RESPONSE OF *CYCAS REVOLUTA* THUNB. TRANSPLANTS TO SOME BIO, ORGANIC AND CHEMICAL FERTILIZATION

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(Manuscript received 4 April 2012)

Abstract

This experiment was performed in the greenhouse at the nursery of the Ornamental Plants Res. and Landscape Dep., Hort. Res. Inst., ARC., Giza, Egypt through two successive seasons (2010 and 2011) to investigate the response of *Cycas revoluta* Thunb to inoculation with arbuscular mycorrhizal (AM) fungi and Actosol (Acto.) either solely or in a combined mixture as a bio and organic fertilizer in comparison to mineral fertilization (NPK). The obtained results revealed that fertilization treatments significantly stimulated most of the studied characters compared to control. The inoculation of Cycas with either AM fungi and /or Actosol gave the highest values of vegetative growth parameter**s** [leaves length (cm)**,** width (cm), petiole length (cm), number of leaves and pinnae plant^{-1}, fresh and dry weights of leaves plant^{-1} (g)] as well as root length, fresh and dry weights. Inoculation with AM fungi followed by Actosol markedly improved chlorophyll a, b and carotenoids and gave the highest total carbohydrates % in leaves. Likewise, all fertilization treatments greatly raised the percentage of N, P and K in the leaves, as reached the maximum by AM fungi. The addition of half dose of mineral fertilization (½ NPK) plus the inoculation with either AM fungi or Actosol were the best compared to full dose NPK solely for all studied parameters of Cycas plant. In general, the dominance in all previous measurements was for AM fungi followed by Actosol+ AM fungi which gave the highest values in most cases.

Key words: Cycas, Arbuscular Mycorrhizal fungi (AMF), Actosol (Acto.), NPK.

INTRODUCTIN

The subtropical *Cycas revoluta* Thunb-"king sago palm tree" belongs to Cycadaceae family, it is native to the Far East which occurs from Madagascar to Japan and has been used as a choice container and landscape plant for centuries. The growth habit of *Cycas revoluta* displays an upright trunk with a diameter from 1" to 12" depending on age, topped with stiff feather-like leaves growing in a circular pattern which has led to the common name "Sago Palm". This subtropical plant adapts to a wide range of temperatures from 15 to 110 degrees F (-11 to 42 degrees ºC), accepts full sun or bright interior light, thrives with attention, and tolerates neglect. In addition, Cycads are extremely long-lived. Regardless of age or size, *Cycas revoluta* is one of the easiest plants to grow, indoors or out, by beginner or expert.

The plant is one of the most primitive living seed plants, and is very unusual and excellent popular foliage ornamental for indoor decoration as used to grace the large rooms and halls of stately homes and mansions, excellent container plant for the decoration of outdoor areas such as verandahs, terraces, the larger species make graceful subjects for landscape use and are often seen planted around public buildings and as lawn specimens. Cycas is used as a source of food starch, producing gum, oils and fibers exhibit a root nodule symbiosis with nitrogen fixing cyano-bacteria, has a great potential value as antimicrobial and natural source of pesticidal biochemicals.

Organic or biofertilizers are from paramount importance for their beneficial effects on the physical, chemical and biological properties of soil organic matter, cation exchange capacity, availability of mineral nutrients to plant to increase productivity. Using Actosol containing humic acid seems to be valuable in correcting the widespread occurrence of certain nutrient deficiency symptoms. This is attained through increasing the soil water holding capacity, promoting soil structure and enhancing the metabolic activity of micro organisms. Humic acid is an excellent root stimulator, increases the permeability of plant membranes and accelerates cell division. It has been shown to increase the uptake of nitrogen, potassium, calcium, magnesium and phosphorus by plants (Brunetti, 2006). Moreover, Stevenson (1994) concluded that humic substances isolated from different materials contained 45-65% carbon, 30-48% oxygen, 2-6% nitrogen and about 5% hydrogen. Humic substances (HS) are extremely important soil components because they constitute a stable fraction of carbon (C), thus regulating the carbon cycle and release of nutrients including nitrogen (N), phosphorus (P) and Sulphur (S). Additionally, the presence of HS improves pH buffering and thermal insulation. Arbuscular mycorrhizal (AM) fungus can increase plant growth and quality of most plant species by enhancing water absorption and uptake of nutrients: e.g. phosphorus, potassium and nitrogen as well as Zn, Cu, S, B and Mo., reduces uptake of toxic heavy metals e.g. manganese, improves soil structure and aggregation. It may affect plant water relationships leading to healthy plants. Mycorrhiza increased availability of nutrients especially phosphorus due to their metabolic activity of AM roots, particularly with plants grown on high phosphate-fixing soil (Saleh *et. al.*, 2008). Chemical fertilizers are an important source of plant nutrients, however, are expensive and cause accumulation of harmful residual substances in plants.

