

## Effect of some Factors on Growth and Development of *Euphorbia milii* var. *longifolia*

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### ABSTRACT

A study was carried out at the nursery of the Ornamental Plant Research Department, Horticulture Research Institute, Giza, Egypt in two seasons, 2013-2014 and 2014-2015, where plants of *Euphorbia milii* var. *longifolia* were treated with pigeon manure extract, crystal, benzyladenine (BAP), gibberellic acid (GA<sub>3</sub>) and salicylic acid (SA), at three levels each, as soil drenches. Results that showed significance and consistency could be briefed in the following: Plants supplied with pigeon manure at any level were the earliest plants to flower, while those treated with pigeon manure at either 4 or 6 g/l had the broadest inflorescences and the highest number of them. In the same regard, applying pigeon manure at 4 g/l achieved the highest content of carotenoids and K percentage, while pigeon manure at 6 g/l resulted in the heaviest fresh and dry inflorescences. Drenching plants with crystal at 4 g/l gave rise to the highest leaf width, number of inflorescences, inflorescence diameter and fresh and dry weights of inflorescences. On the other hand, using crystal at 6 g/l achieved only the longest leaves. BAP at 100 ppm induced the greatest number of branches. GA<sub>3</sub> at 100 ppm resulted in the heaviest dry stems, while GA<sub>3</sub> at 300 ppm achieved the longest leaves and the greatest P%. Applying salicylic acid at 100 or 300 ppm induced the heaviest dry roots, while salicylic acid at only 300 ppm shared in inducing the longest leaves. Salicylic acid at 500 ppm resulted in the highest percentages of total carbohydrates and N. Untreated control plants shared only in producing the heaviest dry leaves. In order to improve most of the vegetative and flowering characteristics of *Euphorbia milii* var. *longifolia* grown in 25 cm plastic pot, it is recommended to give each pot 250 cm<sup>3</sup> of pigeon manure extract (6 g manure/l water) as a soil drench at biweekly intervals from mid June to mid May the next year with a pause in this regime from mid December to be resumed in 1<sup>st</sup> March. On the other hand, applying BAP at 100 ppm in the same sequence will induce the most number of branches.

**Key words:** *Euphorbia milii*, crystal, benzyladenine, gibberellic acid and salicylic acid.

### Introduction

Crown of thorns, *Euphorbia milii* Des Moul. is a succulent plant growing 5 to 6 feet tall. The woody stems are greyish brown, branched and with many prominent grey spines. The thick fleshy leaves are arranged in spiral and they are bright green to greyish green, oval shaped with a smooth edge. What looks like flowers are in fact inflorescences, each one is composed of a specialized structure called a cyathium comprising a cup-like involucre, within which there is a single much reduced female flower surrounded by three male flowers reduced to single stamens. The cyathia are borne in clusters (cymes) and each cyathium has two colorful bracts. Plants are blooming year round, but are at their best in dry and sunny locations (InterNet Site 1, 2015). *Euphorbia milii* var. *longifolia* Rauh has elongated dark green linear leaves, up to 20 cm long, spiny branches and red cyathia (InterNet Site 2, 2015 and Eggli, 2002).

*Euphorbia milii* is a succulent plant much esteemed for its brilliant flower-like inflorescences. However, it is a slow-growing limited-branching plant. These insufficiencies affect its use in different aspects of landscaping as bed, pot or hedge plant and even for indoor decoration. In order to overcome this problem different nutritional and hormonal approaches were tried. They include pigeon manure, crystal, 6-benzylaminopurine (BAP), gibberellic acid (GA<sub>3</sub>) and salicylic acid (SA).

#### Plant nutrients:

Devlin (1972) wrote that phosphorus compounds are essential for photosynthesis, the interconversion of carbohydrates and related glycolysis, amino acid metabolism and biological oxidation. Lack of phosphorus, therefore, hampers metabolic processes such as the conversion of sugars into starch and cellulose. Potassium is also important in metabolism and formation of soluble sugars and proteins. Such important physiological roles enable potassium to perform its functions which lead to an increase in vegetative growth. Bidwell (1974) mentioned that nitrogen is a constituent of most organic compounds such as amino acids, many enzymes and energy transfer materials such as chlorophyll, ADP and ATP. Photosynthesis produces soluble sugars from CO<sub>2</sub>

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and H<sub>2</sub>O, but the process can't go on to the production of proteins. Thus, shortage of nitrogen will halt the processes of growth and reproduction. Hopkins and Hüner (2009) stated that as plants are autotrophic organisms, they take their entire nutritional needs from the inorganic environment. Plants require carbon, hydrogen, and oxygen, plus 14 other naturally occurring elements that are taken from the soil (Table a). These 17 elements are considered essential, as in their absence all plants are unable to complete a normal life cycle. Essential elements may be considered either macronutrients or micronutrients, depending on the quantity normally required. Each essential element has a role to play in the biochemistry and physiology of the plant.

**Table a:** Macronutrients and Micronutrients

Macronutrients	Micronutrients
Nitrogen	Iron
Potassium	Boron
Phosphorous	Copper
Sulfur	Zinc
Calcium	Manganese
Magnesium	Molybdenum
	Chlorine
	Nickel

#### *Pigeon manure:*

Poultry manures, among other organic materials containing comparatively higher contents of plant nutrients, are grouped under concentrated organic manures, (Chandra, 2005). Pigeon manure is an organic waste and is used as an organic fertilizer resource due to its nutrient content as mentioned by Villa-Serrano *et al.* (2010). Because of poultry manure's high nitrogen content, it has long been recognized as one of the most desirable manures. Besides fertilizing crops, manures also serve as a soil amendment by adding organic matter, which helps improve the soil's moisture and nutrient retention, (Davis *et al.*, 2013). The ancient Egyptians knew the high value of the pigeon dung. When they planted vines they filled the plant hole with a mix of Nile mud and pigeon dung. With the watery fruits the pigeon dung is said to give a better taste and with the flower plants it makes the colors more intense. Pigeon dung not only has a record in nitrogen amounts but also in phosphor, potassium, magnesium, calcium and the highest organic matter, compared to other bird's. It is rich also in humic and fulvic acids. Noticeable is the low concentration of nitrate. It's first pH is 6,5 and then after 100 hours, the pH reaches 4,5, (InterNet Site 3, 2015).

#### *Cytokinins:*

Sachs *et al.* (1975) postulated that the increment in branch number as a result of BAP application may be attributed to its influence on counteracting or eliminating the apical dominance. Pobudkiewicz (2008) mentioned that the aim of cytokinin application is to obtain well branched plants without removing the apical meristem. They usually increase the number of axillary shoots but also can influence flowering. Cytokinins can affect flower size, number of flowers, and number of days to the first flower opening. Flowering of cytokinin-treated plants depends in the highest degree on the rate used. When applied at rates appropriate for habit control, very seldom influence flowering of ornamental plants, but when applied at high rates can delay flowering, diminish flower diameter and can also decrease the number of flowers per plant. Hopkins and Hüner (2009) mentioned that cytokinins are derivatives of the nitrogenous base adenine and are noted primarily for their capacity to stimulate cell division in tissue culture. Cytokinins also influence a number of other developmental responses, including shoot and root differentiation in tissue culture, chloroplast development, delay of senescence, leaf expansion and the growth of lateral buds. Cytokinins also antagonize the auxin effect in regulating the growth of axillary buds, or apical dominance. In many species the application of cytokinins either to the shoot apex or directly to the axillary bud will release the bud from inhibition. It has been found also that cytokinins play a fundamental role in maintaining the indeterminate property of shoot apical meristems. Benzyladenine (BAP) is an aromatic cytokinin that is found in only a few species. It is most commonly used in micropropagation work. Taiz and Zeiger (2010) stated that although apical dominance may be determined primarily by auxin, physiological studies indicate that cytokinins play a role in initiating the growth of lateral buds. For example, direct applications of cytokinins to the axillary buds of many species stimulate cell division activity and growth of the buds.

