

USAGE OF ACTOSOL (HUMIC ACID) AND SOME GROWTH REGULATORS FOR IMPROVING PLANT QUALITY OF *CHAMAEDOREA SEIFRIZII*, BURRET

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ABSTRACT: The present experiment was performed during two successive seasons (2017/2018), (2018/2019) at the nursery of Horticulture Research Institute, Agriculture Research Center, Giza, Egypt. It intended to solve the main important problem facing the production of *Chamaedorea seifrizii* plant under Egyptian conditions of the slow rate of growth especially at the early stage, besides improving plant quality. So, the individual as well as the combined effects of different actosol levels (organic fertilizer) as a main factor and different levels of the mixture of different growth regulators GA₃ (gibberellic acid), BA (benzyladenine) and NAA (naphthalene acetic acid) as a subfactor were investigated. In both seasons (on November, 1st) transplants of 9-10 cm length and 2-3 leaves were planted in 25 cm plastic pot filled with the mixture of sand and clay (1:1, v/v). Actosol (humic acid) was applied as a soil drench at different levels (0, 1, 2 and 3 ml/l). Whereas the mixture of the different growth regulators it was applied at different levels (0, 50, 150, 250 and 350 ppm) as a foliar spray. All of them were applied at monthly intervals commencing from three months after planting (February, 1st) till the termination of the experiment (December, 1st). Thus, the plants were treated by either actosol or the mixture of the different growth regulators 11 times in every season. Results emphasized the beneficial effect of using the highest levels of actosol (2 and 3 ml/l) for improving root length and its fresh and dry weights, comparing with that gained from untreated control plants with significant effect in the two seasons. Meanwhile, the same levels (2 and 3 ml/l) gave rise to the utmost highest values of the different vegetative growth parameters expressed by plant height, No. of leaves/plant, stem diameter and fresh and dry weight of vegetative part, chemical constituents of vegetative parts was also affected by treating plants with actosol. Pigment contents (chlorophyll a, b and carotenoides), total carbohydrates and minerals (N, P and K %) revealed also an increment due to applying the different levels of actosol, with the mastery of applying the highest level (3 ml/l). With respect to the effect of the mixture of the different levels of growth regulators on roots, vegetative growth parameters and chemical constituents of the plant, it is clear the beneficial effect of the mixtures on improving such traits especially with using the highest level (350 ppm) in the two seasons. From the aforementioned results and the interaction, it could be recommended to supply plants with the highest level of actosol (3 ml/l) and that of the mixture of growth regulators (350 ppm) after three months after transplanting and then at monthly interval for 11 times throughout the growth season in order to produce



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Chamaedorea seifrizii of good quality with solving the problem of the slow rate of growth under Egyptian conditions.

Key words: *Chamaedorea seifrizii*, actosol (humic acid), gibberellic acid, benzyladenine, naphthalene acetic acid.

INTRODUCTION

Chamaedorea includes approximately 100 species of solitary and clustering palms from Mexico to South America. It is a diverse and variable group of small palms, which are often difficult to identify hybrids may occur in cultivation. Male and female flowers are on separate plants (dioecious), though some cultivated individuals appear to be self-fertile. Leaves are pinnate, the leaflet margins often partly or wholly coherent. These seedlike or bamboolike understory palms generally prefer bright broken light or bright shade with plenty of air movement, though some do quite well in full sun. The tall clustering types are highly recommended for screening in narrow spaces with minimal footing. They can be very effective as privacy hedges and to hide ugly walls or deter graffiti. They grow relatively quickly from seed but even faster by divisions. If stems become too tall, the longest canes can be selectively thinned and the shorter ones will fill in save the cut canes for natural plant stakes. With specimen plants, the dry crown shafits and lower leaves may be removed to expose the bamboolike structure. Plants are suitable for containers Mock-ingbirds like the fruit. *Chamaedorea seifrizii*, Bamboo palm, Reed palm, Clustering palm, to 12 ft; Blooms intermittently in warm, wet months. Seasonally moist/dry. Average to fertile, well-drained soil. Full sun to bright filtered light. Flowers: unisexual, fruit olive sized waxy green ripening to glossy black, rachis orange, leaves pinnate, leaflets in 12-24 staggered pairs, a few of the distal pairs fused. Stem to 1 inch diameter, partly enclosed by papery leaf bases, leaf scar rings widely spaced reedlike (Liamas, 2003).

Organic fertilizers are of paramount importance for their beneficial effects on the

physical, chemical and biological properties of soil, cation exchange capacity and available minerals nutrients for plant productivity (El-Nagar, 1996). Actosol (humic acid) is an organic fertilizer containing humic acid and other nutritional elements (El-Seginy, 2006). Using actosol seems to be valuable in correcting the widespread occurrence of certain deficiency symptoms. This is attained through increasing the soil water holding capacity, improving soil structure and enhancing the metabolic activity of microorganisms. It also acts as a source of nitrogen, phosphorus, sulphur and other elements for plants (Petrovic *et al.*, 1982; Higa and Wididana, 1991). Moreover, Stevenson (1994) concluded that humic acid substances isolated from different materials contained 45-65% carbon, 30-48% oxygen, 2-6% nitrogen and 5% hydrogen. Humic substances (HS) are important as a soil component because they constitute a stable fraction of carbon (C) thus regulating the carbon cycle and release nutrients including nitrogen (N), phosphorus (P) and sulphur (S).