The goal of this research work was undertaken to use natural safety environmental materials (mycorrhizal fungi and humic acid) for their beneficial effects on plant growth and avoid the harmful effects caused by synthetic fertilizers through decreasing the use of NPK and costs requirements for *Cycas revoluta* plant.

MATERIALS AND METHODS

This study was carried out at the Experimental Green house (seran) of the Ornamental Plants Res. and Landscape Dep., Horticultural Research Institute, Agricultural Research Center, Giza, Egypt during two successive seasons (2010 and 2011). *Cycas revoluta* plants were purchased from a commercial farm with average height 7-10 cm and 2-3 leaves/ plant. On 1st January 2010 and 2011, the plants were individually planted in 25cm plastic pots filled with a mixture of clay: sand: peat (1:1:1, v/v/v). Physical and chemical analysis of the used soil is presented in Tables (a) and (b). Plants were treated as follows during the growth season:

1- Control.

2- NPK [kristalon (19-19-19) applied at monthly interval either at the rate of 5g/ pot as full dose or as 2.5g/ pot combined with other treatments].

3- Arbuscular mycorrhizal fungi (AMF) [a mixture of mycorrhizal spores which was prepared from the rhizosphere by wet sieving and decanting (Gerdemann and Nicolson, 1963). (AMF) inoculants consisted of 10 ml of wet-sieving suspension of (AMF) containing 50-60 spores ml^{-1}.The application was at planting as a soil drench.

4- Actosol (Acto.) is a commercial liquid organic fertilizer containing 2.9% humic acid and 0.5% for each of Fe, Zn, Mn and Cu and was applied monthly at 30 cm^3/l as a soil drench (50 cm^3/ pot).

5- ½ NPK + Acto.

6- ½ NPK + AMF

7- Acto. +AMF

Measurements

1- Vegetative growth characters:

- Leaves length (cm). -Leaves width (cm). - Petiole length (cm). - Number of leaves /plant. - Fresh and dry weights of leaves/ plant (g). -Pinnae number.

2- Root characters:

- Root length (cm). - Fresh and dry weights of roots

3- Chemical composition:

- Chlorophyll a, b and carotenoids were determined in fresh leaves (mg/g f.w.) according to Saric *et al* (1967).
- Total carbohydrates % in leaves was determined according to Herbert *et al.*, (1971).

- Nitrogen, phosphorus and potassium % in leaves were determined according to Jackson (1973).

The layout of the experiment was completely randomized design containing 7 treatments. Each treatment was repeated three times, each replicate contained 6 plants i.e. 18 plants in each treatment.

Statistical analysis:

All data were subjected to statistical analysis according to the procedure reported by Snedecor and Cochran (1982) and means were compared by New Least Significant Difference (New L.S.D) test at the 5% level of probability in the two seasons.

Table (a): Physical and chemical analysis of the used soil.

Soil type	Particle size (%)	Cations (meq/l)		Anions(meq)/l					
		Ca^{++}	10.00	HCO^{-3}	1.30	N	425 ppm	B.D (g/cm^3)	1.255
Sandy	51.39	Mg^{++}	8.02	SO_4^{--}	0.30	P	38.0 ppm	WHC (%)	46
Silty	31.63	Na^+	1.00	Cl^-	0.45	K	564 ppm	pH	7.22
Clayly	17.98	K^+	0.25	-------	-------		-------	E.C(ds /m)	1.02

Table (b): Chemical analysis of the used peatmoss.

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

RESULTS AND DISCUSSION

I- Morphological characters of vegetative growth

Morphological characters of vegetative growth *of* Cycas plants as affected by Arbuscular Mycorrhizal fungi (AMF), Actosol (Acto.) and mineral fertilization (NPK) in the two growing seasons included data pertaining to leaves [length (cm), petiole length (cm) , width (cm**)**, number, pinnae number, fresh and dry weights plant^{-1}(g)].