#### *GA<sub>3</sub>:*

Gibberellins regulate stem elongation and the mobilization of endosperm reserves during the early stages of seed germination. In addition, gibberellins have been implicated in a wide range of other developmental responses such as flowering and flower development, root and fruit growth, the development of seeds in the fruit, de-etiolation, and the initiation of leaf primordia in meristems. Gibberellins also promote elongation almost exclusively in intact plants, (Hopkins and Hüner, 2009).

#### Salicylic acid:

Salicylic acid is a colorless crystalline organic acid. It is a monohydroxybenzoic acid, a type of phenolic acid and a beta hydroxy acid. It is derived from the metabolism of salicin. Salicylic acid (SA) is a phenolic phytohormone and is found in plants with roles in plant growth and development, photosynthesis, transpiration, ion uptake and transport. SA also induces specific changes in leaf anatomy and chloroplast structure. SA is involved in endogenous signaling, mediating in plant defense against pathogens. It plays a role in the resistance to pathogens by inducing the production of pathogenesis-related proteins. It is involved in the systemic acquired resistance in which a pathogenic attack on one part of the plant induces resistance in other parts. The signal can also move to nearby plants by salicylic acid being converted to the volatile ester, methyl salicylate, InterNet Site 4 (2015).

## Materials and Methods

This study was carried out at the nursery of the Ornamental Plant Research Department, Horticulture Research Institute, Giza, Egypt in two seasons, 2013-2014 and 2014-2015. Transplants of *Euphorbia milii* var. *longifolia*, about 10 cm long in 8 cm pots, were obtained in mid May 2013, where they were left in the plastic-house and were taken care of regularly. An experiment was laid out in a randomized block design to in order to study the efficiency of pigeon manure extract, crystal, BAP, GA<sub>3</sub> and SA, at three levels, each as a soil drench, in improving growth and increasing branching of this plant. Plants were repotted in 25 cm plastic pots before being divided into 16 groups representing 16 treatments. Each treatment comprised 3 replicates, with 3 plants in each replicate. These treatments were:

1 - Pigeon manure extract or crystal solution, each at 4, 6 or 8 g/pot.

2 - Solutions of BAP, GA<sub>3</sub> or SA, each at 100, 300 or 500 ppm.

These add up to 15 treatments. Plants of the 16<sup>th</sup> one was left untreated as control plants. Each pot was given 250 cm<sup>3</sup> of the respective preparation according to treatments. These treatments started on June 15<sup>th</sup>, 2013 at biweekly intervals till mid December 2013 when all applications were stopped. Treatments were resumed again on March 1<sup>st</sup>, 2014, till mid May 2014, when the experiment was ended and data were recorded. The second season was an exact repetition of the first one, starting at June 15<sup>th</sup>, 2014 till mid May, 2015.

#### Preparation of materials:

All preparations were applied as soil drench.

##### Pigeon manure:

After being obtained, pigeon droppings were checked to remove feathers and straws, definite amounts, i.e. 4, 6 and 8 grams of the manure were weighed and put individually in 1 liter conical flasks where they were left to soak in 250 cm<sup>3</sup> of water. One week later, each portion was sieved through cheesecloth. More water was added to each flask to a final size of 1 liter. Table (b) shows analysis of pigeon manure according to Ibrahim and Eleiwa (2008).

**Table b:** Analysis of pigeon manure.

EC (Dsm <sup>-1</sup> )	Organic matter%	pH (1:5)	Total C%
7.65	69.8	6.12	33.6
Total N%	C/N ratio	Total P%	K%
4.31	7.80	0.97	0.98
Fe (µg/g)	Mn (µg/g)	Zn (µg/g)	Cu (µg/g)
240.3	50.8	92.60	7.65

According to Ibrahim and Eleiwa (2008).

##### Crystal:

A package of 1 kg of 20:20:20 crystal powder fortified with minor elements was obtained. Table (c) shows the chemical composition of this fertilizer. Traces of rare elements are also included according to the label of this package. 4, 6 and 8 grams of crystal were weighed and dissolved individually in 1 liter conical flasks.

**Table c:** Chemical composition of crystal

N (%)	P (%)	K (%)
20	20	20
B (ppm)	Cu (ppm)	Fe (ppm)
220	160	700
Mn (ppm)	Mo (ppm)	Zn (ppm)
420	140	140

##### Growth regulators:

Solutions of BAP, GA<sub>3</sub> and SA were prepared individually, each at 100, 300 or 500 ppm.

Data recorded at the end of each season include:

- |                                       |  |
|---------------------------------------|--|
| 1 Plant height (cm)                   | 13 Fresh weight of roots (g)             |
| 2 Number of branches/plant            | 14 Dry weight of stems (g)               |
| 3 Number of leaves/plant              | 15 Dry weight of leaves (g)              |
| 4 Leaf length (cm)                    | 16 Dry weight of inflorescences (g)      |
| 5 Leaf width (cm)                     | 17 Dry weight of roots (g)               |
| 6 Root length (cm)                    | 18 Total chlorophyll content (mg/g f.w.) |
| 7 Number of inflorescences/plant      | 19 Carotenoids content (mg/g f.w.)       |
| 8 Inflorescence diameter (cm)         | 20 Total carbohydrates (% d.w.)          |
| 9 Days to flowering                   | 21 N (% d.w.)                            |
| 10 Fresh weight of stem (g)           | 22 P (% d.w.)                            |
| 11 Fresh weight of leaves (g)         | 23 K (% d.w.)                            |
| 12 Fresh weight of inflorescences (g) |  |

Data were statistically analyzed using analysis of variance as described by Snedecor and Cochran (1989) and means were compared using Duncan critical range at a probability level of 5% (Duncan, 1955) by means of SAS 1995 computer program.

Leaf samples from the three replicates of each treatment were mixed together and chemical analysis of total carbohydrate % were carried out according to Herbert *et al.* (1971). Leaf content of both total chlorophyll and carotenoids were carried out according to Saric *et al.* (1976). Nitrogen, phosphorus, and potassium were carried out in leaf samples according to Jackson (1973), in the Central Lab of the Horticulture Research Institute.

## Results

### Effect of some nutritional and growth regulator treatments on:

*Plant height, Table (1) and Fig. (1):*

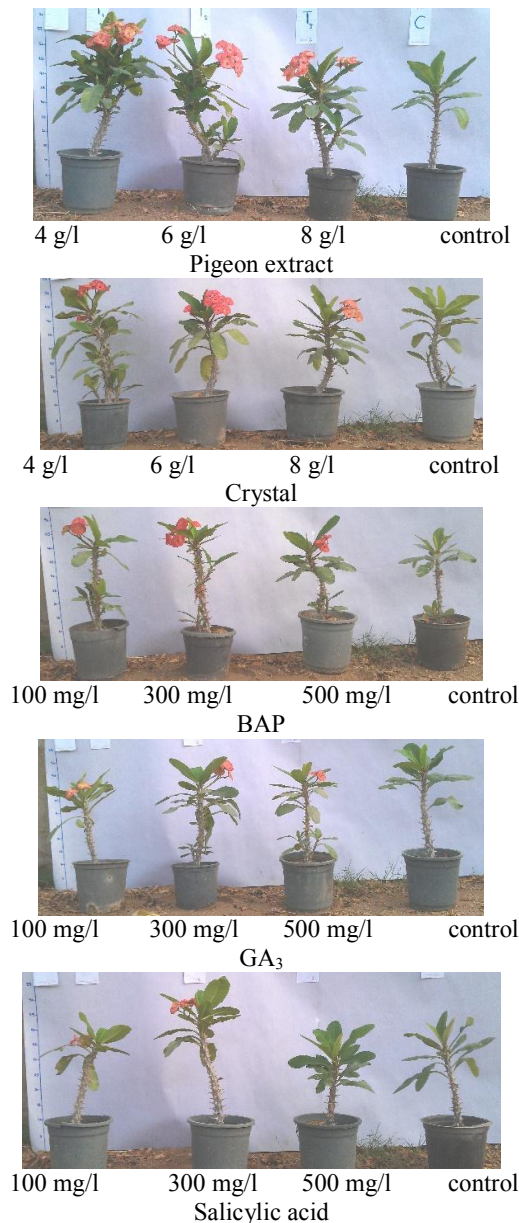
Table (1) shows that the effect of these treatments on plant height was insignificant. However, it could be noticed that the tallest plants in both seasons were those treated with salicylic acid at 300 ppm (41.33 and 42.33 cm. in the first and second seasons, respectively). Plants treated with crystal at either 6 or 8 g/l in the first season only (41.00 and 40.50 cm.) shared also in the highest position. The shortest plants (31.00 and 28.83 cm. in the first and second seasons, respectively) were those treated with BAP at 500 ppm, though the effect was insignificant.

