Bull. Fac. Agric. Cairo Univ.60:188-196 (2009)

ENHANCEMENT OF *Beaucarnea recurvata* LEM. GROWTH BY SOME GROWTH REGULATORS

(Received: 20.10. 2008)

By
S. M. K. Abdel - Wahid and S. G. Sweify

Ornamental Plants and Landscape Gardening Department, Horticulture Research Institute, Agricultural Research Center, Giza, Egypt.

ABSTRACT

The response of *Beaucarnea recurvata* plants to the application of gibberellic acid (GA_3) and benzyladenine (BA) as a soil drench in a plastic house was studied during the two successive seasons of 2005 / 2006 and 2006 / 2007 at the nursery of Ornamental Plants Research and Landscape Gardening Department, Horticultural Research Institute, Agricultural Research Center, Giza, Egypt. The concentrations used were 200, 300 or 500 ppm for GA_3 and 50, 100 or 200 ppm for BA as well as untreated plants. The results reveal that using GA_3 at 200 ppm increased the stem diameter, leaf width, carotenoids content and total carbohydrates percentage in the leaves. Increasing the level of GA_3 to 300 ppm produced the heaviest fresh and dry weights of leaves. The concentration of 500 ppm of GA_3 increased the plant height, number of leaves / plant and P percentage in the leaves.

Also, the data indicate that BA at 50 ppm increased leaf length and chlorophyll (a) content in the leaves. The concentration of 100 ppm BA caused an increase in potassium percentage in the leaves. However the concentration of 200 ppm resulted in the least number of leaves/ plant, fresh and dry weights of leaves, chlorophyll (b) and total chlorophylls content in the leaves.

So, to accelerate the growth of *Beaucarnea recurvata* plant it should be treated with GA_3 at the rate of 400 ppm as a soil drench.

Key words: *Beaucarnea recurvata, benzyladenine (BA), gibberellic acid (GA_3).*

1. INTRODUCTION

Beaucarnea recurvata Lem. "Syn. *Nolina recurvata* Hemsl (Lem.)Hemsl."., Fam. Asparagaceae is a native to Mexico, in semi-desertic areas. It is often called the "Ponytail palm" or "Bottle palm" although it is not a true palm. It is related to the yuccas and century plants. The plants are relatively slow growing. In nature, they will reach about 10 m in height with a base about 4 m across. In containers, they will only reach about 2.5 m in height. The plant usually has one stem until it reaches 90 cm tall, except if the main stem is damaged. Ponytail palm grows well in sun or semi-shade. It is hardy and drought resistant. It makes a large and handsome houseplant, doing well even in rooms with air conditioning as long as it has bright light. It is a good specimen plant for a rock garden in a dry, warm climate. It does well even in rainy climates along as the soil is sandy and extremely well drained. It is often sold as potted plant for the interesting appearance of its swollen base, which is in fact an adaptation for storing water during times of drought. It can store water up to one year (Staples and Herbst, 1996).

Hormones play a vital role in the control of growth within the plant as a whole and also within individual organs (Wareing and Phillips, 1973). Gibberellin is a naturally-occurring plant growth regulator. It is a completely natural, organic substance that is present in many plants, and in fact is essential to certain life-processes in many plants (Salisbury and Ross, 1992). Active gibberellins show many physiological effects, each depending on the type of gibberellin present as well as the species of plant. Also, their effects are highly dependant on its

concentration and stage of plant growth. Application of gibberellin can stimulate the stems of dwarf plants to additional growth by stimulating cell division and elongation (Raven *et al.* 1992).

Benzyladenine (BA) is a synthetic cytokinin effective in promoting elongation of inhibited buds (Cline, 1988). Cytokinin plays an important role in many physiological and developmental processes in the plant, such as cell division, regulation of shoot and root growth, stress response and pathogen resistance (Mok and Mok, 2001). They also participate in cell enlargement and tissue differentiation. Among the hormones, cytokinins have a unique characteristic in that they can be a structural component of RNA (Leopold and Kriedmann, 1980). Cytokinins retard senescence and chlorophyll degradation in aging leaf tissues. They interact with auxins in the control of apical dominance and lateral branching and the root-shoot ratio in intact plants (Srivastava, 2002)

