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EFFECT OF NPK AND GIBBERELLIC ACID ON GROWTH AND QUALITY OF *CYCAS REVOLUTA"*THUNB."

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ABSTRACT: A series of pot experiments was consummated in open field at the nursery of Hort. Res. Inst., Giza, Egypt during 2014 and 2015 seasons to find out the effect of NPK at 2 g/pot, gibberellic acid at 500, and 1000 ppm concentrations (as a foliar spray 6 times with one month interval) and their interaction on vegetative and root growth and chemical composition of 1-year-old *Cycas revoluta*, Thunb. plants grown in 20-cm-diameter plastic pots filled with about 2.5 kg of a mixture of washed sand, and compost (3:1, v/v).

The obtained results indicated that all fertilization treatments significantly improved all vegetative and root growth traits of plants used in this study compared to control, especially the combined treatment between NPK at 2 g/pot and gibberellic acid at 1000 ppm as well as, the leaves content of chlorophylls a and b, carotenoids and total carbohydrates, N, P and K% which were significantly increased in response to the different treatments employed in the present study, with the superiority of the combination between NPK at 2 g/pot and GA_3 at 1000 ppm. The least record, on the other hand, was found due to NPK at 5 g/l alone. A similar trend was also obtained concerning the contents of chlorophyll a, b, carotenoids, N, P and K%.

Hence, in order to get the best vegetative and root growth it is recommended to treat the plants with NPK at 2 g/pot per 20-cm-diameter plastic pot plus spraying the foliage to run-off with 1000 ppm of GA_3 solution 4 times with 1 month interval.

Key words: *Cycas revoluta* Thunb.; gibberellic acid; NPK; vegetative and root growth; chemical composition.

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 is of slow growth. (Bailey, 1950).

Many workers proved that the good nutrition with any type of fertilizers usually improves growth and quality of various plants. This truth was emphasized by Abdel-Fattah *et al.* (2009) who revealed that the combination of Fe + Zn + Mn at 240 + 120 + 120 ppm and active dry yeast at 8g/l significantly enhanced vegetative and root growth of Schefflera transplants, as well as leaf content of chlorophylls a and b, carotenoids, N, P, K, Fe, Zn and Mn. Abdel-Wahid *et al.* (2006) observed that using yeast

twice at 4 g/l + 6 g NPK/plant significantly increased height, fresh and dry weights of shoots and N% in roots of *Euonymus japonicus* plant, while yeast alone led to an increment in number of branches, stem diameter, root length, fresh and dry weights of roots, carotenoids content in the leaves and K% in the roots. On the same line, were those results of Desouky (2004) on *Strelitzia reginae,* Broschat (2006) and El-Sayed *et al.* (2010 a) on Spathiphyllum and El-Sayed *et al.* (2010 b) on *Vinca rosea* cv. Major.

However, GA_3 at 200 ppm increased P% and 400 ppm caused the highest K%. The greatest amount of chlorophyll a was determined in the leaves of plants treated with GA_3 at 400 ppm, while the plants which received 100 ppm of both PP-333 and GA_3 had the greatest percentage of total carbohydrates. In addition, El-Salami and Makary (1997) noticed that treatment of *Cupressus sempervirens* seedlings with GA_3 at the concentration of 200 ppm increased plant height, number of branches and fresh and dry weights of aerial parts and roots. Likely, Abdel-Wahid (1999) concluded that GA_3 at the rate of 500 ppm increased plant height and branch number of *Ficus benjamina* plant. Auda *et al.* (2002) elucidated that soaking tuberose bulbs before planting in 200 ppm of GA_3 resulted the best vegetative growth and flowering parameters. On the same line, were those results of Saadawy *et al*. (2003) on *Rosa hybrida* cv. Mercedes, Gomaa (2003) on *Dahlia pinnata,* Eliwa (2003) on *Cupressus macrocarpa* and Agina *et al.* (2005) on *Bougainvillea glabra, Cordyline terminailis, Ficus microcarpa* Hawaii and *Jasminum sambac.*

However, the current work aims to detect the beneficial effect of NPK at 2g/pot and GA_3 application, as well as, their interaction on growth and chemical constituents of *Cycas revoluta* plant.