*Number of branches/plant, Table (1):*

The effect of some nutritional and growth regulator treatments on number of branches/plant was significant in both seasons. The highest number of branches was obtained when BAP at 100 ppm was applied (4.67 and 3.33 branches, in the first and second seasons, respectively), followed without significant differences by those produced on plants treated with crystal at 4 g/l or pigeon manure at 4 g/l (3.33 and 2.67 branches, in the first and second seasons, respectively). The lowest values in the same regard were noticed after using salicylic acid at 500 ppm (0.00 and 0.33 branches, in the first and second seasons, respectively), in addition to those obtained when GA<sub>3</sub> at 300 or at 500 ppm; or salicylic acid at 100 ppm were used (0.33, 0.00 and 0.33 branches, respectively) in the second season only.

**Table 1:** Effect of some nutritional and growth regulator treatments on plant height and number of branches/plant

Treatments	Plant height (cm)		Number of branches/plant	
	1 <sup>st</sup> Season	2 <sup>nd</sup> Season	1 <sup>st</sup> Season	2 <sup>nd</sup> Season
Control	36.87 a	35.69 a	1.07 c-e	0.93 cd
Pigeon manure 4 g/l	37.67 a	36.33 a	1.00 c-e	2.67 ab
Pigeon manure 6 g/l	36.00 a	36.33 a	1.00 c-e	1.00 cd
Pigeon manure 8 g/l	34.17 a	35.17 a	0.33 de	1.00 cd
Crystal 4 g/l	38.67 a	38.67 a	3.33 ab	0.67 cd
Crystal 6 g/l	41.00 a	39.00 a	2.33 b-d	1.00 cd
Crystal 8 g/l	40.50 a	36.33 a	1.33 b-e	0.67 cd
BAP 100 ppm	32.33 a	37.00 a	4.67 a	3.33 a
BAP 300 ppm	38.33 a	32.33 a	1.67 b-e	2.00 a-c
BAP 500 ppm	31.00 a	28.83 a	1.00 c-e	1.00 cd
GA <sub>3</sub> 100 ppm	34.33 a	39.67 a	2.00 b-e	1.33 b-d
GA <sub>3</sub> 300 ppm	36.67 a	38.67 a	2.67 a-c	0.33 d
GA <sub>3</sub> 500 ppm	35.83 a	38.50 a	0.33 de	0.00 d
Salicylic acid 100 ppm	36.00 a	38.83 a	2.00 b-e	0.33 d
Salicylic acid 300 ppm	41.33 a	42.33 a	0.33 de	0.67 cd
Salicylic acid 500 ppm	38.67 a	35.33 a	0.00 e	0.33 d



**Fig. 1:** Effect of some nutritional and growth regulator treatments on *Euphorbia milii* var. *longifolia*

*Number of leaves/plant, Table (2):*

The effect of some nutritional and growth regulator treatments on number of leaves/plant was significant in both seasons. The highest number of leaves belonged to plants treated by crystal either at 4 g/l in the first season or at 6 g/l in the second one (52.33 and 35.67 leaves, respectively). However, treatments of crystal at 6 g/l and BAP at 100 ppm (47.00 and 37.33 leaves, respectively) in the first season; and pigeon manure at 4 g/l, crystal at 4 g/l, crystal at 8 g/l and BAP at 100 ppm (33.33, 28.67, 29.00 and 30.00 leaves, respectively), in the second season, shared in the first position. The lowest number of leaves/plant was detected in plants treated with BAP at 300 ppm, GA<sub>3</sub> at 100 ppm, GA<sub>3</sub> at 500 ppm and salicylic acid at 500 ppm (20.00, 19.33, 19.00 and 18.00 leaves in the first season) respectively, and GA<sub>3</sub> at 300 ppm (14.33 leaves) in the second one, respectively.

*Leaf length, Table (2):*

The effect of some nutritional and growth regulator treatments on leaf length was significant in both seasons. Results of many treatments reached the highest level. However, results that were consistent in both seasons were confined to treatments of pigeon manure at 6 g/l, crystal at 6 g/l, GA<sub>3</sub> at 300 ppm and salicylic acid at 300 ppm (16.00, 14.33, 14.67 and 14.83 cm in the first season, and 14.67, 14.83, 14.00 and 13.83 in the second one,

respectively). The shortest leaves were those produced on plants treated with either GA<sub>3</sub> at 100 ppm in the first season (11.33 cm) or BAP at 300 ppm in the second one (10.50 cm).

**Table 2:** Effect of some nutritional and growth regulator treatments on number of leaves/plant and leaf length (cm)

Treatments	Number of leaves/plant		Leaf length (cm)	
	1 <sup>st</sup> Season	2 <sup>nd</sup> Season	1 <sup>st</sup> Season	2 <sup>nd</sup> Season
Control	21.00 cd	19.93 b-d	13.03 b-d	12.77 a-d
Pigeon manure 4 g/l	31.33 b-d	33.33 ab	14.00 a-d	14.00 ab
Pigeon manure 6 g/l	22.67 cd	25.33 a-d	16.00 a	14.67 ab
Pigeon manure 8 g/l	25.00 cd	28.00 a-d	12.33 b-d	12.50 a-d
Crystal 4 g/l	52.33 a	28.67 a-c	14.00 a-d	12.83 a-d
Crystal 6 g/l	47.00 ab	35.67 a	14.33 ab	14.83 a
Crystal 8 g/l	31.00 b-d	29.00 a-c	13.00 b-d	13.17 a-c
BAP 100 ppm	37.33 a-c	30.00 a-c	11.50 cd	12.17 b-d
BAP 300 ppm	20.00 d	25.33 a-d	11.50 cd	10.50 d
BAP 500 ppm	25.00 cd	23.00 a-d	12.67 b-d	11.17 cd
GA <sub>3</sub> 100 ppm	19.33 d	28.00 a-d	11.33 d	13.33 a-c
GA <sub>3</sub> 300 ppm	24.00 cd	14.33 d	14.67 ab	14.00 ab
GA <sub>3</sub> 500 ppm	19.00 d	16.67 cd	13.67 a-d	14.17 ab
Salicylic acid 100 ppm	27.33 cd	19.00 cd	13.17 b-d	13.67 a-c
Salicylic acid 300 ppm	21.33 cd	24.33 a-d	14.83 ab	13.83 a-b
Salicylic acid 500 ppm	18.00 d	21.67 a-d	14.17 a-c	13.67 a-c

#### Leaf width, Table (3):

The effect of some nutritional and growth regulator treatments on leaf width was significant in both seasons. The broadest leaves in the first season were a result of treating plants with crystal at 6 g/l (5.67 cm), followed without significant difference by those treated with pigeon manure at 8 g/l, crystal at 4 g/l, GA<sub>3</sub> at 300 ppm or salicylic acid at 300 ppm (5.10, 5.20, 5.00 and 5.17 cm, respectively). In the second season, the highest level in the same respect belonged to plants treated with crystal at 4 g/l or pigeon manure at 4 g/l (6.00 and 5.67 cm, respectively). On the other hand, the narrowest leaves were detected on plants treated with either GA<sub>3</sub> at 100 ppm or BAP at 300 ppm (3.83 cm for both, in the first and second seasons, respectively).

#### Root length, Table (3):

The effect of some nutritional and growth regulator treatments on root length was found to be insignificant in both seasons. Despite this fact, it could be noticed that the longest roots were a result of using either salicylic acid at 100 ppm or pigeon manure at 4 g/l (41.67 and 41.17 cm, in the first and second seasons, respectively). The shortest roots in both seasons were produced by plants treated with crystal at 8 g/l (25.50 and 23.39 cm, in the first and second seasons, respectively).