Length of leaves and petiole

Data shown in Table (1) reveal that all treatments significantly increased length of leaves and petiole over control except for NPK as the differences were insignificant in both seasons. Moreover, the highest significantly values of length of leaves and petiole were found in inoculated plants by Arbuscular Mycorrhizal fungi (AMF) (41.00 and 39.67 cm leaves length, respectively) in both seasons. However, the second category was occupied by plants treated with Actosol (Acto.) (36.62 and 35.33cm leaves length, respectively) and the differences were significant compared with the other treatments used in both seasons. Concerning the effect of the combinations, data in Table (1) clearly indicate that the best results were recorded with plants treated with Actosol (Acto.) +AMF (38.50 and 36.33cm leaves length in the two seasons, respectively). Moreover, it can be noticed from Table (1) that NPK combined with either AMF or Actosol (Acto.) significantly enhanced the length of leaves and petiole compared with NPK alone in both seasons. These results are in harmony with those of Eliwa *et. al*. (2009) on *Iris tingitana* who stated that humic acid improved plant height. Meanwhile, the increase in plant height due to microorganisms of biofertilizer can be attributed to the capability of those microorganisms in inducing beneficial effects on plant growth by contributing hormones such as cytokinins or auxins (Bouton *et. al*., 1985).

Leaves width (cm)

Evidently, data in Table (1) show that plants inoculated by the Arbuscular Mycorrhizal fungi (AMF) increased leaves width over control and other fertilizers treatments (19.67 and 18.30 cm in the two seasons, respectively). However, applying Actosol (Acto.) induced also leaves width over control and NPK (16.67 and 16.00 cm, respectively) in both seasons. Regarding data of the combinations shown in Table (1) pointed out that the highest values of leaves width were found with Actosol (Acto.) +AMF (18.62 and18.80 cm in both seasons, respectively). These results can be attributed the promoting effect of biofertilizer treatment on leaves width which accelerates cell division (Brunetti *et. al*., 2006). Scagel (2004) on Harlequin stated that mycorrhizal fungi promoted plant development growth.

Number of leaves and Pinnae plant^{-1}

It is obvious from data presented in Table (1) that all treatments increased the leaf numbers plant^{-1} (which ranged between 4.00 to 7.00 in 1st season and 5.00 to 6.80 in 2nd one) and pinnae number plant^{-1}(which ranged between 33.20 to 41.00 in 1st season and 32.50 to 38.67 in 2nd one more than control (3.33 and 3.67 for leaves number and 30.00 and 27.33 for pinnae number plant^{-1} in both seasons, respectively). In this respect, the maximum increment in leaf formation was obtained when the seedlings were inoculated with Arbuscular Mycorrhizal fungi (AMF) followed by those treated with Actosol (Acto.) in both seasons. As for the effect of the combinations, the highest estimation of number of leaves and pinnae number plant^{-1} were recorded from plants treated with Actosol (Acto.) +AMF in the two seasons. Also, the addition of NPK to either AMF or Actosol (Acto.) led to an increment in number of leaves plant $^{-1}$ compared with NPK alone in both seasons. In this regard, the pronounced effect of fertilization with Arbuscular Mycorrhizal fungi (AMF) and Actosol (Acto.) treatments may be related to the improving effect on soil structure, aeration, water retention and uptake of nutrients from the soil. Moreover, they increase microbial activity in the soil and enhance plant cell biomass. The low molecular weight humics in Actosol have the cytokinnin / auxin like response and not only help in transport of trace elements, but also greatly stimulate vegetative growth (Putti *et. al.*, 1988). However, the great influence of Actosol on vegetative growth parameters was confirmed by many authors on different plant species. El- Khateeb *et. al.* (2010) found that the use of humic acid and Mycorrhizae on *Calia secundiflora* gave the maximum number of leaves and branches per plant.