MATERIALS AND METHODS

A series of pot experiments was carried out under open field at the nursery of Hort. Res. Inst., Giza, ARC, Egypt during the two successive seasons of 2014 and 2015 to study the response of Cycas plants to treatments with NPK and different levels of GA_3 and their interaction, to determine the most effective treatment for healthy growth and high quality

One-year-old plants of Cycas (8-10 cm long with 3-5 leaves) were cultured on March, 1st in both seasons in 20-cm-diameter plastic pots filled with about 2.5 kg of a mixture of washed sand, and compost 25% (3:1, v/v). The physical and chemical analysis of the used sand is shown in Table (1), but properties of the used compost are shown in Table (2). After one month, the plants received the following treatments:

Table 1. The physical and chemical analysis of sand during 2013 and 2014 seasons.

Soil texture	Seasons	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^{--}
Sandy	**2014**	89.03	2.05	0.40	8.52	23.00	3.72	7.92	7.50	1.63	33.60	0.50	3.20	22.00	18.03
	2015	90.10	1.95	0.50	7.45	22.86	3.74	7.80	19.42	8.33	7.20	0.75	1.60	7.00	27.10

Table 2. The physical and chemical analysis of the used compost.

Weight of dry (m^3)	590 kg/m^3	**Organic matter**	58%
Weight of wet (m^3)	730 kg/m^3	**P**	0.60%
Humidity	24%	**K**	0.79%
pH	6.6	**Fe**	630 ppm
E.C.	1.6 ds/m	**Mn**	157 ppm
Total Nitrogen	1.4 %	**Cu**	30 ppm
Amonium nitrogen	5.5 ppm	**Zn**	40 ppm
Nitrate nitrogen	315 ppm		

1- No treatment, referred to as control.

2- NPK (2:1:1) at 2 g/pot. Ammonium sulphate (20.5% N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48.5% K_2O) fertilizers were used to obtain the required ratio.

3- Gibberellic acid in the form of berelex tablets manufactured by ICI Co., England, as each tablet contains 1 g of gibberellin (92% GA_3), and was sprayed on the foliage six times with four weeks interval to run-off at the concentrations of 500 and 1000 ppm. Moreover, each level of GA_3 was combined with the dose of NPK at 2 g/pot form two combined treatment.

The layout of the experiment in the two seasons was a complete randomized design (Mead *et al*.,1993) with three replicates, as each replicate consisted of five plants. All plants under various treatments received the usual agricultural practices recommended for such plantation whenever required.

Data were taken at the end of each season (September, 30th) as follows: Plant height (cm), number of the leaves/plant, stem diameter (cm), number of roots, root length (cm), as well as, fresh and dry weights of leaves, stems and roots (g). However, in fresh leaf samples taken from the middle part of the plants, photosynthetic pigments (chlorophyll a, b and carotenoids, mg/g f.w.) were determined according to Moran (1982). However, in dry 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 statistically analyzed according to SAS program (1994) using Duncan's Multiple Range Test (Duncan, 1955) to compare among means of the different treatments.

RESULTS AND DISCUSSION

Effect of NPK and gibberellic acid on vegetative and root growth and chemical composition of Cycas plant on:

1. Vegetative and root growth:

It is obvious from data in Tables (3 and 4) that all fertilization treatments employed in this work caused a marked increment in plant height (cm), stem diameter (cm), number of leaves/plant and fresh and dry weights of leaves, stem and roots (g) with various significant differences in comparison to control treatment in the two seasons, especially the combined treatment between 2 g/pot NPK and gibberellic acid at 1000 ppm which recorded the utmost high means in both seasons. However, the superiority in the two seasons was due to the interaction treatment between fertilization with 2 g/pot NPK and GA_3 at 1000 ppm. These results are in harmony with those detected by Wazir *et al.* (2004), Cardoso and Rameriz (2006), El-Sayed and El-Shal (2008) and Abdel-Fattah *et al.* (2008) on Schefflera, Abdel-Wahed *et al.* (2006) on *Euonymus japonicus* and El-Sayed *et al*. (2010 a) on Spathiphyllum.

2. Chemical composition:

As shown in Tables (5 and 6), it is clear that the content of chlorophyll a, b, carotenoids (mg/g f.w.), total indoles as well as the percentages of N, P, K and total carbohydrates in the leaves were markedly increased as a result of treating with either fertilization treatments used in such trial. Combining treatment between NPK (at 2 g/l) and GA_3 at 1000 ppm registered the highest values at all, except for total phenols. This may indicate the synergistic effect of both NPK and GA_3 to lump their benefits for supplying the plants luxuriously with some nutrients and vital components that accelerate biosynthesis rate and lead finally to accumulation of more constituents in plant organs. On the same line, were those results

Table 3. Effect of NPK and GA_3 on some vegetative and root growth traits of *Cycas revoluta* Thunb. plants during 2014 and 2015 seasons.