**Table 3:** Effect of some nutritional and growth regulator treatments on leaf width (cm) and root length (cm)

Treatments	leaf width (cm)		Root length (cm)	
	1 <sup>st</sup> Season	2 <sup>nd</sup> Season	1 <sup>st</sup> Season	2 <sup>nd</sup> Season
Control	4.76 a-c	4.04 ef	30.60 a	33.34 a
Pigeon manure 4 g/l	4.83 a-c	5.67 ab	29.67 a	41.17 a
Pigeon manure 6 g/l	4.67 a-c	4.83 b-e	30.67 a	35.83 a
Pigeon manure 8 g/l	5.10 ab	4.83 b-e	30.50 a	34.83 a
Crystal 4 g/l	5.20 ab	6.00 a	33.50 a	28.10 a
Crystal 6 g/l	5.67 a	5.17 a-c	26.83 a	38.53 a
Crystal 8 g/l	4.67 a-c	5.17 a-c	25.50 a	23.39 a
BAP 100 ppm	4.17 bc	4.50 c-f	28.83 a	34.50 a
BAP 300 ppm	4.83 a-c	3.83 f	28.80 a	29.10 a
BAP 500 ppm	4.50 bc	4.17 d-f	29.05 a	26.33 a
GA <sub>3</sub> 100 ppm	3.83 c	5.33 a-c	33.13 a	35.17 a
GA <sub>3</sub> 300 ppm	5.00 ab	4.80 c-e	33.17 a	38.83 a
GA <sub>3</sub> 500 ppm	4.27 bc	4.50 c-f	31.90 a	35.00 a
Salicylic acid 100 ppm	4.57 bc	4.83 b-e	41.67 a	35.00 a
Salicylic acid 300 ppm	5.17 ab	5.00 b-c	38.33 a	33.33 a
Salicylic acid 500 ppm	4.27 bc	4.67 c-f	32.00 a	27.33 a

#### Number of inflorescences, Table (4):

The effect of some nutritional and growth regulator treatments on number of inflorescences was significant in the two seasons. The highest number in the first season was induced by plants treated with crystal at 4 g/l, followed without significant difference by those treated with either pigeon manure 6 g/l or pigeon manure 4 g/l (16.67, 15.67 and 12.67 inflorescences, respectively). Corresponding values in the second season were detected when pigeon manure at 6 g/l or at 4 g/l; or crystal at 4 g/l were applied (16.33, 11.67 and 11.67 inflorescences, respectively). The lowest number of flowers detected in the first season belonged to the untreated control plants

in addition to those treated with GA<sub>3</sub> at 300 ppm, salicylic acid at 100 ppm or salicylic acid at 500 ppm (0.60, 1.00, 0.00 and 0.00 inflorescences, respectively). In the second one, the lowest values of number of inflorescences resulted on the untreated control plants, plants treated with BAP at 100 or 500 ppm; GA<sub>3</sub> at 100 or 300 ppm; or with GA<sub>3</sub> at 500 ppm (0.00, 1.00, 0.00, 1.33, 0.00 and 0.00 inflorescences, respectively).

*Inflorescence diameter, Table (4):*

The effect of some nutritional and growth regulator treatments on inflorescence diameter was significant in both seasons. The widest inflorescences in the two seasons emerged on plants treated with crystal at 4 g/l (4.33 and 4.77 cm, respectively), or pigeon manure at 6 g/l (4.00 and 4.43 cm, respectively), in addition to those treated with pigeon manure at 4 g/l (4.17 cm) in the second season only. The narrowest inflorescences resulted on the control plants in the first season (0.83 cm), or when applying BAP at 100 or 300 ppm; or salicylic acid at 500 ppm (1.33 cm for all) in the second one. Plants treated with salicylic acid at 100 or 500 ppm in the first season; together with the control plants, plants treated with BAP at 500 ppm, GA<sub>3</sub> at 300 or at 500 ppm in the second season produced no inflorescence at all.

**Table 4:** Effect of some nutritional and growth regulator treatments on number of inflorescences and inflorescence diameter (cm)

Treatments	Number of inflorescences		Inflorescence diameter (cm)	
	1 <sup>st</sup> Season	2 <sup>nd</sup> Season	1 <sup>st</sup> Season	2 <sup>nd</sup> Season
Control	0.60 d	0.00 d	0.83 cd	0.00 d
Pigeon manure 4 g/l	12.67 ab	11.67 ab	3.50 a-c	4.17 ab
Pigeon manure 6 g/l	15.67 a	16.33 a	4.00 ab	4.43 ab
Pigeon manure 8 g/l	2.67 b-d	2.67 b-d	1.33 a-d	2.67 a-d
Crystal 4 g/l	16.67 a	11.67 ab	4.33 a	4.77 a
Crystal 6 g/l	11.67 a-c	11.33 a-c	2.27 a-d	2.33 a-d
Crystal 8 g/l	1.50 cd	9.33 a-d	1.50 a-d	4.00 a-c
BAP 100 ppm	4.67 b-d	1.00 d	2.83 a-d	1.33 cd
BAP 300 ppm	4.67 b-d	1.67 cd	2.67 a-d	1.33 cd
BAP 500 ppm	2.33 b-d	0.00 d	2.67 a-d	0.00 d
GA <sub>3</sub> 100 ppm	4.00 b-d	1.33 d	2.67 a-d	1.67 b-d
GA <sub>3</sub> 300 ppm	1.00 d	0.00 d	1.33 a-d	0.00 d
GA <sub>3</sub> 500 ppm	1.33 cd	0.00 d	1.33 a-d	0.00 d
Salicylic acid 100 ppm	0.00 d	5.33 b-d	0.00 d	3.83 a-c
Salicylic acid 300 ppm	2.00 cd	2.33 b-d	1.17 b-d	1.67 b-d
Salicylic acid 500 ppm	0.00 d	2.67 b-d	0.00 d	1.33 cd

*Number of days to flowering, Table (5):*

The effect of some nutritional and growth regulator treatments on number of days to flowering was significant in both seasons. The earliest plants to flower in both seasons were those treated with pigeon manure at 4 g/l (170.00 and 161.67 days, in the first and second seasons, respectively). The second fastest plants to flower were those supplied with pigeon manure at either 6 or 8 g/l (17.67 and 177.67 days, respectively) in the first season, and with the same substances (171.33 and 172.33 days, respectively) in the second one. The latest flowering was due to either leaving plants without any treatment or to applying crystal at 4 g/l or GA<sub>3</sub> at 500 ppm (208.00 days for each of the three treatments) in the first season, or to BAP at 100 ppm in the second one. Plants treated with salicylic acid at either 100 or 500 ppm in the first season; together with the control plants, plants treated with BAP at 500 ppm, GA<sub>3</sub> at 300 ppm and GA<sub>3</sub> at 500 ppm in the second season produced no inflorescences at all during the experimental period.

*Fresh weight of stems, Table (5):*

The effect of some nutritional and growth regulator treatments on fresh weight of roots was found to be insignificant in the two seasons. However, it could be observed that the heaviest fresh stems belonged to plants treated with crystal at 4 g/l or pigeon manure at 4 g/l (91.27 and 102.75 g, in the first and second seasons, respectively). The lightest fresh stems resulted when crystal at 8 g/l was used or when plants were left untreated as control ones (54.06 and 52.98 g, in the first and second seasons, respectively).

*Fresh weight of leaves, Table (6):*

The effect of some nutritional and growth regulator treatments on fresh weight of leaves was found to be significant in both seasons. The heaviest fresh leaves emerged on plants treated with crystal at either 4 or 8 g/l (42.17 and 29.80 g, in the first and second seasons, respectively). The lightest fresh leaves were a result of applying either GA<sub>3</sub> at 500 ppm or BAP at 300 ppm (14.29 and 14.22 g, in the first and second seasons, respectively).