The effect of GA_3 and BA on the growth of various plants was studied by many investigators. Dwivedi *et al.* (1999) on strawberry noticed that GA_3 at 50 ppm resulted in the maximum leaf number. Farid *et al.* (1999) stated that foliar application of kinetin at 50 ppm increased fresh and dry weight of sweet marjoram. Total carbohydrates, chlorophyll a, b contents as well as N, P and K percentage were increased due to the application of kinetin. Salama *et al.* (2002) stated that spraying fennel plants with GA_3 (100 or 200 ppm) and kinetin (10 or 20 ppm) increased plant height, number of leaves, fresh and dry weights of fennel shoots. Kinetin increased stem diameter, while GA_3 decreased it. Farahat *et al.* (2002) on fennel found that BA at 50 or 100 ppm increased significantly plant height, chlorophyll a, total chlorophylls as well as N, P and total carbohydrate contents. Abdel-Wahid and Manoly (2003) mentioned that GA_3 at 100 ppm increased plant height, leaf length and width as well as P content in the leaves of *Ficus benjamina*. The concentration of 50 ppm increased the total carbohydrates in the leaves, while 150 ppm increased N % in the leaves and 200 ppm increased stem diameter. Hussien (2004) found that supplying Iris plants with BA at 10 or 20 ppm significantly increased the plant height and fresh weight of leaves, total carbohydrates and N % in the leaves. BA at 10 ppm increased the leaf formation. Ahmed *et al.* (2005) on *Peperomia obtusifolia* indicated that GA_3 at 400 ppm resulted in the tallest plants with the heaviest fresh and dry weights and the thickest stem diameter. While, the concentration of 200 ppm increased leaf length and width. Eissa (2007) found that spraying *Pelargonium zonal* with BA at 10 or 20 ppm increased plant height, fresh weight of vegetative parts, chlorophyll b, total chlorophylls and total sugars content in the leaves. Mahmoud (2007) noticed that spraying *Chasmanthe aethiopica* with kinetin at 25, 50 or 75 ppm improved plant height and fresh and dry weights of leaves.

This work was carried out to investigate the effect of GA_3 and BA on the vegetative growth and chemical constituents of *Beaucarnea recurvata* plants.

2. MATERIALS AND METHODS

A pot experiment was conducted in a plastic house at the Ornamental Nursery of Ornamental Plants Research and Landscape Gardening Department, Horticulture Research Institute, Agricultural Research Center, Giza, Egypt, during the two successive seasons of 2005 / 2006 and 2006 / 2007 to study the effect of gibberellic acid (GA_3) and benzyladenine (BA) on the vegetative growth and chemical constituents of *Beaucarnea recurvata* plants.

On March 20^{th} in the two seasons of 2005 / 2006 and 2006 / 2007 homogenous plants were transplanted in plastic pots (20 cm diameter) filled with a mixture of clay and sand (1:1 v/v). The plants were fertilized with NPK at the ratio of 1: 1: 1 at the rate of 3 g / pot as basic. The application started on May 4^{th} and repeated every 2 months till the termination of the experiment. The fertilizers used were ammonium sulphate (20%N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48 % K_2O). The concentrations used of growth regulators were 0, 200, 300 or 500 ppm for GA_3 and 0, 50, 100 or 200 ppm for BA. Thirty five ml of each concentration were added to each plant

Table (A): Mechanical analysis of the soil.

Sand %	Silt %	Clay %	Soil texture
38.30	32.51	29.19	Sandy clay

Table (B): Chemical analysis of the soil.

Cations Meq / L		Anions Meq / L					
Na^+	1.15	$HCO3^-$	2.11	pH	8.12	N	467 ppm
K^+	0.32	$SO4^-$	0.45	E.C.	1.38 mmohs	P	35.0 ppm
Ca^{++}	9.21	Cl^-	0.64	Organic matter	0.34	K	553.0 ppm
Mg^{++}	6.20						

as a soil drench every two months during the period of the investigation. The application started on June the 4th. The plants were irrigated whenever required. The plants were left to grow for 12 month every season. Data were taken in the following May in the two seasons.

The mechanical and chemical analyses of the soil used in the experiment are shown in Tables (A) and (B). These analyses were conducted before planting in both seasons.

At the end of the experiment of each season the following data were recorded:

2.1. Vegetative growth

1- Plant height (cm).
2- Stem diameter (mm) at the middle of the stem.
3- Number of leaves / plant.
4- Leaf length (cm).
5- Leaf width (mm).
6- Fresh and dry weights of leaves (g).

