	5.2 cdefg	5.3 cdef	24.0 abc	24.0 bcde	2.1 efg	2.2 fg	1.1 efg	0.95 def	5.3 efgh	6.0 de	76.0 bcd	70.3 efg
	100 ppm BAP	4.7 fgh	5.0 defg	23.0 abc	22.3 cdef	1.9 g	2.3 efg	0.7 hi	0.8 ef	5.0 fgh	5.0 ef	66.0 cd	61.7 g
Pulchella variety	Control	4.9 efgh	4.5 fg	21.0 bcd	19.0 defg	2.1 defg	2.2 fg	0.8 ghi	0.7 ef	4.0 h	4.3 f	81.0 abc	83.7 bcd
	25 ppm kinetin	6.6 a	6.6 a	29.0 a	32.0 a	2.5 cd	2.8 cd	1.4 cde	1.3 cd	7.7 d	6.7 de	96.7 a	99.0 a
	50 ppm kinetin	6.5 ab	6.4 ab	27.0 ab	30.0 ab	2.3 de	2.7 de	1.5 de	1.5 bc	7.0 de	6.7 de	97.7 a	96.3 ab
	50 ppm BAP	6.2 abcd	5.5 bcde	26.0 ab	26.0 abcd	2.3 de	2.7 de	1.3 def	1.3 cd	6.3 defg	6.3 de	93.3 ab	94.0 ab
	100 ppm BAP	5.4 bcdefg	5.9 abcd	19.0 cde	21.0 cdef	2.7 c	2.4 def	1.0 fgh	1.0 de	6.0 defg	6.3 de	86.7 ab	90.3 abc
Lorenziana variety	Control	4.50 gh	4.7 efg	12.3 f	12.7 g	3.2 b	3.2 bc	1.4 cde	1.9 ab	10.7 c	10.7 c	68.3 cd	73.3 defg
	25 ppm kinetin	6.5 ab	6.83 a	19.0 cde	15.7 fg	3.98 a	4.3 a	2.4 a	2.1 a	15.7 a	15.7 a	89.0 ab	89.3 abc
	50 ppm kinetin	6.4 abc	6.8 a	16.0 def	16.0 fg	4.1 a	4.2 a	1.9 b	1.9 ab	15.7 a	15.3 a	89.0 ab	85.7 bcd
	50 ppm BAP	5.97 abcde	5.10 defg	14.7 def	15.7 fg	3.5 b	4.3 a	1.7 bc	1.96 a	13.7 b	15.0 a	82.7 abc	83.7 bcd
	100 ppm BAP	5.2 defg	5.9 abcd	13.0 ef	12.3 g	3.2 b	3.5 b	1.7 bcd	1.8 ab	13.3 b	13.0 b	76.7 bcd	80.3 cde

1st and 2nd; first season and second season. Values marked with the same alphabetical letters, do not differe significantly, using Tukey's Honest Significant Difference test at 0.05 level of probability.

The general increase in inflorescence longevity and flowering duration as a result of kinetin treatments is in agreement with the findings of Reda *et al.,* (2010) on chamomile plant, Mara (2017) on *Echinacea Hybrids*, Mohamed (2017) on *Symphyotrichum novi-belgii* L. and Abou-El-Ghait *et al*., (2018) on *Dendranthema grandiflorium* cv. Art Queen plants.

The effects of interaction between the gaillardia varieties and different levels of BAP and kinetin on flowering growth parameters of gaillardia plants were significant during both seasons (Table 5). The obtained results, generally, revealed that the combined treatment which included Pulchella variety and 25 ppm kinetin gave the highest mean values of inflorescence diameter, number of inflorescences per plant and flowering duration in the both seasons. Whereas, the combined treatment of the Lorenziana variety and either 25 or 50 ppm kinetin presented the highest mean values of inflorescence fresh weight, inflorescence dry weight and inflorescence longevity in both seasons. The estimated percentages increase in inflorescence diameter, number of inflorescences per plant and flowering duration for Pulchella variety were (34.69 and 46.67%), (38.1 and 68.42%) and (19.38% and 18.28%) compared to the control treatment for the first and second seasons, resiectively. Whereas, the estimated percentages increase in inflorescence fresh weight, inflorescence dry weight and inflorescence longevity for Lorenziana variety were (24.38, 28.13 and 34.38, 31.25%), (71.43 and 10.53, 3.16%) and (46.73% and 46.73, 42.99, 40.19%) compared to the control treatment for the first and second seasons, resiectively.