Many scientists studied the effect of actosol (H.A.) on various plant species, but few information are available on the effect of actosol (H.A.) on chamaedorea palm. So, the literature on other plants is indispensable in this respect. El-Sayed and El-Shal (2008) on schefflera (*Brassaia actinophylla*) found that humic acid treatments revealed significant effect on plant parameters, which reached maximum due to use of actosol (H.A.) as foliage spray at the rate of 5.0 cm³/l plus soil drench at the rate of 10.0 cm³/l. Saber (2018) on *Chamaedorea elegans* tested the effect of different levels of humic acid applied as a soil drench (3 and 6 ml/l). Results revealed that application of organic humic acid treatments significantly increased all the

vegetative growth parameters and chemical composition as compared with control plants.

With respect to the effect of actosol (H.A.) on chemical constituents of the plants, El-Attar (2006) found that using humic acid at 0.5 or 1.0 ml/l on *Ficus allii* (cv. Green and cv. Variegata) plants caused increase in N and P content at the different parts for both cultivars and using humic acid at high level increased the total carbohydrates content. Abdel-Fattah *et al.* (2009) on *Dracaena* and *Ruscus* plants reported that a combination of humic acid at 5 ml/l as a foliar spray and at 10 ml/l as a soil drench recorded marked increments in the leaf content of chlorophyll a, b, carotenoids, total carbohydrates, N, P and K %.

Hormones play a vital role in the content of growth within individual organs (Wareing and Phillips, 1973). Gibberellin is a naturally occurring plant growth regulators. It is a completely natural organic substance 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 dependent 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 on 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 characteristics in that they are a structural component of RNA (Leopold and Kriedmann, 1975). 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 in intact plant (Srivastava, 2002).

The effect of GA₃ and BA on the growth and chemical constituents of various plants was studied by many investigators. Abdel Wahid and Manoly (2003) mentioned that GA₃ 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 total carbohydrates in the leaves and 200 ppm increased leaf diameter. 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.

Sardoei *et al.* (2014) studied the effect of gibberellic acid and bezyladenine on *Ficus benjamina*, *Schefflera arboricola* and *Dizigotheca elegantissima* plants was evaluated at pot cultivation conditions study their response the foliar application with gibberellic acid (GA₃) at 0, 100 and 200 mg l⁻¹ GA₃ + 200 mg l⁻¹ BA respectively. Results, revealed that the highest rate of plant height in three indoor plants was related to *Ficus benjamina* that taller plants compared to two other plants. The highest rate of number of leaves/plant was belonged to 200 mg l⁻¹ GA₃ + 100 mg l⁻¹ BA and 200 mg l⁻¹ GA₃ + 200 mg l⁻¹ BA for the three plants. Auxins, however, as a class of phytohormones are involved in many aspects of plant growth and development, mainly induction of root primordial (Davies, 1995), El-Hedairi *et al.* (1998) found that injection of soil with NAA at 500 ppm gave the best rooting and length of roots in Taaghiyaat date palm. Rizk and El-Sayed (2004) mentioned that the easiness and difficulty in rooting of date palm of shoots is correlated with their content of endogenous auxins. Moreover, El-Sayed *et al.* (2010) recommended to treat *Phoenix dactylifera* cv. Zaghloul offshoots cultivated in 50 cm diameter pots with both IBA and NAA at

1000 ppm for each, three times with one month interval in order to obtain higher survival and rooting percentages accompanied with better growth under the condition of nursery.

Therefore, the present experiment was consummated with the aim to overcome the important problem of the slow rate of plant growth, especially at the early growth stages of *Chamaedorea seifrizii*. Moreover, it intended to improve plant quality under Egyptian conditions.

MATERIALS AND METHODS

This investigation was performed throughout two successive seasons (2017/2018) and (2018/2019) at the nursery of Horticulture Research Institute, Agriculture Research Center, Giza, Egypt with the aim to overcome the problem of the slow rate of plant growth especially at the early growth stages of *Chamaedorea seifrizii* under Egyptian conditions. Thus, the individual as well as the combined effects of different levels of actosol (humic acid) and a mixture of different growth regulators (GA₃, benzyladenine (BA) besides, the naphthalene acetic acid (NAA) on vegetative growth and roots parameters as well as some chemical constituents of the plants, were investigated in both seasons.

Materials:

- Transplants of 9-10 cm and 2-3 leaves were used in both seasons.
- Actosol (humic acid) with different levels (1, 2 and 3 ml/l). Main characteristics of the used liquid active fertilizer (Actosol) according to El-Seginy (2006) are presented in Table (a).
- The mixture of different growth regulators (GA₃, benzyladenine (BA) and naphthalene acetic acid (NAA) with different levels (0, 50, 150, 250 and 350 ppm).
- 25 cm plastic pots filled with a mixture of sand/clay (1:1, v/v). the physical and chemical properties of the growing medium are presented in Table (b).

- Saran house of 65% (170-200 fc) shading and 14, 6 and 3.5 m in dimension.