2.2. Chemical constituents

Pigment contents in the leaves, total carbohydrates percentage and elements (N, P & K) in the leaves were estimated. The chemical analyses were performed as follows:

1- Pigment content determination was carried out in the fresh leaves according to Saric *et al.* (1967).
2- Total carbohydrates in the leaves were determined according to Herbert *et al.* (1971).
3- Nitrogen percentage was determined using micro-Kjeldahl method (Pregl, 1945 and Piper, 1947).
4- Phosphorus content was determined according to Troug and Meyer (1939).
5- Potassium content was carried out by using operation chart for Shimadzu Atomic Absorption Flame Spectrophotometer AA-646 with a boiling air-acetylene burner and recorded readout.

The layout of the experiment was a randomized complete blocks with 7 treatments, each treatment contained three replicates. Each replicate consisted of five plants, *i.e.* 15 plants in each treatment. The statistical analysis was carried out according to Snedecor and Cochran (1982). L.S.D. at 0.05 was used to compare the differences between means of treatments.

3. RESULTS AND DISCUSSION

3.1. Vegetative growth

The data on the vegetative growth are presented in Tables (1) and (2).

3.1.1. Plant height

The data indicate that in the two seasons, both GA_3 and BA significantly increased the plant height over the control. GA_3 treatments were more effective in this concern than BA. Increasing the concentration of GA_3 gradually increased the plant height, while increasing BA more than 100 ppm decreased it. The tallest plants (107.56 and 120.28 cm, in the first and second seasons, respectively) were found in the plants treated with GA_3 at 500 ppm. However, the shortest ones were those of control plants (81.88 and 78.33 cm, in the first and second seasons respectively). The promotive effect of GA_3 on plant height may be a result of both larger number of cells formed and elongation of individual cells (Sacks, 1961). Also, Runkova (1977) found that GA_3 increased plant height by increasing the leaf content of active indolic compounds and accelerated the synthesis of IAA. Moreover, cytokinins affected both cell division and enlargement (Arteca, 1996), in addition, he added that exogenous application of cytokinins promotes cell expansion and enlargement due to water uptake caused by a decrease in the osmotic potential.

3.1.2. Stem diameter

The results show that in both seasons, treating the plants with growth regulators increased the stem diameter over the control, same as in plant height. Application of GA_3 at 200 ppm resulted in the thickest stems (10.77 and 22.12 mm, respectively) in the two seasons. While, the thinnest stems (8.16 and 13.88 mm, in the first and second seasons, respectively) were those of the control plants. Increasing GA_3 rate led to a gradual decrease in stem diameter in both seasons. Similar

results were obtained by Abdel-Wahid and Manoly (2003) who found that GA_3 at 200 ppm increased stem diameter of *Ficus benjamina*. Also, Ahmed *et al.* (2005) on *Peperomia obtusifolia* indicated that GA_3 at 400 ppm resulted in the thickest stem diameter.

3.1.3. Number of leaves / plant

The data on the number of leaves / plant show that, in the two seasons all the treatments increased the number of leaves / plant over the control except the concentration of 200 ppm BA. Increasing GA_3 concentration gradually increased the leaf number, while increasing BA rate gradually decreased it. Supplying the plants with GA_3 at 500 ppm resulted in the greatest number of leaves / plant in both seasons (48.61 and 35.67 leaves / plant), same as in plant height. Meanwhile, the plants treated with BA at 200 ppm had the least number of leaves / plant (31.00 and 25.00 leaves/ plant, in the first and second seasons, respectively). These results are in accordance with those obtained by Nofal *et al.* (1998) who mentioned that spraying kinetin at the levels of 25, 50 or 75 ppm increased the mean number of leaves. Dwivedi *et al.* (1999) on strawberry noticed that GA_3 at 50 ppm resulted in the maximum leaf number. Salama *et al.* (2002) stated that spraying fennel plants with GA_3 (100 or 200 ppm) and kinetin (10 or 20 ppm) increased number of leaves, Hussien (2004) found that supplying Iris plants with BA at 10 ppm significantly increased the leaf formation.

3.1.4. Leaf length

From the Tables (1) and (2) it can be noticed that in both seasons, same as in plant height and stem diameter, all the treatments increased the leaf length over the control. The longest leaves (67.32 and 69.28 cm, in the first and second seasons; respectively) were formed on the plants treated with BA at 50 ppm. The shortest ones (47.18 and 44.11 cm, respectively) were those of the control plants. Raising GA_3 or BA levels decreased the leaf length in the two seasons.

