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EFFECT OF NATURAL ACTIVATOR (BIOHORM) AND HUMIC ACID ON GROWTH AND QUALITY OF CYCAS PLANT

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ABSTRACT: This investigation was conducted under open field conditions at the Experimental Farm of Hort. Res. Inst., ARC, Giza, Egypt during 2014 and 2015 seasons to find out the response of two-years-old cycas plant (*Cycas revoluta*, Thunb.) grown in 20-cm diameter plastic pots filled with about 2.5 kg of a mixture of sand, clay and peatmoss (1:1:1, v:v:v) to natural activator viz. BioHorm at 1 and 3 ml/l and commercial humic acid liquid fertilizer (high K humic acid) at the rate of 5 ml/l (as a foliar spray 6 times with one month interval) and their interactions.

The results showed that all vegetative and root growth parameters, were significantly improved over control in response to either single or combined treatments applied in this study, but the best individual treatments were humic acid at 5 ml/l followed by BioHorm at 3 ml/l. The best improvement was obtained when combining BioHorm at 3m/l + humic acid at 5 ml/l which gave high means of vegetative and root growth parameters at all in the two seasons. A similar trend was also observed as well regarding the content of chlorophyll a, b, carotenoids, N, P, K, total carbohydrates % and total indoles in the leaves, but the phenols content was decreased in all treatments.

Hence, it is recommended to spray the cycas plants with combination of BioHorm at 3 ml/l + 5 ml/l humic acid to score the best growth performance and highest quality.

Key words: *Cycas revoluta* Thunb., natural activator, humic acid, vegetative growth, root growth.

INTRODUCTION

Cycas revoluta, Thunb. (Fam. Cycadaceae), Sage palm is a graceful palm-like tree or shrub, becoming 6-10 feet high, with the trunk simple or branching. Leaves long and recurved (2-7 feet), pinnae numerous, subopposite curved downward, narrow, stiff, acute, terminating in a spine-like tip, dark shining green. This is the most common cycas in conservatories, Javanese origin, it is usually found in all of the better parks and gardens, it is suitable as a center about which to arrange other ornamental shrubs, this species are of slow growth. (Bailey, 1950).

Several reports were suggested to restore the natural biological balance which is disturbed by the misuse of chemical fertilizers, besides improving growth and keeping quality of the plants. In this regard, El-Sayed (2012) on seashore paspalum reported that combining between humic acid at 20 ml/l and Oligo-X (an algae extract) at 1.5 ml/l level gave the tallest plants, best coverage, more number of plants/pot, heaviest fresh and dry weights as well as the

highest content of pigments in the leaves and of total soluble sugars, indoles and phenols in the herb. In another study, El-Sayed *et al*. (2015) recommended to spray verdure of seashore paspalum turf with combination of SBG (3 ml/l) + Ascobien (9 g/l) + BioHorm (1 ml/l) during the growth stage to score the best growth performance and highest quality.

Humic acid and humates are being used widely now for enhancing growth and quality of most crops, as they provide soil microbs with energy, improve nutrients relation in the soil and increase the water holding capacity (Dorer and Peacock, 1997). Evans and Li (2003) revealed that humic acid at 2500 ppm increased lateral root number and length as well as roots dry weight of *Cathranthus roseus*, *Pelargonium hortorum*, *Tagetes patula* and *Viola tricolor*. El-Sherbeny *et al.* (2012) declared that the highest growth parameters or biomass represented by leaves and roots of turnip plant were obtained with NPK or humic acid, but it can be recommended to use humic acid as an organic fertilizer to produce organic products. Also, humic acid increased carbohydrates, minerals, total lipids and fatty acids contents, El-Fouly *et al.* (2014) on cordylin plant, found that spray the foliage of one-year-old transplants of *Cordaline terminalis*, every month with citreen and humic acid at 5 ml/l gave the best performance and highest quality.