Preparation of growth regulators solution:

One gram from every type of growth regulator was dissolved in 1000 cm³ distilled water for giving 1000 ppm of every type of growth regulators. Thereafter, the following solutions were prepared.

- 50 cm³ from stock solution of growth regulators + 950 cm³ distilled water for giving solution of 50 ppm of growth regulator.
- 150 cm³ from stock solution of growth regulators +850 cm³ distilled water for giving solution of 150 ppm of growth regulator.
- 250 cm³ from stock solution of growth regulators + 750 cm³ distilled water for giving solution of 250 ppm of growth regulator.
- 350 cm³ from stock solution of growth regulators +650 cm³ distilled water for giving solution of 350 ppm of growth regulator.

After the preparation of the different levels of the solutions of the three growth regulators (GA₃, BA and NAA), the mixture of the different types of growth regulators, concerning their levels were mixed together.

Procedure:

On November 1st in every season, transplants of 9-10 cm length and 2-3 leaves were planted in 25 cm plastic pots (one plant each) filled with the mixture of sand and clay (1:1, v/v) in both seasons. After three months from planting (February, 1st) the plants were treated with different levels of actosol (H.A.) at 0, 1, 2 and 3 ml/l as a soil drench and different levels of the mixture of growth regulators (GA₃, benzyladenine (BA) and naphthalene acetic acid (NAA) at 0, 50, 150, 250 and 350 ppm) applied as a foliar spray. Thereafter, the plants received actosol (H.A.) or the mixture of the different growth regulators at monthly intervals till the

Table a. The physical and chemical analysis of the used sand and clay in the two seasons.

Soil type	Particle size distribution (%)				S.P.	E.C (ds/m)	pH	Cations (meq/l)				Anions (meq/l)		
	Coarse sand	Fine sand	silt	clay				Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻
Clay	7.46	16.75	34.53	40.84	41.67	2.18	8.33	16.93	9.33	20.44	0.37	3.82	1.46	41.79
Sand	18.72	71.28	4.76	5.34	21.83	1.58	8.20	2.65	2.48	21.87	0.78	3.85	13.00	10.93

Table b. Main characteristics of the used liquid active fertilizer (Actosol) according to El-Seginy (2006).

Components	Value	Components	Value	Components	Value
Humic acid (%)	2.9	EC (dS/m)	5.90	B (ppm)	70.00
Organic matter/total solids (%)	42.51	N (%)	10.00	Fe (ppm)	900.00
Total H.A./total solids	168.80	P (%)	10.00	Mn (ppm)	90.00
Organic carbon (%)	24.64	K (%)	10.00	Zn (ppm)	90.00
C/N ratio	2.46	Ca (%)	0.06		
pH	8.10	Mg (%)	0.05		

terminate of the experiment (December, 1st) i.e. 11 times in every season.

The layout of the experiment was factorial in a randomized complete design (RCD) with three replicates. The main factor was actosol (humic acid) treatments, whereas, the sub factor was the mixture of the different growth regulators treatments. Every experimental unit was represented by 3 plants.

Regular agriculture practices such as weeding and watering etc., were carried out whenever needed.

At the termination of the experiment the following data were recorded: plant morphological traits of root length (cm), fresh and dry weight of roots (g), plant height (cm), No. of leaves/ plants, stem diameter (cm) and fresh and dry weights of vegetative parts (g).

Chemical analysis:

1. Pigments content:

Determinations of chlorophyll a, b and carotenoids in fresh leaves as mg/g f.w. were carried out according to Wettstein (1957).

2. Total carbohydrates content in leaves:

Total carbohydrates in the leaves were determined using colorimetric method described by Dubois *et al.* (1956)

3. Nitrogen, phosphorus and potassium% in the leaves:

Nitrogen was determined by micro-Kjeldahle apparatus (Blake, 1965). Phosphorus was colorimetrically determined in the acid digested using ascorbic acid method (John, 1970). Potassium was determined using the flamephotometer (Dewis and Freitas, 1970).

Data were then tabulated and statistically analyzed using SAS program (1994) and means were compared by L.S.D. method according to Snedecor and Cochran (1986).

RESULTS AND DISCUSSION

Root parameters:

Data registered in Tables (1, 2 and 3) exert the beneficial effect of using the highest levels of actosol (2 and 3 ml/l) on root length as well as fresh and dry weights. These parameters progressively increased by raising actosol level. However, applying the highest levels of actosol (2 and 3 ml/l) gave means closely near together with insignificant difference in between on the above mentioned traits in the two seasons. In contrast, the least scores were a result of untreated control plants.