3.1.5. Leaf width

The data reveal that in both seasons all the treatments led to an increase in leaf width over the control. Same as in leaf length, increasing the concentration of GA_3 or BA decreased the leaf width. The widest leaves (17.67 and 12.72 mm) were found in the plants treated with GA_3 at 200 ppm. The narrowest leaves (11.33 and 7.72 mm) were found in the control plants. These results are in agreement with the findings of Abdel-Wahid and Manoly (2003) who indicated that GA_3 at 100 ppm increased leaf length and width. Ahmed *et al.* (2005) on *Peperomia obtusifolia* found that GA_3 at 200 ppm increased leaf length and width.

3.1.6. Fresh and dry weight of leaves

The data point out that in the two seasons, the heaviest fresh and dry weights of leaves were found due to the application of GA_3 at 300 ppm. The values were 65.75 and 56.83 g, respectively for the fresh weight and 15.79 and 13.97 g, respectively for the dry weight. The plants treated with BA at 200 ppm had the lightest fresh and dry weights of leaves. The values were 43.38 and 31.87 g, respectively for the fresh weight and 10.18 and 7.48 g, respectively for the dry weight. The increasing effect on fresh and dry weights which was obtained with GA_3 may be attributed to the stimulating effect of GA_3 on

(1): Effect of GA_3 and BA on the vegetative growth of *Beaucarnea recurvata* Lem. plant during the first season (2005 / 2006).

Treatments	Plant height (cm)	Stem diameter (mm)	Number of leaves / plant	Leaf length (cm)	Leaf width (mm)	Leaves fresh weight (g)	Leaves dry weight (g)
Control	81.88	8.16	35.67	47.18	11.33	52.40	12.75
GA_3 200 ppm	99.22	10.77	40.72	63.27	17.67	59.66	13.86
GA_3 300 ppm	103.17	9.85	46.56	59.13	15.78	65.75	15.79
GA_3 500 ppm	107.56	8.54	48.61	54.81	14.20	59.40	13.82
BA 50 ppm	93.78	9.76	39.56	67.32	15.11	48.64	12.21
BA 100 ppm	95.67	8.56	36.86	53.93	14.56	51.49	12.58
BA 200 ppm	89.33	8.28	31.00	51.91	12.52	43.38	10.18
L.S.D. at 0.05	2.70	0.56	2.73	1.98	1.02	2.03	1.54

Table (2): Effect of GA_3 and BA on the vegetative growth of *Beaucarnea recurvata* Lem. plant during the second season (2006 / 2007).

Treatments	Plant height (cm)	Stem diameter (mm)	Number of leaves / plant	Leaf length (cm)	Leaf width (mm)	Leaves fresh weight (g)	Leaves dry weight (g)
Control	78.33	13.83	27.22	44.11	7.72	33. 04	7.85
GA_3 200 ppm	106.67	22.12	28.44	64.83	12.72	33. 92	9.98
GA_3 300 ppm	110.72	17.64	30.83	60.56	9.56	56.83	13.97
GA_3 500 ppm	120.28	16.72	35.67	56.33	9.44	37.63	9.10
BA 50 ppm	98.00	19.28	33.17	69.28	11.67	41.59	10.44
BA 100 ppm	105.28	20.78	29.67	65.44	11.11	45.57	11.52
BA 200 ppm	93.83	21.50	25.00	55.83	9.89	31.87	7.48
L.S.D. at 0.05	2.86	1.01	1.51	2.35	0.95	2.95	1.56

plant height and enhanced the number of leaves. Salama *et al.* (2002) stated that spraying fennel plants with GA_3 (100 or 200 ppm) and kinetin (10 or 20 ppm) increased fresh and dry weights of fennel shoots. Hussien (2004) found that supplying Iris plants with BA at 10 or 20 ppm significantly increased the fresh weight of leaves. Ahmed *et al.* (2005) on *Peperomia obtusifolia* indicated that GA_3 at 400 ppm resulted in the heaviest fresh and dry weights. Eissa (2007) found that spraying *Pelargonium zonal* with BA at 10 or 20 ppm increased fresh weight of vegetative parts. Mahmoud (2007) noticed that spraying *Chasmanthe aethiopica* with kinetin at 25, 50 or 75 ppm improved fresh and dry weights of leaves.