Treatments	Plant height (cm)	Stem diameter (cm)	No. leaves/ plant	Root length (cm)	No. roots/ plant
			First season: 2014		
Control	15.57 c	1.43 c	2.67 b	25.67 c	1.33 d
NPK 2 g/pot	19.50 bc	1.87 b	3.00 b	29.67 b	2.00 d
GA_3 at 500 ppm (A)	17.00 c	1.90 b	3.33 ab	30.50 b	2.33 cd
GA_3 at 1000 ppm (B)	21.83 ab	2.23 b	3.33 ab	30.50 b	3.67 bc
NPK 2 g/pot + A	23.33 ab	3.00 a	4.00 a	32.00 b	4.00 ab
NPK 2 g/pot + B	25.63 a	3.30 a	4.00 a	35.50 a	5.33 a
			Second season: 2015		
Control	17.28 d	1.56 c	3.00 b	28.04 c	1.67 c
NPK 2 g/pot	20.86 cd	2.04 b	3.33 b	32.17 b	2.33 c
GA_3 at 500 ppm (A)	18.71 d	2.10 b	3.63 ab	33.75 b	2.55 c
GA_3 at 1000 ppm (B)	23.66 bc	2.40 b	3.65 ab	33.23 b	4.00 b
NPK 2 g/pot + A	24.94 ab	3.31 a	4.33 a	35.29 ab	4.34 b
NPK 2 g/pot + B	27.49 a	3.51 a	4.29 a	37.99 a	5.78 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 NPK and GA_3 on fresh and dry weights of *Cycas revoluta* Thunb. plants during 2014 and 2015 seasons.

Treatments	Fresh weight (g)			Dry weight (g)		
	Leaves	Stem	Roots	Leaves	Stem	Roots
			First season: 2014			
Control	21.32 e	25.21 d	22.32 d	9.70 d	11.39 d	11.12 d
NPK 2 g/pot	23.00 d	26.00 cd	24.20 c	9.99 d	12.25 d	11.79 d
GA_3 at 500 ppm (A)	25.21 c	26.99 c	25.32 c	10.05 d	14.00 c	12.00 d
GA_3 at 1000 ppm (B)	29.00 b	30.21 b	29.70 b	11.22 c	14.99 c	13.99 c
NPK 2 g/pot + A	30.10 ab	32.25 a	31.00 b	13.00 b	17.00 b	14.90 b
NPK 2 g/pot + B	31.50 a	33.00 a	32.99 a	14.22 a	18.99 a	15.99 a
			Second season: 2015			
Control	23.75 c	27.35 d	23.83 d	10.51 e	12.46 d	12.16 c
NPK 2 g/pot	25.30 bc	28.39 cd	26.69 cd	10.90 de	13.49 d	12.88 c
GA_3 at 500 ppm (A)	26.83 b	29.64 c	27.40 c	11.02 d	15.24 c	13.13 c
GA_3 at 1000 ppm (B)	31.63 a	33.85 b	32.63 b	12.27 c	16.22 c	15.18 b
NPK 2 g/pot + A	32.48 a	35.25 ab	33.87 ab	14.06 b	18.77 b	16.57 ab
NPK 2 g/pot + B	34.38 a	36.78 a	36.37 a	15.03 a	20.64 a	17.24 a

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

Table 5. Effect of NPK and GA_3 on some chemical constituents of *Cycas revoluta* Thunb. leaves during 2014 and 2015 seasons.

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	0.302 f	0.133 e	0.200 f	0.470 e	0.052 a
NPK 2 g/pot	0.621 c	0.261 c	0.342 c	0.447 f	0.049 b
GA_3 at 500 ppm (A)	0.401 e	0.192 d	0.300 e	0.497 d	0.051 ab
GA_3 at 1000 ppm (B)	0.521 d	0.200 d	0.321 d	0.540 c	0.042 c
NPK 2 g/pot + A	0.732 b	0.299 b	0.491 b	0.597 b	0.019 d
NPK 2 g/pot + B	1.000 a	0.442 a	0.600 a	0.677 a	0.011 e
			Second season: 2015		
Control	0.401 e	0.127 e	0.200 e	0.513 de	0.057 a
NPK 2 g/pot	0.812 c	0.253 b	0.499 b	0.487 e	0.053 b
GA_3 at 500 ppm (A)	0.599 d	0.132 de	0.390 d	0.533 d	0.056 ab
GA_3 at 1000 ppm (B)	0.612 d	0.149 d	0.388 d	0.580 c	0.046 c
NPK 2 g/pot + A	0.991 b	0.225 c	0.452 c	0.643 b	0.021 d
NPK 2 g/pot + B	1.421 a	0.473 a	0.527 a	0.760 a	0.012 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 NPK and GA_3 on N, P, K and total carbohydrates of *Cycas revoluta* Thunb. leaves during 2014 and 2015 seasons.