CONCLUSIONS

This study recommends, generally, that the interaction between Pulchella variety and either BAP at 100 ppm or kinetin at 25 ppm considerd as a best treatment for the production of admirable vegetative and flowering growth of gaillardia plants under the environmental conditions of this study.

REFERENCES

Abd El-Aziz, N. 2007. Stimulatory effect of NPK fertilizer and benzyladenine on growth and chemical constituents of *Codiaeum variegatum* L. American-Eurasian J. of Agri & Envi. Sci. 2(6): 711-719.

Abou-El-Ghait, E. M, Gomaa, A. O., Youssef, A. S. M. and EL-Nemr, A. M. 2018. Effect of kinetin and GA3 treatments on growth and flowering of *Dendranthema grandiflorium* cv. Art Queen plants. Middle East J. Agric. Res., 7(3): 801-815.

Aier, Sh., Langthasa, S., Hazarika, D. N., Gautam, B.P. and Goswami, R.K. 2015. Influence of GA3 and BA on morphological, phenological and yield attributes in Gladiolus Cv. Red Candyman. J. Agri & Vet. Sci (IOSR)., (8): 6, 37-42.

Anonymous: U.S. department of agriculture. The plant database (2007).

Arteca, R. N. 1996. Plant Growth Substances: Principles and Applications, Chapman & Hall, New York. 133: 67- 69.

Baily, L. H. 1947.The standard encyclopadia of horticulture. The Macmillan Company.

Bairwa, S and Mishra, J. S. 2017. Effect of NAA, BA and Kinetin on Yield of African Marigold (*Tagetes erecta* Linn.). Int.J.Curr.Microbiol.App.Sci. 6(6): 1236-1241.

Black, C.A., Evans, D.D. and Dinauer, R.C. 1965. Methods of soil analysis. Madison, WI: Amer. Soc. of Agron., 9: 653-708.

Bosse, C. A and Van Staden, J. 1989. Cytokinin in cut carnation flowers. V- Effect of cytokinin type, concentration and mode of opplication on flower longevity. C. F. Hort., Abst.,60: (6304).

Chatsudthipong, V and Muanprasat, C. 2009. Stevioside and related compounds: therapeutic benefits beyond sweetness. Pharmacology & Therapeutics, 121(1): 41-54.

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 (C.F. Chem. Abst., 52: 7692).

CoStat. 2008. CoStat program, version 6.4. CoHort Software, Monterey, CA., USA.

Cox, R. A. and Klett, J. E. 1984. Evaluation of some indigenous western plants for xeric landscape. Hort. Sci., 19: 856-858.

Dyer, D. J., Carlson, D. R., Cotterman, C. D., Sikorski, J. A. and Ditson, S. L. 1986.Soybean pod set enhancement with synthetic cytokinin analogs. Plant Physiol. 84: 240-243.

Eid, R. A and Abou-Leila, B. H. 2006. "Response of croton plants to gibberellic acid, benzyl adenine and ascorbic acid application." World J. Agric. Sci 2.2: 174-179.

El-Bably, S.M. and Rashed, M., 2017. Effect of Kinetin and Zinc Foliar Spray on Growth Performance of *Clivia miniata*. L. Plant. Alexandria Journal of Agricultural Sciences, 62 (6).

El-Keltawi, N. E and Croteau, R. 1987. Influence of foliar applied cytokinin on growth and essential oil content of several members of the Lamiacea. Phytochem., 26: 891-895.

Elkinany, R. G. 2016. Possibility of enhancing commercial characteristics of zinnia (*Zinnia elegans* l.) by using cycocel. J. Agric. & Env. Sci. Damanhour University. 15(2): 85-98.

Farooqi, A. H and Sharma, S. 1988. Effect of growth retardants on flowering of *Rosa damascene*. In: Proc. Int. Cong. of Plant Physiol: 1369–72.

Farooqi, A. H., Sharma, S., Naqvi, A. A. and Khan, A. 1993. The effect of Kinetin on flower and oil production in *Rosa damascena*. J. Essent. Oil Res., 5: 305–9.

George, E. F., Hall, M. A. and De Klerk, G. J. 2008. Plant Propagation by Tissue Culture 3rd Edition, Vol. 1. Springer, Dordrecht, The Netherlands: 501 p.

Ghatas, Y. A. 2015. Response of *Hemerocallis aurantiaca* plants to kinetin and chemical fertilization treatments. Middle East Journal of Agriculture Research., 4(4): 650-659.