3.2. Chemical constituents of leaves

3.2.1.Photosynthetic pigments in fresh leaves

3.2.1.1. Chlorophyll (a) content:

As shown in Table (3) the data on chlorophyll (a) show that treating the plants with GA_3 or BA increased chlorophyll (a) content over the control plants in the second season, while in the first one they decreased it except the concentration of BA at 50 ppm. Raising the concentration of BA decreased chlorophyll (a) content in the two seasons. The highest value of chlorophyll (a) resulted from BA at 50 ppm (0.33 and 0.42 mg / g FW, respectively) in both seasons. The least content of chlorophyll (a) (0.27 mg / g FW) was formed as a result of supplying the plants with BA at 200 ppm in the first season. While, in the second one the control plants had the least amount of chlorophyll (a) (0.25 mg / g FW). Similar results had been reported by Farid *et al.* (1999) who found that foliar application of kinetin at 50 ppm increased chlorophyll a content in the leaves of sweet marjoram. Also, Kanddeel *et al.* (1998) pointed out that chlorophyll a content in the leaves of *Crinum* or *Hemerocallis* was increased due to kinetin at various levels (25, 50 or 75 ppm). Khafagy *et al.* (2002) on fennel indicated that chlorophyll (a) was increased due to kinetin (10 or 20 ppm), while the treatment of GA_3 at 100 or 200 ppm decreased it.

3.2.1.2. Chlorophyll (b) content

Data presented in Table (3) indicate that the highest chlorophyll (b) content in the two seasons (0.25 and 0.27 mg / g FW, respectively) was detected in the leaves of the control plants. The plants treated with BA at 200 ppm had the least content of chlorophyll (b) (0.17 and 0.15 mg / g FW, in the first and second seasons, respectively). All the treatments of GA_3 and BA significantly decreased chlorophyll (b) content.

3.2.1.3. Total chlorophylls (a + b) content

From the data shown in Table (3) it can be noticed that the highest content of total chlorophylls (a + b) in the first season (0.57 mg / g FW) was found in the control plants. This increase may be due to the increase in chlorophyll (b) content. In the second season, treating the plants with GA_3 at 500 ppm or BA at 50 ppm resulted in more accumulation of total chlorophylls (0.58 and 0.57 mg / g FW, respectively). The least amount (0.44 and 0.42 mg / g FW) was determined in the leaves of the plants treated with 200 ppm BA in the two seasons. In this respect, Farahat *et al.* (2002) on fennel found that BA at 50 or 100 ppm increased significantly the total chlorophylls. Eissa (2007) found that spraying

Pelargonium zonal with BA at 10 or 20 ppm increased the total chlorophylls.

3.2.1.4. Carotenoids content

The data in Table (3) reveal that the highest content of carotenoids (0.29 mg / g FW) was due to treating the plants with GA_3 at 300 ppm in the first seasons. Meanwhile, the plants received GA_3 at 200 ppm or BA at 50 ppm had the least amount of carotenoids (0.25 mg / g FW). In the second season, the control plants and those received GA_3 at 200 ppm had the highest content of carotenoids (0.19 mg / g FW). The least content of carotenoids (0.13 mg / g FW) was determined in the leaves of the plants treated with GA_3 at 300 ppm and BA at 50 or 100 ppm.

Table (3): Effect of GA_3 and BA on photosynthetic pigments (mg / g fresh weight) in the leaves of *Beaucarnea recurvata* Lem. plant during the two successive seasons of 2005 / 2006 and 2006 / 2007.

Treatments	Chlorophyll (a)		Chlorophyll (b)		Total chlorophylls		Carotenoids	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Control	0.32	0.25	0.25	0.27	0.57	0.52	0.26	0.19
GA_3 200 ppm	0.30	0.29	0.18	0.18	0.48	0.47	0.25	0.19
GA_3 300 ppm	0.31	0.38	0.19	0.23	0.50	0.51	0.29	0.13
GA_3 500 ppm	0.31	0.35	0.19	0.23	0.50	0.58	0.28	0.17
BA 50 ppm	0.33	0.42	0.20	0.15	0.53	0.57	0.25	0.13
BA 100 ppm	0.30	0.32	0.18	0.19	0.48	0.51	0.28	0.13
BA 200 ppm	0.27	0.27	0.17	0.15	0.44	0.42	0.28	0.18
L.S.D. at 0.05	0.01	0.04	0.02	0.03	0.03	0.04	0.02	0.01