Table 1. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on root length (cm) of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season				
	Control	Actosol			Mean	Control	Actosol			Mean
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l	
Control	13.30	15.00	18.50	19.20	16.50	15.10	17.89	21.89	22.89	19.44
50 ppm	15.80	17.30	19.90	20.40	18.40	17.40	19.78	22.90	23.50	20.90
150 ppm	18.70	19.10	22.10	22.50	20.60	20.23	22.55	24.78	25.01	23.14
250 ppm	22.00	22.90	25.40	26.10	24.10	24.12	24.87	26.22	26.80	25.50
350 ppm	22.70	22.10	26.10	26.90	24.50	24.54	25.08	26.51	27.02	25.79
Mean	18.50	19.30	22.40	23.10		20.28	22.03	24.44	25.04	
LSD at 0.05 for										
	A = 1.09					A = 1.88				
	B = 2.15					B = 2.33				
	A×B = 3.67					A×B = 4.08				

Table 2. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on fresh weight of root (g) of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season				
	Control	Actosol			Mean	Control	Actosol			Mean
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l	
Control	19.50	21.90	26.00	26.60	23.50	21.30	24.25	29.00	29.24	25.95
50 ppm	22.40	25.60	28.20	28.90	26.30	24.12	28.36	31.50	32.22	29.05
150 ppm	25.10	28.60	31.40	32.10	29.30	27.30	31.20	34.22	36.52	32.21
250 ppm	30.00	32.70	36.50	37.30	34.20	32.20	35.60	39.51	41.02	37.08
350 ppm	30.20	33.30	37.50	37.90	34.70	32.53	36.20	41.23	41.89	37.96
Mean	25.40	28.40	31.40	32.60		27.49	31.12	35.09	36.18	
LSD at 0.05 for										
	A = 2.32					A = 2.62				
	B = 2.89					B = 3.09				
	A×B = 5.02					A×B = 6.11				

Table 3. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on dry weight of root (g) of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season				
	Control	Actosol			Mean	Control	Actosol			Mean
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l	
Control	9.90	10.90	15.30	16.00	13.00	10.25	11.50	17.25	18.55	14.39
50 ppm	13.70	15.90	17.70	18.50	16.50	14.22	17.23	19.32	21.36	18.03
150 ppm	17.30	19.80	22.20	23.00	20.60	18.60	20.78	25.30	26.50	22.80
250 ppm	21.10	24.60	26.80	27.60	25.10	22.30	26.20	29.12	30.42	27.01
350 ppm	21.60	25.20	27.70	29.60	26.10	22.89	27.30	30.51	31.48	28.05
Mean	16.70	19.30	22.00	22.90		17.65	20.60	24.30	25.66	
LSD at 0.05 for										
	A = 0.97					A = 1.08				
	B = 1.15					B = 1.42				
	A×B = 1.87					A×B = 2.12				

On the other side, the effect of the mixture of the different growth regulators levels on root parameters showed great influence of applying the highest levels (250 and 350 ppm) for improving such traits in the two seasons comparing with that gained from either control or the lowest level used (50 ppm).

The beneficial effect of humic acid (actosol) on improving root parameters was also recorded by Abdel-Fattah *et al.* (2009) who reported that a combination of humic acid at 5 ml/l as a foliar spray and 10 ml/l as a soil drench recorded the high means of root length and diameter as well as fresh and dry weights of roots of *Dracaena* and *Ruscus* plants.

On the other hand, the prevalence of auxin for improving root growth and parameters was also mentioned by El-Hedairi *et al.* (1998) on *Phoenix dactylifera*, they found that injecting soil with NAA at 50 ppm gave the highest number and length of roots. Moreover, Rizk and El-Sayed (2004) concluded that the easiness and difficulty in rooting of date palm of shoots is correlated with their content of endogenous auxins. Moreover, El-Sayed *et al.* (2010) recommend to treat *Phoenix dactylifera* cv. Zaghoul offshoots cultivated in pot of 50 cm diameter with both IBA and NAA at 1000 ppm for each, three times with one month interval for obtaining higher survival and rooting percentage.

In the matter of the interaction, it is evident from data scored in Tables (1-3) the superiority of plants which received actosol at the highest level (3 ml/l) and treated with the highest level of the mixture of different growth regulators (350 ppm) for giving the highest values of the above mentioned traits.

Vegetative growth parameters:

Data exhibited in Tables (4-8) clear the beneficial effect of receiving plants the highest actosol levels (2 and 3 ml/l) as well as the highest ones of the mixture of the different growth regulators levels (250 and 350 ppm) in giving the utmost highest values

of the different vegetative growth parameters studied in both seasons. In contrast, the least scores were gained due to untreated control plants in the two seasons.

The beneficial effect of actosol (H.A.) on improving vegetative growth parameters is in accordance with other authors on other plants as El-Sayed and El-Shal (2008) on *Schefflera* (*Brassaia actinophylla*) who concluded that humic acid treatments revealed significant effect on plant parameters, which reached maximum due to using actosol (humic acid) as a foliar spray at the rate of 5.0 cm³/l plus soil drench at the rate of 10 cm³/l. Moreover, Abdel Fattah *et al.* (2009) on *Dracaena* and *Ruscus* plants concluded that treating plants with humic acid liquid fertilizer added monthly either as a foliar spray at the rate 5 ml/l or as soil drench at the rate of 10 ml/l (50 ml from the humic acid solution/pot) significantly improved all vegetative growth parameters of both studied plants