Fresh and dry weights of leaves plant^{-1}(g)

As shown in Table (1) all treatments significantly increased fresh weight of leaves compared with control in both seasons, with the significantly superiority of using Arbuscular Mycorrhizal fungi (AMF) giving 51.80 and 55.36 (g) in both seasons, respectively. Actosol (Acto.) treatment showed also marked increase in this concern in both seasons. Regarding the effect of the combinations, it is clear from the data that the greatest increment was obtined with the treatment of Actosol (Acto.) +AMF in the two seasons. As for the effects of NPK as well as the biostimulants treatments on dry weight of leaves, it is clear that they were in parallel with their effects on fresh weight of leaves. Arbuscular Mycorrhizal fungi (AMF) as well as actosol (Acto.) treatments were the most effective. The increase in leaves fresh and dry weights can be attributed to the increase in both plant height and number of leaves /plant. The increment in growth of leaves by treating the plants with humic acid may be attributed to humic acid contain many elements which in turn improve the plant growth. These results are in harmony with those reported by some researchers who reported that soil inoculation with Mycorrhizae leads to best seedling growth and nutrients uptake (Phanuphong and Gregory, 2003).

П-Root parameters

Beneficial effects were scored on roots length due to using NPK and the biostimulants treatments in both seasons, with the mastery of Arbuscular Mycorrhizal fungi (AMF) followed by Actosol (Acto.) treatment in elevating the values more than the control and other treatments used (Table,1). It was noticed that the presence of

AMF with actosol (Acto.) recorded the highest values of root length compared with the other combinations treatments in both seasons. In this respect, the low molecular weight humics in Actosol have the cytokinnin/ auxin like response greatly stimulate root growth (Putti *et. al.*, 1988). Also, these data may be attributed to the role of mycorrhizal fungi which improved plant growth as recorded in many crops through enhancing root growth and function (Westphal *et. al.*, 2008). A similar trend was observed on fresh and dry weights of roots as affected by NPK as well as the biostimulants treatments. Receiving Arbuscular Mycorrhizal fungi (AMF) and Actosol (Acto.) treatments proved their mastery in increasing the fresh and dry weights of roots values. Meanwhile, the combination treatment of Actosol (Acto.) +AMF had the heaviest fresh and dry weights of roots (Table, 1). In conclusion, the increment in root length, fresh and dry weights due to using biofertilizer treatments or their combinations with organic fertilizer may be due to both plant hormones and nitrogen fixation produced from biofertilizer organisms. Similar results were obtained by El-Khateeb *et al* (2010) who found that the use of humic acid and Mycorrhizae on *Calia secundiflora* were the most effective on increasing the root length, fresh and dry weights.

Table 1. Effect of Actosol, AM fungi and NPK either single or in combination on some vegetative and roots characteristics of *Cycas revoluta* during two successive seasons (2010&2011).

Treatments	Leaves						Pinnae number	Roots		
	Length (cm)	Width (cm)	Petiole length (cm)	No.	F.W. (g)	D.W. (g)		Length (cm)	F.W. (g)	D.W. (g)
1st season										
Control	28.40	13.00	11.80	3.33	29.21	2.10	30.00	16.80	2.20	0.68
NPK	30.17	15.00	14.20	4.00	37.45	4.11	33.20	17.80	2.67	0.96
Actosol (Acto.)	36.62	16.67	17.50	5.00	43.50	5.18	36.00	24.00	3.87	1.29
AM fungi (AMF)	41.00	19.67	19.00	7.00	51.80	8.16	41.00	27.20	4.34	1.35
½ NPK + Acto.	35.27	16.00	16.00	5.67	45.30	6.25	36.60	23.30	3.28	1.07
½ NPK + AMF	34.50	18.00	17.50	5.00	47.51	7.48	35.67	24.80	3.65	1.24
Acto. + AMF	38.50	18.62	17.80	6.71	49.08	7.80	37.32	26.00	3.82	1.27
L.S.D. 0.05	3.75	3.36	3.39	3.37	4.76	4.45	3.65	3.67	3.57	1.12
2nd season										
Control	27.00	14.15	10.60	3.67	31.12	3.70	27.33	18.60	1.70	0.87
NPK	29.00	15.40	13.50	5.00	39.31	4.80	32.50	20.60	2.89	0.98
Actosol (Acto.)	35.33	16.00	16.64	6.00	46.62	6.39	35.33	23.00	3.28	1.05
AM fungi (AMF)	39.67	18.30	18.15	6.80	55.36	9.13	38.67	26.30	4.08	1.28
½ NPK + Acto.	35.00	15.07	15.80	5.72	49.08	7.10	36.70	22.00	3.20	1.03
½ NPK + AMF	33.20	17.44	16.66	5.33	51.00	7.35	34.00	24.00	3.60	1.20
Acto.+ AMF	36.33	18.80	18.00	6.67	53.22	8.12	37.45	25.75	3.80	1.22
L.S.D. 0.05	3.69	3.70	3.47	3.64	4.57	3.70	3.47	3.68	3.07	1.25