*Fresh weight of inflorescences, Table (6):*

The effect of some nutritional and growth regulator treatments on fresh weight of inflorescences was found to be significant in both seasons. In the first season, the heaviest fresh inflorescences emerged on plants treated with crystal at 4 g/l, followed without significant differences by those produced on plants treated with Pigeon manure at 6 g/l (10.13 and 9.97 g, respectively).

In the second one, corresponding values were a result of applying pigeon manure at 6 g/l, crystal at 4 or at 8 g/l; or pigeon manure at 4 g/l (11.20, 9.72, 9.14 and 8.24 g, respectively) without significant differences between these 4 treatments. The lightest fresh inflorescences were those obtained from the control plants in the first season, besides those treated with salicylic acid at 500 ppm in the second one (0.62 and 1.58 g, respectively). Plants treated with salicylic acid at either 100 or 500 ppm in the first season; together with the control plants, plants treated with BAP at 500 ppm, GA<sub>3</sub> at 300 ppm and GA<sub>3</sub> at 500 ppm in the second one produced no inflorescences at all.

**Table 5:** Effect of some nutritional and growth regulator treatments on number of days to flowering and fresh weight of stems (g)

Treatments	Number of days to flowering		Fresh weight of stems (g)	
	1 <sup>st</sup> Season	2 <sup>nd</sup> Season	1 <sup>st</sup> Season	2 <sup>nd</sup> Season
Control	208.00 a	-----	61.14 a	52.98 a
Pigeon manure 4 g/l	170.00 d	161.67 d	79.09 a	102.75 a
Pigeon manure 6 g/l	176.67 c	171.33 c	68.71 a	69.30 a
Pigeon manure 8 g/l	177.67 c	172.33 c	68.95 a	63.99 a
Crystal 4 g/l	208.00 a	204.67 ab	91.27 a	71.39 a
Crystal 6 g/l	207.67 a	204.00 ab	84.13 a	80.06 a
Crystal 8 g/l	177.33 c	175.67 c	54.06 a	79.22 a
BAP 100 ppm	207.00 a	206.00 a	80.58 a	76.37 a
BAP 300 ppm	207.33 a	204.33 ab	85.18 a	63.66 a
BAP 500 ppm	201.33 b	-----	55.41 a	53.14 a
GA <sub>3</sub> 100 ppm	207.00 a	203.33 ab	74.40 a	93.11 a
GA <sub>3</sub> 300 ppm	207.00 a	-----	62.68 a	74.67 a
GA <sub>3</sub> 500 ppm	208.00 a	-----	68.94 a	73.68 a
Salicylic acid 100 ppm	-----	204.00 ab	66.36 a	73.94 a
Salicylic acid 300 ppm	205.33 a	205.33 ab	79.95 a	81.78 a
Salicylic acid 500 ppm	-----	201.33 b	57.24 a	55.50 a

**Table 6:** Effect of some nutritional and growth regulator treatments on fresh weight of leaves (g) and fresh weight of inflorescences (g)

Treatments	Fresh weight of leaves (g)		Fresh weight of inflorescences (g)	
	1 <sup>st</sup> Season	2 <sup>nd</sup> Season	1 <sup>st</sup> Season	2 <sup>nd</sup> Season
Control	17.56 c	16.09 b	0.62 de	0.00 d
Pigeon manure 4 g/l	19.82 c	26.26 ab	6.44 a-d	8.24 ab
Pigeon manure 6 g/l	24.02 bc	21.80 ab	9.97 ab	11.20 a
Pigeon manure 8 g/l	26.26 bc	24.47 ab	1.68 c-e	2.08 cd
Crystal 4 g/l	42.17 a	25.27 ab	10.13 a	9.72 a
Crystal 6 g/l	33.53 ab	26.38 ab	7.28 a-c	7.60 a-c
Crystal 8 g/l	23.43 bc	29.80 a	1.45 c-e	9.14 ab
BAP 100 ppm	19.31 c	16.30 b	3.66 b-e	0.87 d
BAP 300 ppm	14.40 c	14.22 b	3.44 c-e	1.12 d
BAP 500 ppm	18.46 c	18.00 ab	1.63 c-e	0.00 d
GA <sub>3</sub> 100 ppm	16.68 c	26.03 ab	2.23 c-e	1.13 d
GA <sub>3</sub> 300 ppm	20.34 c	16.50 b	1.23 c-e	0.00 d
GA <sub>3</sub> 500 ppm	14.29 c	17.61 ab	0.86 c-e	0.00 d
Salicylic acid 100 ppm	22.49 bc	18.15 ab	0.00 e	3.49 b-d
Salicylic acid 300 ppm	23.55 bc	24.00 ab	1.33 c-e	2.19 cd
Salicylic acid 500 ppm	20.20 c	24.03 ab	0.00 e	1.58 d

*Fresh weight of roots, Table (7):*

The effect of some nutritional and growth regulator treatments on fresh weight of roots was found to be insignificant in both seasons. However, it could be noticed that the heaviest fresh roots belonged to plants treated with either salicylic acid at 300 ppm or pigeon manure at 4 g/l (31.80 and 37.24 g, in the first and second seasons, respectively). The lightest fresh roots resulted when pigeon manure at 4 g/l was used or when plants were left untreated as control ones (17.02 and 19.31 g, in the first and second seasons, respectively).

*Dry weight of stems, Table (7):*

The effect of some nutritional and growth regulator treatments on dry weight of roots was significant in the two seasons. The heaviest dry weight of stems was a result of experiencing either BAP at 300 ppm or GA<sub>3</sub> at 100 ppm (10.76 and 10.26 g, respectively) in the first season, and pigeon manure at 4 g/l or GA<sub>3</sub> at 100 ppm (10.13

and 11.38 g, respectively) in the second one. The lightest dry stems belonged to plants provided with salicylic acid at 500 ppm (4.28 and 4.26 g, in the first and second season, respectively).

**Table 7:** Effect of some nutritional and growth regulator treatments on fresh weight of roots (g) and dry weight of stems (g)

Treatments	Fresh weight of roots (g)		Dry weight of stems (g)	
	1 <sup>st</sup> Season	2 <sup>nd</sup> Season	1 <sup>st</sup> Season	2 <sup>nd</sup> Season
Control	20.70 a	19.31 a	4.93 de	4.66 ef
Pigeon manure 4 g/l	17.02 a	37.24 a	9.05 a-d	10.13 ab
Pigeon manure 6 g/l	23.64 a	32.38 a	7.78 a-e	9.03 a-c
Pigeon manure 8 g/l	19.59 a	27.14 a	6.58 a-e	5.07 d-f
Crystal 4 g/l	29.42 a	25.15 a	7.80 a-e	5.71 c-f
Crystal 6 g/l	19.23 a	21.18 a	6.38 a-e	5.81 c-f
Crystal 8 g/l	25.68 a	22.33 a	5.42 c-e	8.31 a-d
BAP 100 ppm	18.09 a	27.38 a	9.92 a-c	7.92 a-e
BAP 300 ppm	27.63 a	26.41 a	10.76 a	6.53 c-f
BAP 500 ppm	17.86 a	21.36 a	4.91 de	5.04 d-f
GA <sub>3</sub> 100 ppm	24.41 a	27.85 a	10.26 ab	11.38 a
GA <sub>3</sub> 300 ppm	26.08 a	21.28 a	6.74 a-e	7.69 b-f
GA <sub>3</sub> 500 ppm	23.73 a	26.50 a	8.26 a-e	8.80 a-c
Salicylic acid 100 ppm	23.22 a	32.49 a	5.72 b-e	6.43 c-f
Salicylic acid 300 ppm	31.80 a	28.52 a	8.62 a-e	8.66 a-c
Salicylic acid 500 ppm	22.96 a	26.12 a	4.28 e	4.26 f

*Dry weight of leaves, Table (8):*

The effect of some nutritional and growth regulator treatments on dry weight of leaves was found to be significant in both seasons. The heaviest dry leaves in the first season were obtained from the untreated control plants, plants treated with either crystal at 4 g/l or salicylic acid at 300 ppm (6.70, 6.60 and 5.90 g, respectively). In the second season, leaves of plants treated with crystal at 6 g/l together with the untreated control plants had the heaviest dry weight (5.74 and 5.55 g, respectively). On the other hand, the lightest dry leaves were a result of treating plants with either BAP at 300 ppm or GA<sub>3</sub> at 500 ppm (3.72 and 3.87 g, respectively) in the first season, or with GA<sub>3</sub> at 300 ppm or GA<sub>3</sub> at 500 ppm (3.66 g for both treatments) in the second one.