3.2.2. Total carbohydrates percentage

The data on total carbohydrates contents as shown in Table (4) show that all the treatments of the growth regulators significantly increased the percentage of the total carbohydrates compared to untreated plants in the two seasons. Increasing the rate of GA_3 decreased the accumulation of total carbohydrates in the leaves. The highest total carbohydrates percentages (27.18 and 26.00 %, respectively) were formed in the plants treated with GA_3 at 200 ppm. The least percentage of total carbohydrates (22.42 and 22.75 %, respectively) was detected in the control plants. Similar results were obtained by Abdel-Wahid and Manoly (2003) who mentioned that GA_3 at 50 ppm increased the total carbohydrates in the leaves of *Ficus benjamina*. Hussien (2004) found that supplying Iris plants with BA at 10 or 20 ppm significantly increased the total carbohydrates Eissa (2007) stated that spraying *Pelargonium zonal* with BA at 10 or 20 ppm increased the total sugars content in the leaves.

3.2.3. Nitrogen percentage

Nitrogen percentage as affected by the growth regulators is presented in Table (4), in

Table (4): Effect of GA_3 and BA on total carbohydrates, N, P and K percentages in the leaves of *Beaucarnea recurvata* Lem. plants during the two successive seasons of 2005 / 2006 and 2006 / 2007.

Treatments	Total carbohydrates % (D.W)		Nitrogen % (D.W)		Phosphorus % (D.W)		Potassium % (D.W)	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Control	22.42	22.75	1.46	1.10	0.22	0.24	1.90	1.89
GA_3 200 ppm	27.18	26.00	2.06	1.70	0.19	0.21	1.93	1.91
GA_3 300 ppm	24.00	25.67	1.92	1.15	0.23	0.23	1.99	1.95
GA_3 500 ppm	23.75	23.63	1.59	0.90	0.25	0.28	1.93	1.92
BA 50 ppm	23.58	25.17	2.07	1.20	0.24	0.20	1.98	1.97
BA 100 ppm	27.00	25.63	2.10	1.20	0.24	0.21	2.06	2.02
BA 200 ppm	22.88	25.25	2.23	1.24	0.24	0.22	1.94	1.92
L.S.D. at 0.05	1.07	1.21	0.04	0.18	0.02	0.03	0.06	0.02

both seasons, all the treatments increased nitrogen percentage over the control except the treatment of GA_3 at 500 ppm in the second season. In the first season, the highest accumulation of nitrogen (2.23 %,) was detected in the plants treated with BA at 200 ppm, while the least percentage (1.46 %) was found in the control plants. In the second season, application the plants with GA_3 at 200 ppm resulted in the formation of the highest percentage of nitrogen (1.70 %). The least percentage of nitrogen (0.90 %) was determined in the plants treated with GA_3 at 500 ppm.

3.2.4. Phosphorus percentage

The recorded data for phosphorus percentage in *Beaucarnea recurvata* plants (Table 4) reveal that in the two seasons, the greatest amount of P (0.25 and 0.28 %, respectively) was determined in the plants received GA_3 at 500 ppm. The least percentage (0.19 %) was found in the plants treated with GA_3 at 200 ppm in the first season. In the second one, BA at 50 ppm reduced the accumulation of P to the least percentage (0.20 %). There was insignificant difference among BA treatments in both seasons.

3.2.5. Potassium percentage

Data shown in Table (4) indicate that in both seasons, all the treatments led to an increase in potassium percentage over the control plants. The greatest percentage of potassium in both seasons (2.06 and 2.02 %, respectively) was determined in the plants treated with BA at 100 ppm. The least percentages (1.90 and 1.89 % in both seasons, respectively) were found in the control plants.

These results are in harmony with those obtained by Abdel-Wahid and Manoly (2003) who mentioned that GA_3 increased N and P content in the leaves of *Ficus benjamina*. Farahat *et al.* (2002) on fennel and Hussien (2004) on Iris, found that BA at various concentrations significantly increased N and P % in the leaves.