Helen, D, H. , Richard, K. S., Sandra, B. W. and Jeffrey, G. N. 2007. Evaluation of gaillardia cultivars and ecotypes for landscape performance in North-Central Florida.SNA. Res. conference, 52: 204-209.

Hembrom, R. and Singh, A.K. 2015. Effect of iron and zinc on growth, flowering and bulb yield in Lilium. Inter. J. Agric, Envi and Biotech., 8(1): 61-64.

Henschke, M, Czuchaj, P. K. and Szczepaniak, S. J. 2015. The effect of benzyladenine and gibberellic acid on growth and flowering of *Helleborus Orientalislam*. Bulgarian J. Agri. Sci, 21 (6): 1198-1203.

Hossain, M. S, Rahman, M. M., Rashid, M. R., Farid, A. T. M., Kaium, M. A., Ahmed, M., Alam, M. S. and Uddin, K. M. S. 2006. In "Handbook on Agro technology". 4th ed., Bangladesh Agricukltural Res. Inst., Gazipur-1701, Bangladesh, 356-358.

Hugar, A. H. and Nalawadi, U. G. 1999. Effect of growth regulators on morphological characters, flower production and seed yield of Gaillardia. Karnataka J. Agric. Sci., 12(1-4 combined): (226-229).

Khalighi, A, Hojati, Y., Babalar, M. and Naderi, R. 2005. Effects of nutrition solutions, cytokinin and soil texure on bulb growth, quality of bulb and number of bulblet in Drawin hybrid tulip Apeldoorn. Journal of Pajoush and Sazandegi., 73: 58-64.

Khandaker, M. M, Liyana, N., Majrashi, A., Dalorima, T., Alias, N.and Mat, N. 2018. Effects of kinetin on the morpho-physiological and biochemical characteristics of stevia (*Stevia rebaudiana*). Bulgarian J. Agri. Sci, 24(4): 638-647.

Khatun, S, Roy, T. S., Haque, M. d. N. and Alamgir, B. 2016. Effect of Plant Growth Regulators and Their Time of Application on Yield Attributes and Quality of Soybean. International Journal of Plant & Soil Science. 11(1): 1-9.

Krug, B.A.,Whipker, B.E., McCall, I. and Dole, J.M. 2006. Narcissus response to plant growth regulators. HortTechnology, 16: 129–32.

Kumari, S. 2017. Effect of Kinetin (6-FAP) and Cycocel (CCC) on Growth, Metabolism and Cellular Organelles in Pearl Millet (*Pennisetum glaucum*) Under Water Stress. Int.J.Curr.Microbiol.App.Sci. 6(8): 2711-2719.

Leshem, Y, Grossman, S., Frimer, A.and Zir, J. 1979. Endogenous Lipoxygenase control and lipid associated free redical scavenging as model of cytokinin action in plant senescence retardation. In. L. Aplequist and C. L. Liljenberg (eds) Advances in the biochemistry and physiology of plant Lipids, Vol. 3. Elisevier, Amsterdam. p. 193-198.

Maclean, D. C and Dedolph, R. R. 1962. Effects of N'-benzylaminopurine on postharvest respiration of *Chrysanthemum morifolium* and *Dianthus caryophyllus*. Bot Gaz 124: 20-21

Mansour, H. A., El Maadwy, A. I. and Mustafa, H. G. 2016. Effect of Irrigation Intervals and Cytokinin Treatments on Vegetative Growth of *Conocarpus erectus* L. Plants. Middle East J. Agric. Res., 5(3): 324-332.

Mara, C. G. 2017. Controlling growth in *Echinacea Hybrids*. Ph. D. Thesis, Virginia Polytechnic Institute and state University.

Mazher, A. A. M., Zaghloul, S. M., Mahmoud, S. A. and Siam, H. S. 2011. Stimulatory Effect of Kinetin, Ascorbic acid and Glutamic Acid on Growth and Chemical Constituents of *Codiaeum variegatum* L. Plants. American-Eurasian J. Agric. & Environ. Sci., 10 (3): 318-323.

Mazrou, M.M. 1992. The growth and tropane alkaloids distribution in the different organs of *Datura innoxia* Mill. plants in relation to benzyladenine (BA) application. Menofiya J. Agric. Res., 17(4).

Menaka, P, Ashoka Rani, Y., Narasimha Rao, K. L., Hareesh Babu, P. and La Ahamed, M. 2018. Response of Chickpea (*Cicer arietinum* L.) to Foliar Application of Ethrel, Kinetin and Boron. Int.J.Curr.Microbiol.App.Sci. 7(11): 1653-1660.