The above mentioned results of the effect of the different levels of the mixture of growth regulators used in accelerating the growth of *Chamaedorea seifrizii* as well as improving vegetative growth parameters was ascertained by many authors on various plants. Referring the effect of GA₃ and BA on such parameters, Dwivedi *et al.* (1999) on strawberry noticed that GA₃ 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 weights of sweet marjoram. Salama *et al.* (2002) stated that spraying fennel plants with GA₃ (100 or 200 ppm) and kinetin (10 or 20 ppm) increased plant height, number of leaves, fresh and dry weights of fennel shoots, whereas kinetin increased stem diameter. Farahat *et al.* (2002) on fennel found that BA at 50 or 100 ppm significantly increased plant height. Abdel-Wahid and Manoly (2003) mentioned that GA₃ at 100 ppm increased plant height. The concentration of 200 ppm increased stem diameter of *Ficus benjamina*. Hussien (2004) found that supplying Iris plant with BA at 10

Table 4. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on plant height (cm) of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season					
	Control	Actosol			Mean	Control	Actosol			Mean	
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l		
Control	34.10	36.00	39.10	40.66	37.47	37.20	41.09	46.30	49.44	43.51	
50 ppm	35.40	37.60	41.60	42.00	39.15	38.60	42.81	48.59	51.08	45.27	
150 ppm	37.20	39.40	43.70	44.11	41.10	40.50	44.60	50.66	53.50	47.32	
250 ppm	38.70	41.10	46.30	47.22	43.33	41.80	46.20	53.10	56.43	49.38	
350 ppm	39.40	43.70	48.80	50.56	45.62	42.60	48.25	45.75	59.45	49.01	
Mean	36.96	39.62	43.90	44.91		40.14	44.27	48.88	53.38		
LSD at 0.05 for											
A = 4.41						A = 4.66					
B = 4.84						B = 5.01					
A×B = 10.52						A×B = 12.85					

Table 5. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on No. of leaves of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season					
	Control	Actosol			Mean	Control	Actosol			Mean	
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l		
Control	4.10	4.50	4.60	5.60	4.70	6.31	7.21	8.11	10.08	7.93	
50 ppm	4.70	5.50	6.20	6.60	5.70	6.50	8.13	10.10	11.20	8.98	
150 ppm	5.50	6.30	6.80	7.40	6.50	7.42	9.09	10.50	12.08	9.77	
250 ppm	6.50	7.30	7.60	8.10	7.30	8.30	10.25	11.20	13.00	10.69	
350 ppm	7.30	7.70	8.20	8.40	7.90	9.22	10.46	12.15	13.07	11.23	
Mean	5.62	6.26	6.68	7.90		7.55	9.03	10.41	11.89		
LSD at 0.05 for											
A = 1.05						A = 1.14					
B = 1.35						B = 1.78					
A×B = 2.12						A×B = 2.89					

Table 6. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on stem diameter (cm) of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season					
	Control	Actosol			Mean	Control	Actosol			Mean	
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l		
Control	0.74	0.76	0.82	0.83	0.78	0.82	0.84	0.90	0.91	0.87	
50 ppm	0.79	0.83	0.88	0.90	0.85	0.87	0.91	0.96	0.98	0.93	
150 ppm	0.85	0.88	0.91	1.01	0.91	0.93	0.96	0.99	1.09	0.99	
250 ppm	0.89	0.93	0.95	1.07	0.91	0.97	1.01	1.03	1.15	1.04	
350 ppm	0.91	0.94	0.99	1.16	1.00	0.99	1.02	1.07	1.24	1.08	
Mean	0.83	0.86	0.91	0.99		0.92	0.95	0.99	1.07		
LSD at 0.05 for											
A = 0.08						A = 0.12					
B = 0.11						B = 0.16					
A×B = 0.29						A×B = 0.35					

Table 7. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on fresh weight of vegetative growth (g) of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season				
	Control	Actosol			Mean	Control	Actosol			Mean
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l	
Control	45.30	49.30	53.70	54.10	50.60	62.50	70.09	73.20	75.33	70.28
50 ppm	47.10	51.10	57.80	58.20	53.50	65.60	74.51	78.36	79.33	74.45
150 ppm	50.60	54.10	61.90	62.50	57.20	68.90	78.22	80.25	82.44	77.45
250 ppm	53.20	57.60	66.70	66.90	61.10	70.21	82.50	84.66	85.09	80.62
350 ppm	54.10	58.20	67.80	68.40	62.10	71.20	83.89	86.50	89.63	82.81
Mean	50.10	54.10	61.60	62.10		67.68	77.84	80.59	82.36	
LSD at 0.05 for										
A = 3.52						A = 4.02				
B = 4.22						B = 5.11				
A×B = 7.82						A×B = 8.24				

Table 8. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on dry weight of vegetative growth (g) of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season				
	Control	Actosol			Mean	Control	Actosol			Mean
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l	
Control	16.5	19.4	22.8	23.3	20.5	28.45	32.23	34.25	36.98	32.98
50 ppm	18.8	21.5	23.8	24.6	22.2	30.12	34.33	37.15	38.22	34.96
150 ppm	20.9	23.9	26.5	27.4	24.7	33.56	37.24	39.22	40.54	37.64
250 ppm	23.7	26.8	29.7	30.4	27.7	36.74	39.52	41.50	42.12	39.97
350 ppm	24.4	27.5	30.5	31.5	28.5	38.66	40.22	42.33	44.25	41.37
Mean	20.9	23.8	26.7	27.4		33.51	36.71	38.89	40.42	
LSD at 0.05 for										
A = 1.12						A = 1.50				
B = 2.42						B = 2.73				
A×B = 3.33						A×B = 4.02				

or 20 ppm significantly increased the plant height and fresh weight of leaves. BA at 10 ppm increased the leaf formation. Ahmed *et al.* (2005) on *Peperomia obtusifolia* indicated that GA₃ at 400 ppm resulted in the tallest plants with the heaviest fresh and dry weights and 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, and fresh weight of the vegetative parts. Mahmoud (2007) noticed that spraying *Chasmanthe aethiopica* with kinetin at 25, 50 or 75 ppm improved plant height and fresh and dry weight of leaves.