*Dry weight of inflorescences, Table (8):*

The effect of some nutritional and growth regulator treatments on dry weight of inflorescences was found to be significant in both seasons. The heaviest dry inflorescences in both seasons were a result of using pigeon manure at 6 g/l (3.28 and 3.49 g) or crystal at 4 g/l (3.27 and 3.09 g), in the first and second seasons, respectively, followed without significant difference by those obtained after applying pigeon manure at 4 g/l (2.84 g) in the first season or crystal at 8 g/l (2.96 g) in the second one. The lowest values in this respect were produced by the untreated control plants in the first season (0.49 g) or by plants treated with BAP at 300 ppm, salicylic acid at 300 ppm or salicylic acid at 500 ppm (0.79, 1.00 and 0.90 g, respectively) in the second one. Plants treated with salicylic acid at either 100 or 500 ppm in the first season; together with the control plants, plants treated with BAP at 500 ppm, GA<sub>3</sub> at 300 ppm and GA<sub>3</sub> at 500 ppm in the second one produced no inflorescences at all.

**Table 8:** Effect of some nutritional and growth regulator treatments on dry weight of leaves (g) and dry weight of inflorescences (g)

Treatments	Dry weight of leaves (g)		Dry weight of inflorescences (g)	
	1 <sup>st</sup> Season	2 <sup>nd</sup> Season	1 <sup>st</sup> Season	2 <sup>nd</sup> Season
Control	6.70 a	5.55 ab	0.49 cd	0.00 d
Pigeon manure 4 g/l	4.74 b-d	5.27 a-d	2.84 ab	3.10 ab
Pigeon manure 6 g/l	5.09 a-d	4.77 a-e	3.28 a	3.49 a
Pigeon manure 8 g/l	5.07 a-d	4.99 a-e	0.81 b-d	1.58 b-c
Crystal 4 g/l	6.60 a	5.03 a-d	3.27 a	3.09 ab
Crystal 6 g/l	5.67 a-c	5.74 a	2.14 a-d	2.19 a-b
Crystal 8 g/l	4.55 b-d	5.46 a-c	0.89 b-d	2.96 ab
BAP 100 ppm	4.35 b-d	4.19 c-e	1.88 a-d	0.44 d
BAP 300 ppm	3.72 d	3.95 de	2.40 a-c	0.79 cd
BAP 500 ppm	4.45 b-d	4.32 b-e	1.36 a-d	0.00 d
GA <sub>3</sub> 100 ppm	4.18 b-d	4.62 a-e	2.41 a-c	0.81 cd
GA <sub>3</sub> 300 ppm	4.01 cd	3.66 e	0.85 b-d	0.00 d
GA <sub>3</sub> 500 ppm	3.87 d	3.66 e	0.76 b-d	0.00 d
Salicylic acid 100 ppm	4.23 b-d	4.98 a-e	0.00 d	2.40 a-c
Salicylic acid 300 ppm	5.90 ab	5.23 a-d	0.74 b-d	1.00 cd
Salicylic acid 500 ppm	5.03 a-d	4.57 a-e	0.00 d	0.90 cd

*Dry weight of roots, Table (9):*

The effect of some nutritional and growth regulator treatments on dry weight of roots was significant in the two seasons. The heaviest dry roots were produced by plants treated with salicylic acid at 300 ppm in both seasons (10.89 and 11.50 g, in the first and second seasons, respectively), followed without significant difference by plants treated with crystal at 4 g/l (8.85 g) in the first season, or with pigeon manure at 6 g/l, salicylic acid at 100 or at 500 ppm (11.08, 11.70 and 9.46 g, respectively) in the second one.

The lowest dry weight of roots was obtained when plants were subjected to BAP at 100 ppm (3.82 g) in the first season, or to BAP at 500 ppm, GA<sub>3</sub> at 100 or at 300 ppm (4.36, 4.35 and 3.95 g, respectively) in the second one.

**Table 9:** Effect of some nutritional and growth regulator treatments on dry weight of roots (g)

Treatments	1st Season	2nd Season
Control	6.34 b-d	6.10 b-d
Pigeon manure 4 g/l	5.42 b-d	9.17 a-c
Pigeon manure 6 g/l	4.71 b-d	11.08 a
Pigeon manure 8 g/l	4.48 cd	5.93 b-d
Crystal 4 g/l	8.85 ab	6.86 b-d
Crystal 6 g/l	5.09 b-d	6.71 b-d
Crystal 8 g/l	6.37 b-d	5.28 cd
BAP 100 ppm	3.82 d	5.27 cd
BAP 300 ppm	6.82 a-d	5.12 cd
BAP 500 ppm	5.80 b-d	4.36 d
GA <sub>3</sub> 100 ppm	4.12 cd	4.35 d
GA <sub>3</sub> 300 ppm	5.82 b-d	3.95 d
GA <sub>3</sub> 500 ppm	5.42 b-d	5.60 b-d
Salicylic acid 100 ppm	8.26 a-c	11.70 a
Salicylic acid 300 ppm	10.89 a	11.50 a
Salicylic acid 500 ppm	7.53 a-d	9.46 ab

*Total chlorophyll content, Table (10):*

The effect of some nutritional and growth regulator treatments on total chlorophyll content in leaves was significant. The highest value was found in plants treated with pigeon manure at 6 g/l (2.76 mg/g f.w.), while the lowest value in this regard was induced when either GA<sub>3</sub> at 100 or 300 ppm (0.64 and 0.53 mg/g f.w.) was applied.

*Carotenoid content, Table (10):*

The effect of some nutritional and growth regulator treatments on carotenoid content in leaves was significant. The highest value was a result of using Pigeon manure at 4 g/l (2.86 mg/g f.w.). On the other hand, the lowest content of the same constituent was found in plants treated with plants treated with GA<sub>3</sub> at 500 ppm (0.15 mg/g f.w.).

*Total carbohydrate%, Table (10):*

The effect of some nutritional and growth regulator treatments on total carbohydrate% in leaves was significant. The highest percentage of this constituent was found in plants treated with salicylic acid at 500 ppm, while the lowest record in this concern was a result of applying crystal at 6 g/l (10.64 and 4.69%, respectively).

**Table 10:** Effect of some nutritional and growth regulator treatments on total chlorophyll content, carotenoid content and total carbohydrates %

Treatments	Total chlorophyll content (mg/g f.w.)	Carotenoid content (mg/g f.w.)	Total carbohydrate (% d.w.)
Control	1.93 c-f	0.89 d-f	8.46 c
Pigeon manure 4 g/l	2.03 b-e	2.86 a	6.38 ef
Pigeon manure 6 g/l	2.76 a	2.42 ab	6.83 e
Pigeon manure 8 g/l	2.12 b-d	1.02 c-f	7.89 cd
Crystal 4 g/l	1.72 ef	0.82 ef	5.23 gh
Crystal 6 g/l	1.90 c-f	0.74 ef	4.69 h
Crystal 8 g/l	2.36 b	0.88 ef	7.45 d
BAP 100 ppm	1.73 ef	0.96 c-f	7.81 d
BAP 300 ppm	1.56 f	0.60 ef	9.86 b
BAP 500 ppm	2.07 c-e	0.69 ef	5.36 g
GA <sub>3</sub> 100 ppm	0.64 g	0.61 ef	9.29 b
GA <sub>3</sub> 300 ppm	0.53 g	0.26 f	4.81 gh
GA <sub>3</sub> 500 ppm	2.17 bc	0.15 f	6.15 f
Salicylic acid 100 ppm	1.89 c-f	1.51 b-e	6.75 e
Salicylic acid 300 ppm	1.76 d-f	1.93 a-d	9.32 b
Salicylic acid 500 ppm	2.38 b	1.95 a-c	10.64 a

N (% d.w.), Table (11):

The effect of some nutritional and growth regulator treatments on N% in leaves was significant. The highest percentage was a result of treating plants with salicylic acid at 500 ppm, while the lowest value of the same parameter was obtained when GA<sub>3</sub> at 100 ppm was used (3.09 and 2.06%, respectively).