Miller, C. O. 1956. Similarity of Some Kinetin and Red Light Effects. Plant Physiology, 31: 318.

Mohamed, Y. F.Y. 2017. Effect of some growth stimulants on growth, flowering and postharvest quality of aster (*Symphyotrichum novi-belgii* L.) cv. Purple Monarch. Middle East J. Agri. Res. 6(2): 264-273.

Neetu, R. K and Singh, A. K. 2016. Effect of different kinetin concentration on growth and flowering attributes in gladiolus cultivars. Agric. Sci. Digest., 36 (4); 319-322.

Noor El-Deen, T. M., El-Sayed, B. A. and Shahin, S. M. 2014. Chrysanthemum and gaillardia as stunted winter annuals. ii. Blanket flower (*Gaillardia pulchella pulchella*.). Scientific J. Flowers and Ornamental Plants, 1(2):155-162.

Reda, F., El-Wahed, M. S. A. A. and El Din, K. M. G. 2010. Effect of indole acetic acid, gibberellic acid and kinetin on vegetative growth, flowering, essential oil pattern of chamomile plant (*Chamomile recutita* L. Rausch). world journal of Agricultural Sciences 6 (5): 595-600.

Riedell, W. E, Khoo, U.and Inglett, G. E. 1985. Effects of bio regulators on soybean leaf structure and chlorophyll retention. In: Plant Growth Regulation, Lake Alfred, Florida, Proceedings. Lake Alfred. 204-212.

Sachs, T. and Thimann, K. V. 1964, Release of lateral buds from apical dominance. Nature (Lond,), 20: 939-940.

Sachs, T and Thimann, K. V. 1967. The role of auxins and cytokinins in the release of buds from dominance. American Journal of Botany, 54: 136-144.

Sadak, S. M, Dawood, M. G., Bakry, B. A. and El-Karamany, M. F. 2013. Synergistic effect of Indole Acetic Acid and Kinetin on performance, some biochemical constituents and yield of *faba bean* plant grown under newly reclaimed sandy soil. Journal of Agricultural Sciences. 9 (4): 335-34.

Saffari, V. R., Khalighi, A., Lesani, H., Babalar, M. and Obermaier, J. F. 2004. Effects of different plant growth regulators and time of pruning on yield components of *Rosa damascena* Mill. Int. J. Agri. Biol., Vol. 6, No. 6.

Saifuddin. M, Hossain, A. B. M. S., Normaniza, O ., Nasrulhaq, B. A. and Moneruzzaman, K. M. 2009. The effects of naphthalene acetic acid and gibberellic acid in prolonging bract longevity and delaying discoloration of *Bougainvillea spectabilis*. Biotechnol. 8: 343-350.

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

Sardoei, A.S., Sarhadi, H., Rahbarian, P., Yazdi, M.R., Arbabi, M. and Jahantigh, M. 2013. Effect of gibberellic acid and benzyladenine growth regulators on offsets production of *Aloe barbadensis* at greenhouse conditions. Inter. J. Advanced Biolo and Biomed. Res., 1 (11): 1457-1465.

Schmulling, T. 2002. New insights into the functions of cytokinins in plant development. J. Plant Growth Regular., 21: 40-49.

Sharief, A. E and El-hamady, M. M. 2017. Influence of Growth Regulators on Shedding of Broad Bean, Growth, Yield and Seed Quality. International J. Envi, Agri and Biotec (IJEAB). 2(2).

Sharma, S and Farooqi, A. H. 1990. Effect of 2-Chloroethyl phosphonic acid on economic yield of damask rose. Indian J. Agric. Sci., 60: 691–2.

Shreedhar, D. 1993. Effect of growth regulators on growth and flower yield of gaillardia (*Gaillardia pulchella* F.) cv. Kanabargi Local. M.Sc. Thesis, Univ. Agri. Sci., Dharwad.

Shukla, A and Farooqi, A. H. 1990. Utilization of plant growth regulators in aromatic plant production. Curr. Res. Med. Arom. Plants, 12: 152–7.

Snedecor, G.W and Corchan, W.G. 1967. Statistical Methods. 6th Edition. Iowa State Univ. Press, Ames, Iowa, U.S.A.

Sorokin, H. and Thiamann, K.V. 1964 The histological basis for inhibition of axillary buds in Pisum salivum and the effects of auxins and kinetin on xylem development. Protoplasma, 59: 326-350.