On the other hand, and referring to the interaction it is evident from data the prevalence of supplying plants with the highest level of actosol (3 ml/l) with receiving plants the highest level of the mixture of the different growth regulators at the level of 350 ppm. On the contrary, untreated control plants gave the least scores in both seasons.

Chemical constituents of the plant:

Pigments content in leaves:

It is evident from data registered in Tables (9-11) that pigments content (chlorophyll a, b and carotenoids) progressively increased with increasing

Table 9. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on chlorophyll a content (mg/g f.w) of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season				
	Control	Actosol			Mean	Control	Actosol			Mean
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l	
Control	0.41	0.44	0.47	0.51	0.46	0.46	0.48	0.51	0.55	0.50
50 ppm	0.43	0.48	0.50	0.55	0.49	0.49	0.53	0.55	0.59	0.54
150 ppm	0.46	0.51	0.52	0.57	0.52	0.52	0.57	0.61	0.64	0.59
250 ppm	0.50	0.53	0.56	0.59	0.55	0.55	0.59	0.63	0.66	0.61
350 ppm	0.52	0.55	0.57	0.61	0.56	0.57	0.61	0.65	0.68	0.63
Mean	0.46	0.50	0.52	0.56		0.52	0.56	0.57	0.62	
LSD at 0.05 for										
	A = 0.05					A = 0.07				
	B = 0.08					B = 0.11				
	A×B = 0.15					A×B = 0.19				

Table 10. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on chlorophyll b content (mg/g f.w) of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season				
	Control	Actosol			Mean	Control	Actosol			Mean
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l	
Control	0.19	0.22	0.25	0.28	0.24	0.22	0.26	0.29	0.30	0.27
50 ppm	0.21	0.24	0.27	0.31	0.26	0.25	0.27	0.31	0.32	0.29
150 ppm	0.26	0.27	0.29	0.34	0.29	0.28	0.30	0.34	0.37	0.32
250 ppm	0.29	0.32	0.33	0.36	0.33	0.32	0.33	0.36	0.41	0.36
350 ppm	0.31	0.34	0.36	0.38	0.35	0.35	0.37	0.39	0.44	0.39
Mean	0.25	0.28	0.30	0.33		0.28	0.31	0.34	0.37	
LSD at 0.05 for										
	A = 0.04					A = 0.06				
	B = 0.06					B = 0.09				
	A×B = 0.12					A×B = 0.17				

Table 11. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on carotenoids content (mg/g f.w) of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season				
	Control	Actosol			Mean	Control	Actosol			Mean
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l	
Control	0.39	0.46	0.48	0.50	0.46	0.48	0.51	0.62	0.70	0.58
50 ppm	0.48	0.64	0.69	0.72	0.63	0.53	0.69	0.74	0.76	0.68
150 ppm	0.51	0.68	0.75	0.73	0.67	0.56	0.70	0.78	0.83	0.72
250 ppm	0.56	0.72	0.77	0.79	0.71	0.59	0.77	0.86	0.89	0.78
350 ppm	0.59	0.76	0.80	0.85	0.75	0.71	0.80	0.92	0.98	0.85
Mean	0.51	0.65	0.70	0.72		0.57	0.69	0.78	0.83	
LSD at 0.05 for										
	A = 0.09					A = 0.13				
	B = 0.14					B = 0.20				
	A×B = 0.39					A×B = 0.46				

either actosol levels or the different growth regulators mixture which were applied in the two seasons, whereas, the untreated control plants gave the least scores of the different pigments content in both seasons.

Concerning the interaction, it is obvious from data the mastery was of receiving plants the highest actosol level (3 ml/l) with applying the highest mixture level of the different growth regulators (350 ppm) for giving the highest values of chlorophyll a, b and carotenoids in the two seasons. In contrast, the least scores of the above mentioned pigments content were a result of untreated control plants in the two seasons.

Total carbohydrates in leaves %:

Highest values were scored of total carbohydrates content in leaves due to using either the highest actosol level (3ml/l) or the highest mixture level of the different growth regulators (350 ppm). Meanwhile, the lowest values were recorded as a result of untreated control plants in both seasons as shown in Table (12).

Concerning the interaction, data exhibited in Table (12) indicated the prevalence of treating plants with the highest actosol level (3 ml/l) with applying the highest level of the different growth regulators level (350 ppm) for giving the utmost highest values of total carbohydrates% in the two seasons. In contrast the lowest means were gained due to untreated control plants in the two seasons.

Nitrogen, phosphorus and potassium %:

It is obvious from data listed in Tables (13, 14 and 15) that supplying plants with the highest level of either actosol (3 ml/l) or the mixture of the different growth regulators (350 ppm) were the best treatments used for producing the highest nitrogen, phosphorus and potassium % in leaves in both seasons.