This work, however aims to study the role of natural activators and commercial humic acid liquid fertilizer (high K humic acid) and the interactions between them on improving growth and quality of cycas plants under our local climatic conditions.

MATERIALS AND METHODS

The current investigation was performed under the open field conditions at the Experimental Farm of Hort. Res. Inst., ARC, Giza, Egypt throughout the two consecutive seasons of 2014 and 2015 to study the effect of some natural activators on growth and chemical composition of cycas plants.

Therefore, 2-years-old plants of *Cycas revoluta*, Thunb. of about 35-40 cm height with 2-3 leaves were planted on March, 15th for the two seasons in 20-cm-diameter plastic pots filled with about 2.5 kg sand + clay + peat at (1:1:1, v:v:v). The physical and chemical properties of the used sand + clay are shown in Table (1), while those of the used peatmoss are averaged in Table (2).

After 15 days from planting (on April, 1st), the transplants received the following fertilization treatments:

1- No fertilization (referred to as control).

2- A commercial humic acid liquid organic fertilizer (high K humic acid) was applied as foliar spray at the rate of 5 ml/l till the solution was run off.

3- BioHorme at the rate of 1 ml/l (natural enzymatic activator that contains cytokinin, riboflavin, niacin, thiamin as well as citric, L. ascorbic and volvic acids + L-free amino acids (20%) + Mo (4%) + Co (0.005%).

4- BioHorme at the rate of 3 ml/l.

5- The previous treatments were combined to give the following 2 combinations:

   a. Humic acid at 5 ml/l + BioHorm at 1 ml/l.

   b. Humic acid at 5 ml/l + BioHorm at 3 ml/l.

The pots were arranged in a completely randomized design (Mead *et al.,* 1993), with 3 replicates for each treatment as each replicate contained 3 pots.

At the end of each season, data were recorded as follows: plant height (cm), number of leaves and leavlets/plant, stem diameter at the base (cm), number of roots, root length (cm), as well as leaves, stem and roots fresh and dry weights (g). In fresh leaf samples, photosynthetic pigments (chlorophyll a, b and carotenoids (mg/g f.w.) were determined according to the method described by Moran (1982). However, in dry

Table 1. 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^{--}
Clayey	7.46	16.75	34.53	40.89	41.76	2.18	8.33	16.93	9.33	20.44	0.37	3.82	1.46	41.79
Sandy	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 2. Physical and chemical analysis of the used peatmoss in the two seasons.

Organic matter	90-95%	**N**	1.09 %
Ash	5-10%	**P**	0.23%
Density (Vol. dry)	80-90 mg/l.	**K**	1.77 %
pH value	3.4	**Fe**	421 ppm
Water relation capacity	60-75%	**Mn**	27 ppm
Salinity	0.3 g/l	**Zn**	41 ppm

samples, the content of total carbohydrates (Herbert *et al.,* 1971), nitrogen using micro-Kjeldahle method (Jackson, 1973), phosphorus colorimetrically as recommended by Cottenie *et al.* (1982) and potassium using flame-photometer (Jackson, 1973), all of them as percentage were measured. Total indoles and total phenols (mg/100 g f.w.) were measured according to the method of Saric *et al.* (1967), A.O.A.C. (1990) and William *et al.* (1965).

Data were then tabulated and subjected to analysis of variance using SAS Institute program (1994), following Duncan's Multiple Range Test (Duncan, 1955) to detect the significancy among means of the various treatments.

RESULTS AND DISCUSSION

Effect of fertilization treatments on:

1. Vegetative growth parameters:

Data presented in Tables (3 and 4) cleared that all vegetative growth parameters were improved with all treatments applied in this study, expressed as plant height (cm), Number of leaves/plant, stem diameter, number of roots and root length (cm), as well as fresh and dry weight of leaves, stem and roots (g). However, the dominance in both seasons was for the interaction treatment between BioHorm 3 ml/l and humic acid at 5 ml/l, as such combination increased the means of all previous parameters to the highest values comparing with control and other individual treatments in the two seasons. Humic acid alone at 5 ml/l or combined with BioHorm at 3 ml/l improved all parameters. In this concern, humic acid at 5 ml/l + BioHorm at 3 ml gave the highest values of fresh and dry weights of leaves, stem and roots in the first and second seasons except for humic acid alone at 5 ml/l which resulted the highest significant value of stem dry weight in the first season only.