It can be recomneded that accelerate the growth of *Beaucarnea recurvata* plant it hould be treated with GA_3 at the rate of 400 ppm as soil drench**.**

4. REFERENCES

Abdel-Wahid S.M.K. and Manoly N.D. (2003). Effect of GA_3 on *Ficus benjamina* L. seedlings. Proc. 1st Egypt. & Syr. Conf. for Agric. & Food, El-Minia: Dec. 8 – 11, 2003, Vol. 1 No. 1 (145 – 160).

Ahmed G.E.F., Abdel-Wahid S.M.K. and Sabh A.Z.E. (2005). Effect of paclobutrazol and gibberellic acid on *Peperomia obtusifolia* (L.) A. Dietr. plant. 1- Vegetative growth. The 6th Arabian Conf. for Hort., Ismailia, Egypt: March 20 – 22, 2005 (65 – 74).

Arteca R.N. (1996). Plant Growth Substances Principles and Application. Chapman & Hall Press.

Cline M.G. (1988). Apical dominance. Bot. Rev., 57: 318 – 358.

Dwivedi M.P., Negi K.S., Jindal K.K. and Rana H.S. (1999). Effect of bioregulators on vegetative growth of strawberry. Scientific Horticulture, 6: 79 – 84. (Hort. Abst., 70: 1046).

Eissa T.E.A. (2007). Physiological Studies on Handling of *Pelargonium zonal*, L., *Chrysanthemum leucanthemum,* L. and *Rudbeckia tricolor,* L. Ph.D. Thesis, Fac. Agric. Kafr El-Sheikh, Tanta Univ.

Farahat M.M., Habba E.E. and Rashad El-Sh.M. (2002). Physiological response of fennel to tryptophan, naphthalene acetic acid and benzyladenine treatments in sandy soil. Egypt. J. Appl. Sci., 17 (11): 642 – 633.

Farid M.R., Habba E.A and Mahmoud H.F. (1999). Physiological and biochemical response of sweet marjoram (*Majorana hortensis* L.) to foliar kinetin application and gamma radiation. Minufiya J. Agric. Res., 24 (1): 251 – 260.

Herbert D., Philipps P.J. and Strange R.E. (1971). Determination of total carbohydrates. Methods in Microbiol., 58: 209 – 344.

Hussien H.S.M. (2004). Physiological Studies on Iris Plant. M. Sc. Thesis, Fac. Agric. Cairo Univ.

Kanddeel Y.M., Nofal E.M.S., El-Tarawy, M.A. Auda, M.S. and Shahin S.M. (1998). Effect of kinetin and greenzit on *Crinum longifolium*, Thunb and *Hemerocallis aurantiaca*, Baker plants. II- Effect on bulbs productivity and plants chemical

analysis. The 2nd Conf. of Orn. Hort. Ismailia, Egypt, Oct. 24 - 26, 1998 (199 – 215).

Khafagy M.A., Salama S.M., El-Hadidi M.S. and Ismail S.I.I. (2002). Effect of some growth substances on physiological characters and yield of fennel plants. The 2nd Inter. Conf. Hort. Sci., 10 – 12 Sept. 2002, Kafr El-Sheikh, Tanta Univ., Egypt, (930 – 939).

Leopold A.C. and Kriedmann P.E., (1980). Plant Growth and Development. Mc Graw-Hill Publishing Company Ltd. London, 3rd Ed.

Mahmoud A.M.A. (2007). Response of *Chasmanthe aethiopica* (L.) N.E.Br. plants to foliar spray with kinetin and kristalon. J. Agric. Sci. Mansoura Univ., 32 (7): 5517 – 5528.

Mok D.W. and Mok M.C. (2001). Cytokinin metabolism and action. Plant Mol. Biol., 52, 89–118.

Nofal E.M.S., El-Tarawy M.A., Kanddeel Y.M., Auda M.S. and Shahin S.M. (1998). Effect of kinetin and greenzit on *Crinum longifolium*, Thunb and *Hemerocallis aurantiaca*, Baker plants. I- Effect on vegetative growth and flowering. The 2nd Conf. of Orn. Hort. Ismailia, Egypt, Oct. 24 - 26, 1998 (187 – 198).

Piper C.S. (1947). Soil and Plant Analysis. p. 258 – 275. Univ. of Adelaide, Adelaide, Australia.

Pregl F. (1945). Quantitative Organic Microanalysis 4th Ed. Church. London.

Raven P. H., Evert, R. F., and Eichhorn, S. E. (1992). Biology of Plants. New York: Worth. p. 545 – 572.