Ш- Chemical composition as affected by AM fungi, Actosol (Acto.), NPK and their combinations

Results of Table (2) show the increment of chlorophyll (a) and (b) accumulation in leaves associated with the different fertilizer treatments compared with the control in both seasons. However, the promoting action was more obvious with applying Arbuscular Mycorrhizal fungi (AMF) followed by Actosol (Acto.) treatments in the two seasons. However, a favorable influence was detected due to receiving the combinations which reached the highest effect with plants treated with Actosol (Acto.) +AMF in the two seasons. The aforementioned findings are in harmony with El- Attar (2006) on *Ficus alii*, stated that humic acid significantly increased chlorophylls content. Regarding the effect on the content of carotenoids, a clear increment on carotenoids accumulation in leaves was detected with control treatment (0.52 and 0.46 mg/g F.W., respectively in both seasons) as compared to other treatment. Whereas, supplying the plants Arbuscular mycorrhizal fungi (AMF) followed by Actosol (Acto.) treatments as well as the combination of them behaved the contrary action. Such treatments declined the values of carotenoids in the two seasons. In this connection, El- Khateeb *et. al*. (2010) found that the use of humic acid and mycorrhizae on *Calia secundiflora* decrease the leaves content of carotenoids.

Regarding total carbohydrates % in leaves, as shown in table (2) plants inoculated with Arbuscular Mycorrhizal fungi (AMF) considerably increased total carbohydrates % in leaves comparing with control and other treatments (26.50 and 26.91%, respectively) in both seasons. Also, great influence was observed on the obtained values as a result of supplying the plants Actosol (Acto.) (24.66 and 25.92, respectively) followed by the combination treatment of Actosol (Acto.) +AMF in both seasons. The other fertilizer treatments revealed also an increment but with less effect on total carbohydrates content. Referring to the increment on total carbohydrates content in leaves due to Arbuscular Mycorrhizal fungi (AMF) and Actosol (Acto.), El- Attar (2006) on *Ficus alii* found that humic acid increased the accumulation of total carbohydrates in the different plant parts. El- Khateeb *et. al*. (2010) found that the use of humic acid and Mycorrhizae on *Calia secundiflora* increase the leaves content of total carbohydrates.

As for the mineral analysis, data in Table (3) revealed a clear increment in nitrogen, phosphorus and potassium accumulation in leaves as response to the different fertilizer treatments so as to reach their maximum records with the treatment of inoculation by AMF followed by Actosol (Acto.) in the two seasons. Whereas, receiving the plants NPK recorded the lowest values in this concern. In addition, applying the combinations increased nitrogen accumulation revealed their superiority with the treatment of Actosol (Acto.) +AMF in both seasons. These results are supported by the obtained data results of Dubey and Ginwal (1997) reported that Mycorrhizae increased the absorption area of the roots and provide host plants with nutrients. Mycorrhizae improves the uptake of nutrients. Humic acid has been shown to increase the uptake of nitrogen utilization efficiency, it also enhances the uptake of potassium, calcium, magnesium and phosphorus (Watfa, 2009).This goes in harmony with researches on ficus alii stating that humic acid had a great effect in increasing the N, P and K contents of the plants [Phanuphong and Gregory (2003), El- Attar (2006)].

Table 2. Effect of Actosol, AM fungi and NPK either single or in combination on total carbohydrates % and photo synthetic pigments content in leaves of *Cycas revoluta* during two successive seasons (2010&1011).