P (% d.w.), Table (11):

The effect of some nutritional and growth regulator treatments on P% in leaves was significant. Applying GA<sub>3</sub> at 300 ppm achieved the highest N%. On the contrary, raising GA<sub>3</sub> level to 500 ppm resulted in the lowest record in the same concern (1.03 and .05%, respectively).

K (% d.w.), Table (11):

The effect of some nutritional and growth regulator treatments on K% in leaves was significant. The highest percentage was gained as a result of using pigeon manure at 4 g/l, while the lowest value was obtained when salicylic acid at 100 ppm was applied.

**Table 11:** Effect of some nutritional and growth regulator treatments on % of N, P and K

Treatments	N (% d.w.)	P (% d.w.)	K (% d.w.)
Control	2.65 de	0.29 f	1.33 gh
Pigeon manure 4 g/l	2.63 de	0.24 h	1.57 a
Pigeon manure 6 g/l	2.70 c-e	0.24 h	1.44 d
Pigeon manure 8 g/l	2.96 a-c	0.36 d	1.31 h
Crystal 4 g/l	2.57 ef	0.15 i	1.48 c
Crystal 6 g/l	3.02 ab	0.74 b	1.35 fg
Crystal 8 g/l	2.32 fg	0.33 e	1.49 c
BAP 100 ppm	2.90 a-d	0.27 fg	1.37 ef
BAP 300 ppm	2.57 ef	0.24 h	1.30 hi
BAP 500 ppm	2.70 c-e	0.31 e	1.39 e
GA <sub>3</sub> 100 ppm	2.06 g	0.39 d	1.54 b
GA <sub>3</sub> 300 ppm	2.77 b-e	1.03 a	1.31 h
GA <sub>3</sub> 500 ppm	2.96 a-c	0.05 j	1.36 f
Salicylic acid 100 ppm	2.64 de	0.43 c	1.27 i
Salicylic acid 300 ppm	2.06 g	0.26 gh	1.45 d
Salicylic acid 500 ppm	3.09 a	0.31 e	1.54 b

## Discussion

### Mineral fertilizers:

Chase (1989) and Chase and Poole (1989) on *Codiaeum variegatum* cv. "Gold Star" reported that the best plant quality was obtained by using Osmocote (19:6:12) fertilizer.

El-Kiey and El-Bana (1989) on *Philodendron burgundy*, Abou-Dahab (1992) on *Chlorophytum comosum*, Hanafy (1994) on roselle, El-Fouly (1994) on *Peperomia obtusifolia*, El-Sayed (1994) on *Brassica actinophylla*, Hassan (1996) on *Aspidistra elatior* and Atta-Alla *et al.* (1996) on *Cordyline terminalis* reported that NPK fertilization increased the content of chlorophyll a and b. Zaghloul *et al.* (1996) reported that the highest chlorophyll a and b values were recorded with Kristalon at 2 g/l on *Philodendron domesticum*.

Shedeed (1989) on croton, Abdel-Wahid (1995) on *Strelitzia* and Said (1997) on croton found that content of photosynthetic pigments (chlorophyll a, b and carotenoids) in *Codiaeum variegatum* leaves increased by adding NPK fertilizers compared with control plant. Manjul *et al.* (2002) declared that greater carbohydrate accumulation was due to increased photosynthesis that was caused by the optimum balance and supply of plant nutrients present in substrate. Rodolfo *et al.* (2002) indicated that higher N application rates increased the number of leaves, leaf fresh weight, leaf length and leaf diameter of *Aloe vera*.

Abd El-Aziz (2007) found that kristalon fertilizer at 4 g/pot greatly increased growth of croton plants, i.e. plant height, number of leaves, number of branches, fresh and dry weights of leaves, branches and roots, and root length. He also mentioned that the content of photosynthetic pigments (chlorophyll a, b and carotenoids) in *Codiaeum variegatum* leaves and carbohydrate contents increased by adding kristalon (NPK) fertilizers. The magnitude of increase was more pronounced when kristalon was applied at the rate of 4 g/pot, while increasing the level to 8 g/pot caused a significant reduction.

### Pigeon manure:

Tawfik *et al.* (2001) found that application of organic manures increased *Aloe vera* leaf chlorophyll content. Yao *et al.* (2007) investigated the effect of continuous application of chicken manure (CM) and pigeon manure (PM) on soil nutrients. They indicated that concentrations of soil ammonium N, nitrate N, phosphorous and potassium increased considerably after continuous application of CM and PM. This may interpret the positive effect of applying pigeon manure. Hoseini *et al.* (2013) examined the effects of pigeon manure, palm waste and

vermicompost on *Aloe vera* growth grown in pots in the green house. Each one of these organic matters was used in three levels: 90, 180 and 270 g/pot. They found that the highest leaf numbers and fresh weight, leaf diameter and chlorophyll index were achieved when 180 g pigeon manure was applied.

#### BAP:

Several growth regulators have been used to induce branching especially benzyladenine (Keever, 1995; Keever and Morrison, 2003). Benzyladenine has a long history of inducing branching in young fruit trees (Popenoe and Barritt, 1988) and in ornamental plants such as *Sophora* (Carswell *et al.*, 1996), roses (Chu and Lai, 1997), and poplar (Cline and Dong, 2002).

Matsumoto (2006) stated that drenches of BAP at 25 or 50 mM (5630 or 11260 ppm) promoted new vegetative shoots of *Miltoniopsis* orchids and decreased the number of plants with inflorescences. Popenoe (2006) initiated experiments to induce growth of *Magnolia grandiflora* 'D. D. Blanchard' buds with benzyladenine. He found that spraying foliage with 5000 ppm BAP produced significantly more main branches than lower concentrations. Zamanipour and Moghadam (2012) carried out an experiment on one year old apple (*Malus domestica* cvs. 'Red Delicious' and 'Golden Delicious') nursery trees with the main purpose of improving lateral shoot formation and increasing the quality of trees. BAP treatments (0, 200, 400 and 600 mg/l) were applied 3 times at 7 days intervals. They showed that the 'Red Delicious' cultivar had the better response for branching than 'Golden Delicious'. All treatments induced the number of lateral shoots more than the control. Number of lateral shoots increased with application of higher concentrations of BAP in both cultivars.

Mazrou (1992) on *Datura innoxia* and Eraki (1994) on *Hibiscus sabdarifa* showed that foliar application of BAP significantly increased number of branches/plant, plant height as well as fresh and dry weights. Abd El-Aziz (2007) reported that the application of BAP had a significant stimulatory effect on growth parameters of croton plants. Applying BAP at 20 ppm resulted in the tallest plants, the highest number of branches, leaves and root length. BAP at both 20 and 40 ppm were efficient in increasing fresh and dry weights of leaves, branches and roots of *Codiaeum variegatum* plants. On the contrary, Bell *et al.*, 1997 remarked that foliar sprays of BAP at 1000 and 2000 mg/l did not increase lateral shoot count of azalea (*Rhododendron*) cvs. Gloria and Prize. Parletta and Sedgley (1998) investigated methods to induce branching for 21 of *Acacia* species, for commercial production of a flowering potted acacia. They found that benzylamino purine (BAP) did not stimulate branching.