Treatments	N (%)	P (%)	K (%)	Total carbohydrates (%)
		First season: 2014		
Control	1.827 f	0.102 d	0.800 e	16.34 d
NPK 2 g/pot	1.998 e	0.110 d	0.892 d	17.01 c
GA_3 at 500 ppm (A)	2.132 d	0.132 d	0.999 c	17.09 c
GA_3 at 1000 ppm (B)	2.194 c	0.198 c	1.127 b	18.21 b
NPK 2 g/pot + A	2.423 b	0.231 b	1.147 b	18.99 a
NPK 2 g/pot + B	2.632 a	0.319 a	1.432 a	19.21 a
		Second season: 2015		
Control	1.713 f	0.109 e	0.803 f	15.49 f
NPK 2 g/pot	1.799 e	0.110 e	0.873 e	16.00 e
GA_3 at 500 ppm (A)	2.101 d	0.142 d	0.998 d	16.45 d
GA_3 at 1000 ppm (B)	2.199 c	0.163 c	1.132 c	17.21 c
NPK 2 g/pot + A	2.352 b	0.199 b	1.152 b	17.99 b
NPK 2 g/pot + B	2.532 a	0.299 a	1.321 a	18.99 a

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

of Abdel-Fattah *et al.* (2008) on *Brassaia actinophylla*, El-Sayed *et al.* (2009) on *Nephrolepis exaltata* and El-Sayed *et al.* (2010 b) on *Vinca rosea* cv. Major.

Briefly, to obtain the best growth and highest quality from commercial point of view, it is recommended to fertilize Cycas plants with NPK (2 g/pot as a soil drench) + GA_3 at 1000 ppm as foliar spray six times with one month interval during growing season.

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تأثير NPK وحمض الجبريليك على نمو وجودة نبات السيكاس (*Cycas revoluta* "Thunb.")

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أجريت التجربه فى الحقل المفتوح بمشتل معهد بحوث البساتين بالجيزة، مصر خلال موسمي ٢٠١٤ و ٢٠١٥ و ذلك لدراسة تأثير إضافة السماد المركب NPK كإضافة أرضية، بمعدل ٢جم/أصيص و حمض الجبريليك (GA_3) بتركيزات صفر، ٥٠٠، ١٠٠٠ جزء في المليون عند رشه على الأوراق ٦ مرات و بفاصل زمني شهر بين كل رشتين، و كذلك

المعاملات المشتركة بينهما على النمو و التركيب الكيميائي لنباتات السيكاس عمر سنه المنزرعة في أصص بلاستيك قطرها ٢٠ سم ملئت بـ ٢,٥ كجم مخلوط متساوي من الرمل المغسول والكومبوست (١:٣ حجماً).

و لقد أوضحت النتائج المتحصل عليها أن جميع معاملات التسميد أحدثت تحسناً معنوياً في النمو الخضري و الجذري للنباتات موضع الدراسة مقارنة بالكنترول، خاصة التوليفة المكونة من السماد المركب NPK (بمعدل ٢ جم/إصيص) و الرش بحمض الجبريليك بتركيز ١٠٠٠ جزء في المليون. على الجانب الآخر، لقد تم الحصول على نتائج مشابهة فيما يتعلق بمحتوى الأوراق من كلوروفيللي أ، ب، الكاروتينويدات، النيتروجين، الفوسفور و البوتاسيوم. إلا أن السيادة في جميع قياسات النمو الخضري و الجذري، و كذلك محتوى الأوراق من المكونات سالفة الذكر كانت للمعاملة المشتركة بين التسميد بالسماد المركب NPK (٢ جم/إصيص) + الرش بحمض الجبريليك بمعدل ١٠٠٠جزء فى المليون، و التي أعطت بصفة عامة أعلى المتوسطات مقارنة بالكنترول و جميع المعاملات الأخرى.

و عليه، يمكن التوصية بزراعة النباتات عمر سنة في مخلوط الرمل + كومبوست مخلفات المزرعة (بنسبة ٢٥%) مع التسميد بالسماد المركب NPK (بمعدل ٢ جم/إصيص) و الرش بحمض الجبريليك (بمعدل ١٠٠٠جزء فى المليون) ٦ مرات و بفاصل شهر بين كل رشتين متتاليتين خلال موسم النشاط للحصول على أفضل نمو و أعلى جودة.