On the other hand, the interaction showed the superiority in raising the above mentioned minerals by applying the highest level of actosol (3 ml/l) accompanied with the highest one of the mixture of the

different growth regulators (350 ppm) in both seasons. In contrast the least values (N, P and K) were obtained as a result of untreated control plants in both seasons.

The prevalence of actosol in improving chemical constituents of the plants was also recorded by a lot of scientists on various plants El-Attar (2006) found that using humic acid at 0.5 or 1.0 ml/l on *Ficus alii* cv. Green and cv. Variegata plants caused an increment in N, P content at the different parts for both cvs, and using humic acid at high level increased the total carbohydrates content. Abdel-Fattah (2009) on *Dracaena* and *Ruscus* plants added that a combination of humic acid at 5 ml/l as a foliar spray and 10 ml/l as a soil drench recorded a marked increment in leaf content of chlorophyll a, b and carotenoides, total carbohydrates, N, P and K content. Recently, Saber (2018) on *Chamaedorea elegans* tested the effect of different levels of humic acid applied as a soil drench (3 and 6 ml/l) and concluded that the treatments significantly increased all the chemical composition as compared with control plants.

With respect to the effect of growth regulators on chemical constituents of the plant as influenced by the different levels of the growth regulators used in the current study, many scientists ascertained the improving effect on various plants. Farid *et al.* (1999) stated that total carbohydrates, chlorophyll a, b contents as well as N, P and K percentage were increased due to the application of kinetin. Farahat *et al.* (2002) on fennel found that BA at 50 or 100 ppm significantly increased chlorophyll and total carbohydrates content. Abdel-Wahid and Manoly (2003) mentioned that GA3 at 100 ppm increased 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. Hussein (2004) found that supplying Iris plants with BA at 10 or 20 ppm significantly increased total carbohydrates and N% in the leaves. Eissa (2007) found that spraying *Pelargonium zonal* with BA at

Table 12. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on total carbohydrates % of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season				
	Control	Actosol			Mean	Control	Actosol			Mean
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l	
Control	29.32	29.89	30.22	31.58	30.25	31.50	31.90	33.10	34.02	32.63
50 ppm	30.08	30.85	31.12	32.55	31.15	32.87	34.62	36.57	38.25	35.58
150 ppm	31.22	32.58	33.36	34.12	32.82	34.54	36.21	37.55	38.11	36.60
250 ppm	32.30	33.12	34.70	35.09	33.80	36.25	38.21	38.85	40.22	38.38
350 ppm	33.65	34.25	35.52	37.55	35.24	38.45	38.62	40.85	41.65	39.89
Mean	31.31	32.14	32.98	34.18		34.72	35.91	37.38	38.45	
LSD at 0.05 for										
	A = 1.59					A = 1.88				
	B = 2.67					B = 2.89				
	A×B = 3.22					A×B = 4.07				

Table 13. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on nitrogen % of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season				
	Control	Actosol			Mean	Control	Actosol			Mean
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l	
Control	2.21	2.33	2.47	2.61	2.41	2.82	3.16	3.25	3.47	3.18
50 ppm	2.66	2.75	2.98	3.11	2.88	3.42	3.58	3.79	4.05	3.71
150 ppm	2.78	2.90	3.10	3.25	3.01	3.55	3.72	3.95	4.25	3.87
250 ppm	2.81	3.05	3.21	3.29	3.09	3.64	3.85	4.19	4.40	4.02
350 ppm	2.88	3.22	3.33	3.42	3.21	3.69	4.22	4.39	4.75	4.26
Mean	2.67	2.85	3.02	3.14		3.42	3.71	3.91	4.18	
LSD at 0.05 for										
	A = 0.35					A = 0.48				
	B = 0.56					B = 0.76				
	A×B = 1.09					A×B = 1.23				

Table 14. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on phosphorus % of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season				
	Control	Actosol			Mean	Control	Actosol			Mean
		1 ml/l	2 ml/l	3 ml/l			1 ml/l	2 ml/l	3 ml/l	
Control	0.22	0.24	0.29	0.31	0.27	0.30	0.37	0.42	0.45	0.39
50 ppm	0.28	0.31	0.37	0.39	0.34	0.36	0.40	0.46	0.48	0.43
150 ppm	0.30	0.35	0.41	0.44	0.38	0.39	0.44	0.50	0.52	0.46
250 ppm	0.33	0.38	0.45	0.49	0.41	0.41	0.47	0.53	0.58	0.50
350 ppm	0.35	0.40	0.47	0.51	0.43	0.46	0.52	0.56	0.60	0.54
Mean	0.30	0.34	0.40	0.43		0.29	0.44	0.49	0.53	
LSD at 0.05 for										
	A = 0.09					A = 0.12				
	B = 0.14					B = 0.18				
	A×B = 0.21					A×B = 0.49				

Table 15. Effect of actosol (humic acid) and the mixture of different growth regulators (GA₃, BA and NAA) on potassium % of *Chamaedorea seifrizii* during the two seasons (2017/2018 and 2018/2019).