The positive effect of BAP on fresh and dry weights could be interpreted by the findings of Sorokin and Thimann (1964) who claimed that the increment in the fresh weight of *Pisum sativum* could be explained through the role of BAP in stimulating xylem differentiation and vascular strand development, consequently more absorption of water and nutrients from the soil, which was reflected in more growth. It could also be attributed to the increment in plant height and number of branches as a result of overcoming the apical dominance of the plant leading to the formation of more leaves. The effect on fresh and dry weights was authenticated by some authors. El-Sayed *et al.* (1989) on *Polianthus tuberosa* and Menesi *et al.* (1991) on *Calandula officinalis* concluded that BA application increased the fresh and dry weights of roots. Menesi *et al.* (1994) reported that the greatest values of fresh and dry weights of some ornamental plants resulted from BA at 25 mg/L.

The influence of BAP in increasing carbohydrate content was reported by a lot of workers. Krishnamoorthy (1981) explained that BAP increased the synthesis of total carbohydrates in roselle plants. Abou-El-Ghait (1985) on carnation plants, Hassanein (1985) on *Pelargonium graveolens*, Mazrou *et al.* (1988) on roses, Mazrou (1992) on *Datura*, Talaat and Youssef (1998), Eraki (1994) and Zayed *et al.* (1985) on *Hibiscus sabdariffa* and Menesi *et al.* (1994) on the some ornamental plants, stated that BAP treatment increased total carbohydrates. Abd El-Aziz (2007) found that BAP at 20 and 40 ppm significantly increased total carbohydrates% in croton plants.

The number of leaves improved also by BAP application as mentioned by Eid and Abou-Leila (2006) on croton plants who found that application of BAP gave the highest number of leaves.

Reports on cytokinins effect on flowering are contradictory according to species or even cultivar, cytokinin concentration and the stage at which cytokinins were applied. Cytokinins sometimes increase the number of flowers (Jackson, 1975; Heins *et al.* 1981; Farina, 1984; Song *et al.* 1991; Lee *et al.* 1999 and Ferrante *et al.* 2006) or have no influence on flower number (Vlachos, 1985; Tjia, 1986 and Pobudkiewicz, 2005). Kim *et al.* (2000) reported that *Doritaenopsis* 'Happy Valentine' sprayed with BA at a lower concentration (100-200 mg/L) had much more flowers than plants treated with BA at higher concentrations of 400 mg/L.

Richards (1985) stated that BAP at concentrations of 10-150 mg/L did not substantially affect flower production in *Boronia heterophylla* with 4 applications, but with 8 treatments there was a marked decline in flowering with increased BAP concentration. Dawson and King (1993) mentioned that in *Chamelaucium uncinatum* 'Purple Pride' grown in pots, the timing of BA application was crucial for flowering. Benzyladenine at 50 mg/l either depressed or promoted flowering depending on the interval between BA treatment and exposure to short days. BA application 2 months before the start of short day treatment promoted flowering.

The effect of cytokinins on time of flowering was studied by some workers. Foley and Keever (1991) reported that benzyladenine at 200 mg/l delayed flowering by 13 days of *Dianthus caryophyllus*. 'Knight Hybrid Scarlet'. Tjia (1986) reported that benzyladenine accelerated flowering in *Zantedeschia elliottiana* when rhizomes were

soaked in BA at 50-100 mg/l for 30 minutes. Liang and Chang (1998) on *Bougainvillea* 'Taipei Red' and Lee *et al.* (1999) on *Oncidium* 'Aloha' remarked that earlier flowering was also noticed in BA treated plants.

The effect on flower quality was subjected to investigation. Pobudkiewicz (2005) noticed that BA applied at concentrations of 50-300 mg/l had no influence on flower diameter of pot carnation 'Snowmass'. On the other hand, Ferrante *et al.* (2006) stated that BA at 500 at 112.6 ppm diminished the inflorescence length of *Salvia splendens* 'Flamex 2000'.

Some authors investigated the effect of BAP on photosynthetic pigments. Abd El-Aziz (2007) remarked that BAP significantly increased photosynthetic pigments (Chl a, b, total Chl and carotenoids) in leaves of croton plants. Talaat and Youssef (1998) on *Hibiscus sabdariffa*, Zayed *et al.* (1985) on the same plant and Menesi *et al.* (1994) on some ornamental plants, stated that application of BAP increased chlorophyll a, b and carotenoids.

#### GA<sub>3</sub>:

Effects of gibberellic acid on plants are numerous. Dicks *et al.* (1974) reported that 2 mg GA<sub>3</sub>/plant as aqueous applications to the shoot tip of Hybrid lily 'Enchantment', significantly promoted stem extension. Flower number was slightly decreased by GA<sub>3</sub>. GA<sub>3</sub> did not significantly influence the time of anthesis. Little and Loach (1975) stated that the normal growth pattern of 4- and 5-year-old potted balsam fir (*Abies balsamea*) trees was changed by GA<sub>3</sub> applied in both an aqueous soil drench (20 mg per tree, thrice weekly; or 50 mg per tree, twice weekly) and a foliar spray (1000 ppm weekly) for about 3 months. They indicated that exogenous GA<sub>3</sub> increased height growth in balsam fir by altering the normal distribution of photosynthate, not through increasing photosynthate production. Tsai and Arteca (1985) evaluated the effects of root applications of gibberellic acid (GA<sub>3</sub>). They found that relative growth rates, chlorophyll content, photosynthesis and leaf blade area of kochia increased above the control. There were no effects of GA<sub>3</sub> in gomphrena. Omran *et al.* (2005) studied the response of 8 years old "Perlette Seedless" grape variety to gibberellic acid (GA<sub>3</sub>) applied three times 2 weeks after fruit set. They noticed that the content of chlorophyll a, b and carotenoids increased after GA<sub>3</sub> application. Khan *et al.* (2006) declared that GA<sub>3</sub> at 10<sup>-8</sup> M to 10<sup>-4</sup> (0.03-346.4 ppm) gave higher value for plant height and leaf area. However, for fresh and dry weight, GA<sub>3</sub> at 10<sup>-8</sup> M (0.03 ppm) proved superior in its effectiveness to the other 2 treatments. Matsumoto (2006) reported that drenches of GA<sub>3</sub> at 2.5 or 5 mM (866 or 1732 ppm) hastened *Miltoniopsis* inflorescence emergence by 10.9-14.9 days for Bert Field 'Eileen' and by 48.7 days for Rouge 'Akatsuka'. The number of 'Eileen' inflorescences/plant increased with GA<sub>3</sub> at 2.5 mM (866 ppm). Flower size and inflorescence length were unaffected by the GA<sub>3</sub> treatment.

#### Salicylic acid:

Salicylic acid has a remarkable influence on plant physiology as mentioned by some authors. Khan *et al.* (2003) and Yildirim *et al.* (2008) indicated that exogenous SA treatment stimulated root formation and increased mineral uptake by corn, soybean and cucumber plants. Abd El-Razek *et al.* (2013) sprayed 'Egazy Shami' olive trees (*Olea europaea*) one month before beginning the flowering stage with salicylic acid at the concentration of 20 and 40 µg/l, benzyladenine (20 and 30 mg/l), gibberellic acid (50 and 100 mg/l) and water only as a control. They indicated that foliar spray of salicylic acid at 40 µg/l increased flowering percentage and density. Application of 20 or 30 mg/l benzyladenine had the same effect of salicylic acid. On the other hand, GA<sub>3</sub> treatments produced lower values than those of salicylic acid and benzyladenine.

Concerning the impact of salicylic acid on photosynthetic pigments, Gunes *et al.* (2007) attributed the positive effect of SA to enhanced CO<sub>2</sub> assimilation, active Fe content, chlorophyll concentration, and photosynthetic rate, which protected photosynthesis system. Kazemi *et al.* (2010) mentioned that foliar application of SA to plants significantly enhanced the chlorophyll content in young leaves. This phenomenon may be attributed to the fact that foliar application of SA decreased chlorophyll degradation caused by senescence and environmental stress.

This effect on chlorophyll content might be interpreted by the work of Kong *et al.* (2014) who indicated that SA acts as plant growth regulator that can effectively reduce the adverse effect on amylase activity, increase the activities of antioxidant enzymes, alleviate chlorosis and oxidative damage induced by Fe deficiency, as SA increased the uptake and translocation of Fe, promoted the activation of Fe in the leaves of peanut, resulting in increased chlorophyll content and improved seedling growth.

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