Runkova L.V. (1977). Interaction between exogenous and endogenous growth regulators as exemplified on ornamental plants. Bulleten Clavnoge Botanicheskog Sada, 106: 62 – 70.

Sacks R.M. (1961). Gibberellin, auxin and growth retardant effect upon cell division and shoot histogenesis. Adv. Chem., 28: 49 – 58.

Salama S.M., Khafagy M.A., El-Hadidi M.S. and Ismail S.I.I. (2002). Morphological and anatomical studies on fennel plants as affected by some growth substances. The 2nd Inter. Conf. Hort. Sci., 10 – 12 Sept. 2002, Kafr El-Sheikh, Tanta Univ., Egypt, (473 – 483).

Salisbury F. B. and Ross, C. W. (1992). Plant Physiology. Belmont, CA: Wadsworth. p. 357 – 407, 531 – 548.

Saric M., Kastrori R., Curic R., Cupina T. and Geric I. (1967). Chlorophyll Determination. Univerzit et U Noveon Sadu. Praktikum iz Fiziologize Bilijaka Beograd Haucna Anjiga. 215 pp.

Snedecor G.W. and Cochran W.G. (1982). Statistical Methods, 7th Ed. The Iowa State Univ., Press. Iowa, USA, 507 pp.

Srivastava L.M. (2002). Plant Growth and Development Hormones and Environment. Academic Press, London. p. 191 - 204

Staples G.W. and Herbst D.R. (1996). Nomenclature changes affecting cultivated plants. Journal of horticultural taxonomy, 23: 171.

Troug E. and Meyer R.H. (1939). Improvement in deiness colorimetric methods for phosphorus and arsenic. Ind. Eng. Chem. Anal. Ed., (1): 136 – 139.

Wareing P.F. and Phillips I.D.J.. (1973). The Control of Growth and Differentiation in Plants. Pergamon Press Ltd. Oxford, UK. 293pp.

باستخدام بعض منظمات النمو LEM *Beaucanea recurvata* الإسراع من نمو نباتات (الزلوع)

صفوت مصطفى كامل عبد الواحد و سهام جاد الكريم سويفى

قسم بحوث نباتات الزينة وتنسيق الحدائق - معهد بحوث البساتين - مركز البحوث الزراعية
الجيزة - مصر

ملخص

يهدف هذا البحث إلى دراسة استجابة نباتات البوكارنيا ريكورفاتا (الزلوع) لإضافة حمض الجبريلليك والبنزيل أدينين إلى التربة داخل صوبة بلاستيكية خلال الموسمين 2005 / 2006 و 2006/ 2007 فى مشتل قسم بحوث نباتات الزينة وتنسيق الحدائق – معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة . تم إضافة حمض الجبريلليك بتركيزات 200 أو 300 أو 500 جزء فى المليون والبنزيل أدينين بتركيزات 50 أو100 أو 200 جزء فى المليون بالإضافة إلى الكنترول . وكانت أهم النتائج كالآتى:-

1. أدت إضافة حمض الجبريلليك بتركيز 200 جزء فى المليون إلى زيادة قطر الساق ، وعرض الورقة ، ومحتوى الأوراق من الكاروتينات والكربوهيدرات الكلية .
2. أدت إضافة حمض الجبريلليك بتركيز 300 جزء فى المليون إلى الحصول على أكبر وزن غض وجاف للأوراق .
3. أدت المعاملة بحمض الجبريلليك بتركيز 500 جزء فى المليون إلى زيادة ارتفاع النبات ، وعدد الأوراق / نبات ومحتوى الأوراق من الفوسفور .
4. وكان لإضافة البنزيل أدينين بتركيز 50 جزء فى المليون تأثير فى زيادة طول الورقة ومحتوى الأوراق من كلوروفيل ا
5. أدى استخدام البنزيل أدينين بتركيز 100 جزء فى المليون إلى زيادة محتوى الأوراق من البوتاسيوم .
6. أدت المعاملة بالبنزيل أدينين بتركيز 200 جزء فى المليون إلى الحصول على أقل عدد للأوراق / نبات، وأقل وزن غض وجاف للأوراق ، وأقل محتوى من كلوروفيل ب والكلوروفيلات الكلية فى الأوراق.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (60) العدد الثانى (أبريل 2009): 188-196.