Control	**16.67**	**17.73**	**0.88**	**0.66**	**0.30**	**0.32**	**0.52**	**0.46**
NPK	**21.33**	**22.08**	**1.02**	**0.89**	**0.39**	**0.38**	**0.44**	**0.41**
Actosol (Acto.)	**24.66**	**25.92**	**1.19**	**1.29**	**0.51**	**0.49**	**0.38**	**0.40**
AM fungi (AMF)	**26.50**	**26.91**	**1.28**	**1.45**	**0.55**	**0.52**	**0.29**	**0.37**
½ NPK + Acto.	**24.30**	**24.08**	**1.18**	**1.14**	**0.40**	**0.42**	**0.35**	**0.39**
½ NPK + AMF	**25.09**	**24.97**	**1.16**	**1.10**	**0.42**	**0.44**	**0.30**	**0.36**
Acto.+ AMF	**26.90**	**25.52**	**1.22**	**1.19**	**0.54**	**0.45**	**0.31**	**0.37**

Table 3. Effect of Actosol, AM fungi and NPK either single or in combination on N, P and K % in leaves of Cycas revoluta during two successive seasons (2010&1011).

Control	**1.20**	**1.18**	**0.20**	**0.25**	**1.45**	**1.38**
NPK	**1.64**	**1.86**	**0.33**	**0.35**	**2.54**	**2.58**
Actosol (Acto.)	**2.29**	**2.19**	**0.35**	**0.38**	**2.61**	**2.67**
AM fungi (AMF)	**2.58**	**2.32**	**0.39**	**0.41**	**2.77**	**2.80**
½ NPK + Acto.	**2.11**	**2.08**	**0.34**	**0.35**	**2.60**	**2.64**
½ NPK + AMF	**2.21**	**2.27**	**0.36**	**0.38**	**2.63**	**2.72**
Acto. + AMF	**2.36**	**2.30**	**0.37**	**0.39**	**2.65**	**2.76**

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إستجابة شتلات نبات السيكس (نخيل ذيل الجمل) لبعض الأسمدة الحيوية والعضوية والكيماوية

أمال عبد الغفار زكى

قسم بحوث نباتات الزينة و تنسيق الحدائق– معهد بحوث البساتين– مركز البحوث الزراعية– الجيزة– مصر.

أجريت تجربة أصص فى صوبة ساران بمشتل قسم بحوث نباتات الزينة و تنسيق الحدائق – معهد بحوث البساتين بالجيزة– مركز البحوث الزراعية– جيزة– مصر خلال موسمى 2010و2011 لدراسة استجابة نبات السيكس للتلقيح بفطريات الميكوريزا الداخلية والأكتوسول بصورة منفردة أو خليط منهما كسماد حيوى وعضوى ومقارنته بالتسميد المعدنى وتأثيرذلك على الصفات المورفولوجية والمحتوى الكيماوى لنبات السيكس وقد أظهرت النتائج الأتى :

– جميع معاملات التسميد كان لها تأثير منشط لمعظم الصفات النباتية المدروسة مقا رنة بمعاملة الكونترول.

– تلقيح نبات السيكس بفطريات الميكوريزا الداخلية أو المعاملة بالأكتوسول أو خليط منهماحققت أعلى قيمة للنمو الخضرى [طول الأوراق (سم)، عرض الأوراق (سم)، طول عنق الورقة (سم)، عدد الأوراق والوريقات/ نبات والوزن الطازج والجاف للأوراق] كما أدت هذه المعاملات أيضاً إلى زيادة كل من أطوال الجذور والوزن الطازج والجاف للجذور.

– التلقيح بفطريات الميكوريزا ويليها المعاملة بالأكتوسول حسنت بشكل واضح محتوى الأوراق من الكلوروفيل أ، ب والكاروتينويدات (مللجم / جم وزن طازج) كما حققت أعلى زيادة فى النسبة المئوية للكربوهيدرات الكلية فى الاوراق.

–أظهرت النتائج آن كل معاملات التسميد أدت إلى زيادة واضحة فى النسبة المئوية لكل من النتروجين والفسفور والبوتاسيوم فى الاوراق حيث بلغ أقصاه نتيجة للمعاملة بالميكوريزا .

– أشارت النتائج إلى أن إضافة نصف الجرعة الموصى بها من السماد المعدنى إلى فطريات الميكوريزا الداخلية والأكتوسول حققت أفضل النتائج فى جميع القياسات النباتية المدروسة لنبات السيكس مقارنة بالجرعة الكاملة من السماد المعدنى بمفرده .

– بصفة عامة كانت السيادة فى جميع القياسات السابقة نتيجة المعاملة بالميكوريزا يليها المعاملة بالأكتوسول والتى أعطت أعلى النتائج فى معظم الحالات.

الكلمات الدالة : نبات السيكس– فطر الميكوريزا– الأكتوسول– سماد معدنى.