Tamas, I. A. 1995. Hormonal regulation of apical dominance. In P. J. Davies ed., Plant Hormones: Physiology, Biochemistry and Molecular Biology. Second edition. Kluwer Academic Publishers, The Netherlands. 572-597.

Yamaguchi, S. and Kamiya, Y. 2000. Gibberellin biosynthesis: Its regulation by endogenous and environmental signals. Plant Cell Physiology. 4: 251-257.

Youssef, A. S. M. 2004. Physiological studies on growth and flowering of *Strelitzia reginae*, Ait. Plant. Ph.D. Thesis Fac. Agric. Moshtohor, Zagazig.

Youssef, A. S. M. and Ismael, F. H. M. 2009. Response of *Livia minister* plant to light intensity and kinetin treatments Annals Of Agric. Sc., Moshtohor, Vol. 47(1): Ho. 29-44.

Zaghloul, M.A. 1998. Effect of paclobutrazol and benzyladenine on the vegetative growth and chemical composition or *Codiaeum variegatum* and *Cordyline terminalis*. Annals Agric. Sci,.Moshtohor, 36(4): 2447-2461.

Zhao, Z., Andersen, S.U., Ljung, K., Dolezal, K., Miotk, A., Schultheiss, S.J. and Lohmann, J. U. 2010. Hormonal control of the shoot stem-cell niche. Nature 465(7301):1089.

Zidan, E. 1962. Evaluation of some Tomato lines in regard to leaf area efficiency and relation of partial defoliation to early and total yield fruit size, soluble solids, leaf rolling and blossom and rot. Ph. D. Thesis, Cornell Univ. Ithaca. New York, U.S.A.

الملخص العربى

دور البنزيل امينو بيورين والكينيتين فى تحسين نمو وإزهار ثلاثة أصناف من العنبر كشمير

رامى جابر الكنانى[١]، عاطف محمد خضر نصار[٢]، أحمد عامر الستاوى[٣]
[١] قسم البساتين، [٢]وقاية النبات – كلية الزراعة– جامعة دمنهور– دمنهور– محافظة البحيرة– جمهورية مصر العربية
[٣] قسم الغابات وتكنولوجيا الخشب– كلية الزراعة(الشاطبى)– جامعة الإسكندرية– جمهورية مصر العربية

اجريت الدراسة في اصص خلال موسمي الشتاء لعامى ٢٠١٥/ ٢٠١٦ و٢٠١٦/ ٢٠١٧ داخل إحدى الصوب في مشتل خاص– محافظة البحيرة – جمهورية مصر العربية. وكان الهدف من البحث هو دراسه تأثيرات نوعين من السيتوكينينات المخلقة وهم بنزيل امينو بيورين بتركيز ٥٠ و١٠٠ جزء فى المليون والكينتين بتركيز (٢٥ و٥٠ جزء فى المليون) كلا بمفرده علي تحسين نمو وجوده أزهار ثلاثه أصناف لنبات العنبر كشمير "Gaillardia pulchella Pulchella, Mesa Yellow and Lorenziana" مقارنة بمعاملة الكنترول. صممت الدراسة باستخدام تصميم القطاعات المنشقه داخل نظام القطاعات كامله العشوائية. وقد أظهرت النتائج المتحصل عليها خلال الموسمين بشكل عام أن العنبر كشمير صنف "Pulchella" قد سجل أعلى وأفضل النتائج فى صفات النمو المدروسه كذلك بعض صفات النمو الزهرى والتى منها عدد الأزهار لكل نبات وطول فتره الإزهار. بينما قد أعطى الصنف "Lorenziana" أفضل قطر للزهره وأفضل وزن رطب ووزن جاف للزهره وأخيرا أطول عمر للزهره. أدى الرش الورقى لنباتات العنبر كشمير بواسطه البنزيل أمينو بيورين والكينيتين إلى تحقيق زياده فعليه فى صفات النمو الخضرى والجذرى و الزهرى مقارنه بالكونترول. كما سجل الرش الورقى بواسطه البنزيل أمينو بيورين بتركيز ١٠٠ جزء فى المليون أو الكينيتين بتركيز ٢٥ جزء فى المليون أعلى القيم لمعظم الصفات تحت الدراسه. ويمكن أعتبار هذه المعامله بأنها المعامله المثلى لإعطاء أعلى إنتاجيه وأفضل جوده لنباتات العنبر كشمير وذلك تحت الظروف البيئيه لمحافظه البحيره أو المناطق الأخرى المماثله لها.