Growth regulators	1 st season					2 nd season				
	Actosol				Mean	Actosol				Mean
	Control	1 ml/l	2 ml/l	3 ml/l		Control	1 ml/l	2 ml/l	3 ml/l	
Control	1.11	1.20	1.39	1.42	1.28	1.35	1.44	1.50	1.52	1.45
50 ppm	1.30	1.52	1.60	1.67	1.52	1.48	1.78	1.80	1.88	1.74
150 ppm	1.48	1.64	1.69	1.71	1.63	1.60	1.87	1.90	2.02	1.85
250 ppm	1.52	1.72	1.77	1.81	1.71	1.83	2.06	2.10	2.48	2.12
350 ppm	1.61	1.78	1.80	1.97	1.79	1.93	2.15	2.27	2.78	2.28
Mean	1.40	1.57	1.65	1.72		1.64	1.86	1.91	2.14	
LSD at 0.05 for										
A = 0.20						A = 0.31				
B = 0.38						B = 0.47				
A×B = 0.68						A×B = 0.98				

10 or 20 ppm increased chlorophyll b, total chlorophyll and total sugars content in the leaves.

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إستخدام الأكتوسول (حمض هيوميك) و بعض منظمات النمو على تحسين جودة نبات الشمدوريا *Chamaedorea seifrizii*, Burret

عمر نبيل كمال إمام

كلية الزراعة، جامعة بني سيف، بني سويف، مصر

تم تنفيذ التجربة خلال موسمين زراعيين متتاليين (٢٠١٧/٢٠١٨، ٢٠١٨/٢٠١٩) بمشتمل معهد بحوث البساتين، مركز البحوث الزراعية، جيزة، مصر. وذلك بهدف حل مشكلة من أهم المشاكل التي تواجه إنتاج نبات ال-*Chamaedorea seifrizii* تحت الظروف المصرية من حيث بطء معدل النمو خاصة في المراحل الأولية من نمو النبات بالإضافة إلى العمل على تحسين جودة النباتات، و على هذا الاعتبار تمت دراسة تأثير تركيزات مختلفة من الأكتوسول (حمض الهيوميك) كسماد عضوي كعامل رئيسي بتركيزات صفر، ١، ٢، ٣ مل/لتر متداخلة مع العوامل الفرعية المتمثلة في خليط من بعض الهرمونات (حمض الجبرليك و البنزلي أدنين و نفاثلين حمض الخليك) بتركيزات صفر، ٥٠، ١٥٠، ٢٥٠، ٣٥٠ جزء في المليون و تمت زراعة الشتلات ذات ثلاثة أوراق بطول ٩-١٠ سم في بيئة مخلوط الرمل/طين (١:١، حجما) في أول نوفمبر في كلا الموسمين و قد تمت معاملة النباتات بالأكتوسول كمحلول سمادي يضاف للتربة بينما تم إستخدام خليط منظمات النمو عن طريق الرش و قد تمت معاملة النباتات على فترات شهريا بداية من أول فبراير و ذلك حتى نهاية التجربة (أول ديسمبر) و بذلك تمت معاملة النباتات سواء بالمحلول السمادي أو بخلط منظمات النمو إحدى عشر مرة خلال تلك الفترة في كلا الموسمين. و قد أوضحت النتائج التأثير المفيد لإستخدام التركيزات العالية من الأكتوسول (٢، ٣ مل/لتر) في تحسين طول الجذور و كذلك وزنها الطازج و الجاف و ذلك بالمقارنة بمعاملة الكنترول الغير معاملة، في كلا الموسمين. و في نفس الوقت أدى أستخدام نفس التركيزات من الأكتوسول (٢، ٣ مل/لتر) إلى الحصول على أعلى القيم بالنسبة لجميع الصفات الخضرية المتحصل عليها من النبات متمثلة في ارتفاع النبات، عدد الأوراق/نبات، سمك الساق و كذلك الوزن الرطب و الجاف للنمو الخضري. تأثر كذلك المحتوى الكيماوي للنمو الخضري كنتيجة لمعاملة النباتات بالأكتوسول حيث تم الحصول على زيادة في محتوى الصبغات (كلوروفيل أ، ب و الكاروتينيدات، و النسبة المئوية من الكربوهيدرات الكلية) و العناصر المعدنية (النيتروجين، الفوسفور، البوتاسيوم) خاصة مع التركيزات العالية من المحلول السمادي. و بالنسبة إلى تأثير مخلوط منظمات النمو بمستوياته المختلفة على خصائص الجذور و النمو الخضري و المحتوى الكيماوي للنبات يبدو واضحا من النتائج المدونة بالجداول التأثير المفيد لمخلوط تلك المنظمات لتحسين تلك الخصائص خاصة مع إستخدام التركيز العالي (٣٥٠ جزء في المليون) في كلا الموسمين. من النتائج السابقة و التفاعلات يمكن النصح بإمداد النباتات بالمستوى العالي من كل من الأكتوسول (٣ مل/لتر) و مخلوط منظمات النمو (٣٥٠ جزء في المليون) بعد ثلاثة شهور من الزراعة و على فترات شهرية لمدة إحدى عشر شهراً خلال موسم النمو من أجل إنتاج نباتات *Chamaedorea seifrizii* جيدة الصفات مع حل مشكلة بطء النمو تحت الظروف المصرية.