Improvement of vegetative and root growth due to treating with humic acid, it attributed to that improves nutrients relation in the media and increasing the water holding capacity (Dorer and Peacock, 1997) and also, BioHorm is a natural enzymatic activators supplying the plants with vitamins and amino acids which directly influence the physiological activities in plant growth and development (Datir *et al.*, 2012). Also, El-Sayed *et al.* (2015) showed that adding the

Table 3. Effect of fertilization treatments on some vegetative and root growth of *Cycas revoluta* Thunb. plants during 2014 and 2015 seasons.

Fertilization treatments	Plant height (cm)	No. leaves/ plant	Stem diameter (cm)	No. roots/ plant	Root length (cm)
			First season: 2014		
Control	40.20 e	2.33 c	4.50 c	3.67 c	19.67 c
Humic acid at 5 ml/l (A)	55.00 bc	3.00 abc	5.50 b	5.67 b	24.00 c
BioHorm at 1 ml/l (B)	42.67 de	2.67 bc	5.00 bc	6.00 b	22.33 c
BioHorm at 3 ml/l (C)	50.00 cd	3.00 abc	5.30 b	7.00 ab	23.67 c
A + B	63.67 ab	3.33 ab	6.17 a	7.67 a	36.00 b
A + C	67.00 a	3.67 a	6.47 a	8.33 a	47.00 a
			Second season: 2015		
Control	43.00 e	2.33 b	4.85 b	3.93 c	21.00 c
Humic acid at 5 ml/l (A)	57.83 bc	3.33 ab	7.00 a	6.03 b	25.60 c
BioHorm at 1 ml/l (B)	46.17 de	3.33 ab	5.48 ab	6.52 b	23.86 c
BioHorm at 3 ml/l (C)	54.67 cd	3.33 ab	5.88 ab	7.61 ab	25.78 c
A + B	67.00 ab	3.33 ab	6.56 a	8.42 a	39.09 b
A + C	71.00 a	3.67 a	7.05 a	8.92 a	51.70 a

*** Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test at 5% level.**

Table 4. Effect of fertilization treatments on fresh and dry weights of *Cycas revoluta* Thunb. plants during 2014 and 2015 seasons.

Fertilization treatments	Fresh weight (g)			Dry weight (g)		
	Leaves	Stem	Roots	Leaves	Stem	Roots
			First season: 2014			
Control	40.49 f	49.25 f	37.50 e	18.20 c	19.62 f	18.00 d
Humic acid at 5 ml/l (A)	53.01 c	60.00 c	39.60 c	19.20 b	39.99 a	18.99 c
BioHorm at 1 ml/l (B)	44.22 e	55.10 e	37.99 de	18.17 c	24.25 e	18.63 cd
BioHorm at 3 ml/l (C)	47.98 d	58.34 d	38.90 cd	19.76 b	26.34 d	18.45 cd
A + B	55.62 b	63.42 b	45.29 b	23.99 a	31.22 c	24.23 b
A + C	59.24 a	77.22 a	49.01 a	24.33 a	35.33 b	25.99 a
			Second season: 2015			
Control	37.22 e	39.21 d	30.20 d	20.01 c	21.48 f	19.83 c
Humic acid at 5 ml/l (A)	54.11 c	59.99 b	51.22 bc	20.55 bc	39.13 b	20.67 c
BioHorm at 1 ml/l (B)	43.22 d	53.11 c	49.21 c	19.69 c	26.40 e	20.04 c
BioHorm at 3 ml/l (C)	45.35 d	55.00 c	50.00 bc	21.54 b	28.65 d	20.00 c
A + B	57.27 b	60.21 b	53.00 ab	26.40 a	34.05 c	26.16 b
A + C	60.72 a	73.50 a	55.02 a	26.76 a	43.23 a	27.98 a

*** Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test at 5% level.**

natural activators during the growth stage gave the best performance and highest quality of seashore paspalum turf.

2. Chemical composition:

Data averaged in Table (5) indicated that there was a significant effect of different treatments on pigments content (chlorophyll a, b and carotenoids) in the leaves (mg/g f.w.) as treated plants with humic acid at 5 ml/l individualy or in combination with BioHorm at 1 and 3 ml/l increased the leaf content of chlorophyll a, b and carotenoids (mg/g f.w.) over control means in the two seasons, with the dominance of humic acid at 5 ml/l + BioHorm at 3 ml/l.

With regard to total indoles content (mg/100 g f.w.), as it was significantly increased in response to the different treatments employed in this work with the humic acid alone at 5 ml/l individually or added to BioHorm at 3ml/l in the two seasons. The opposite was the right concerning the content of total phenols which was slightly decreased in the two seasons by the individual and combination between humic acid at 5 ml/l + 3 ml/l BioHorm.

As shown in Table (6) it is clear that the percentages of N, P and K and total carbohydrates in the leaves were markedly increased as a result to spraying with humic acid at 5 ml/l + BioHorm at 3 ml/l which registered the highest values at all. This may indicate the effect of both humic acid and the natural activator "BioHorm".

These results are supported by El-Sayed *et al.* (2015) on paspalum turf. Kenneth (1979) reported that the total of plant growth is used not a single hormonal type that of auxin, cytokinins, gibberllins and ethylene, and this further is subjected to modification by certain naturally occurring inhibitors namely phenols, flavonols and absicsic acid, which have been known to modify the activity of IAA-oxidase and might therefore be acting on growth and production by way of changes in endogenous auxin level. In addition, cytokinin has the ability to prevent the emanation of some positive inhibitory influences from the leaves under non-inductive conditions (Audus, 1972).

From the aforementioned results, it could be recommended to spray the 2 years-old plants of *Cycas revoluta*, Thunb. cultivated in 20-cm-diameter plastic pots filled with about 2.5 kg of sand:clay:peatmoss mixture (1:1:1, v:v:v) with humic acid at 5 ml/l + 3 ml/l BioHorm for obtaining healthy growth and high quality plants.

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Table 5. Effect of fertilization treatments on some chemical constituents of *Cycas revoluta* Thunb. leaves during 2014 and 2015 seasons.

Fertilization treatments	Photosynthetic pigments (mg/g f.w.)			Total indoles (mg/100 g f.w.)	Total phenols (mg/100 g f.w.)
	Chl. a	Chl. b	Carotenoids		
			First season: 2014		
Control	0.401 e	0.136 f	0.210 e	0.431 e	0.051 a
Humic acid at 5 ml/l (A)	0.901 c	0.331 c	0.494 c	0.514 c	0.021 c
BioHorm at 1 ml/l (B)	0.634 d	0.159 e	0.332 d	0.483 d	0.042 b
BioHorm at 3 ml/l (C)	0.898 c	0.172 d	0.339 d	0.499 cd	0.023 c
A + B	1.439 b	0.371 b	0.541 b	0.675 b	0.012 d
A + C	1.601 a	0.542 a	0.579 a	0.794 a	0.010 d
			Second season: 2015		
Control	0.420 d	0.139 f	0.209 f	0.498 c	0.051 a
Humic acid at 5 ml/l (A)	0.901 b	0.345 c	0.432 c	0.547 b	0.036 c
BioHorm at 1 ml/l (B)	0.633 c	0.162 e	0.330 e	0.490 c	0.045 b
BioHorm at 3 ml/l (C)	0.897 b	0.183 d	0.339 d	0.499 c	0.031 d
A + B	1.581 a	0.362 b	0.499 b	0.549 b	0.030 d
A + C	1.603 a	0.548 a	0.521 a	0.699 a	0.011 e

*** Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test at 5% level.**

Table 6. Effect of fertilization treatments on N, P, K and total carbohydrates of *Cycas revoluta* Thunb. leaves during 2014 and 2015 seasons.

Fertilization treatments	N (%)	P (%)	K (%)	Total carbohydrates (%)
		First season: 2014		
Control	1.990 d	0.113 f	0.806 e	16.38 e
Humic acid at 5 ml/l	2.212 b	0.126 e	0.921 d	17.11 d
BioHorm at 1 ml/l	2.000 d	0.154 d	1.111 bc	17.99 c
BioHorm at 3 ml/l	2.120 c	0.201 c	1.109 c	18.00 c
A + B	2.300 a	0.215 b	1.129 b	18.99 b
A + C	2.310 a	0.321 a	1.530 a	20.00 a
		Second season: 2015		
Control	1.480 d	0.102 e	0.702 f	15.99 e
Humic acid at 5 ml/l	2.200 b	0.109 e	0.821 e	16.32 d
BioHorm at 1 ml/l	1.950 c	0.140 d	0.999 d	17.21 c
BioHorm at 3 ml/l	1.970 c	0.190 c	1.101 c	17.99 b
A + B	2.160 b	0.199 b	1.132 b	18.22 b
A + C	2.390 a	0.219 a	1.321 a	19.99 a

*** Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test at 5% level.**

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تأثير المنشط الطبيعي (بيوهورم) وحمض الهيوميك على نمو وجودة نباتات السيكاس

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أجريت هذه الدراسة بالمزرعة التجريبية لمعهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر خلال موسمي ٢٠١٤ و ٢٠١٥ لدراسة تأثير الرش بالمنشط الطبيعي (بيوهورم) بمعدل ١ و ٣ مل/لتر والسماد التجاري السائل لحمض الهيوميك عالي البوتاسيوم بتركيز ٥ مل/لتر على نمو وجودة شتلات السيكاس عمر سنتان المنزرعة في أصص بلاستيك قطرها ٢٠ سم ومملوءة بحوالي ٢,٥ كجم من مخلوط الرمل + الطين + البيتموس (بنسبة ١:١:١، حجماً).
أوضحت النتائج المتحصل عليها أن جميع قياسات النمو الخضري والجذري قد تحسنت معنوياً باستخدام مختلف المعاملات الفردية والمشتركة بالمقارنة بالكنترول في كلا الموسمين. وكانت أفضل المعاملات الفردية الرش بحمض الهيوميك عالي البوتاسيوم بمعدل ٥ مل/لتر تلتها المعاملة بالمنشط الطبيعي البيوهورم بمعدل ٣ مل/لتر كما أدى التداخل بين المعاملة بالهيوميك والبيوهورم الى احداث تحسن في جميع قياسات الصفات الخضرية وخاصة عند المعاملة بحمض

الهيوميك عالي البوتاسيوم بمعدل ٥ مل/لتر + المنشط الطبيعي بيوهورم بمعدل ٣ مل/لتر التي أعطت أعلى متوسطات للنمو الخضري على الاطلاق. كما أن محتوى الأوراق من كلوروفيللي أ، ب، الكاروتينويدات والأندولات مع زيادة النسبة المئوية للعناصر الثلاثة النيتروجين، الفوسفور والبوتاسيوم وكذلك النسبة المئوية للكربوهيدرات الكلية، في حين أنها أعطت أقل القيم بالنسبة للفينولات.

وبناء على ذلك يمكن التوصية برش نباتات السيكاس عمر سنتان بحمض الهيوميك عالي البوتاسيوم بمعدل ٥ مل/لتر + المنشط الطبيعي بيوهورم بمعدل ٣ مل/لتر خلال موسم النمو النشط للحصول على أعلى جودة ونمو لنبات السيكاس.