J. Agric. Sci. Mansoura Univ., 29 (12): 7273 - 7285, 2004

EFFECT OF DIFFERENT SCHEDULES OF DRIP IRRIGATION AND COMPLETE LIQUID FERTILIZER RATES ON GROWTH OF CYCAS PLANTS (*Cycas revoluta*).

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ABSTRACT

The present work was designed to study the effect of different schedules of irrigation (every 3, 4 and 5 days as drip irrigation) and fertilizer (NPK 19:19:19) at 1.5, 3 and 4.5g/pot as liquid with the irrigation water on growth of *Cycas revoluta* seedlings during the two periods in 2003 / 2004 in the green-house at Antoniades Branch, Hort. Res. Inst., A.R.C. Alexandria. Egypt.

The results indicated that different irrigation intervals had insignificant effects on growth of *Cycas* seedlings during the two experimental periods (15 and 20 months). However, the highest values of stem characters were observed with irrigation every 3 and 4 days after 20 months.

Concerning the chemical fertilizer rate, the most satisfactory results for the growth of *Cycas revoluta* seedlings was observed with using the lowest fertilizer rate (1.5g/plant) every 2 weeks during the growing season. Considering, the important rate of Cyanobacteria (Nostoc) as a nitrogen fixing symbiosis which leave in association with *Cycas* plants in a modified roots called coralloid roots. The high rates of fertilizers had negative effects on both the plant growth and Cyanobacteria.

In general, drip irrigation system every 4 days (with rate equal to 33% of the field capacity) and applied with 1.5g/plant of chemical complete fertilizer every 2 weeks during the growth of *Cycas revoluta*, is the best treatment to grow *Cycas* seedlings in the green-house.

INTRODUCTION

Cycas revoluta, family *Cycadaceae*, (sago palm) is the common name. This unique plant resembles a palm tree, even though it isn't really a palm but is actually a cycad. This very symmetrical plant supports a crown of shiny dark green leaves on a thick shaggy trunk that can grow to 10-12 ft high. Japanese sago tends to produce suckers at its base forming a large multi-stem clump over time. Sago plants are dioecious, the male structure is a yellow rod shaped cone that grows 12-18 in.

Modified leaves from the female cone which is a globe shaped yellow structure in which scale like leaves cover bright orange seeds that are about 1.5 in. in diameter. The sago palm is native to Japans southern islands, (a subtropical area of high rain full and worm temperature), Bailey (1960).

This is wonderful plant for both indoor and out door uses. It looks great in the shrub border or as an expanse of lown or near the patio. Use in entryways or in rock and sand gardens. It mixes well with palms and combines well with border grass, podocarpus and camellias. Sago is an excellent container plant, it is also used as a bonsai subject. The glassy metallic leaves are harvested for use in flower arrangements and wreaths.

Cycas revoluta is characterized with its coralloid roots, containing nitrogen fixing Cyanobacteria (Nostoc) as plant symbioses that can convert

inert atmospheric nitrogen into an organic form, such as nitrate or ammonia, (Millbank, 1974 and Rai, *et al* 2000 and Lindblad and Costa 2002).

Very little information are available about irrigation and fertilization of *Cycas revoluta* plants. So the literature on other plants seemed to be helpful in this respect. Pool and Conover (1987) found that, the poorest plant quality and the shortest vine length of Cissus were observed with the highest fertilization level and the irrigation frequency had no effect on Dracaena surculesa. Favilli *et al* (1988) used *Azolla biomas* as a biofertilizer (containing Cyanobacteria) for wheat, sunflowers and maize. They found that, using low rate of N (20 Kg/ha) with 8t *Azolla* increased root and stem growth after 60 days in all 3 species. *Azolla* also increased plant N content by up to 20% on sunflowers. Rinaldi and Morgheri (1993) studied the effects of fertilization on *Cycas revoluta*. Nostoc symbiosis they concluded that, higher rates of fertilization had negative effects on both plant growth and cyanobacterial nitrogenase activity, wherase lower rates increased symbiosis efficiency (in terms of good plant development and high nitrogenase activity values) in comparison with the control. EL-Gendy, *et al* (1995) on *Dracaena draco* stated that, fertilizer application increased plant height and leaf and root numbers and weights compared to unfertilized controls. It was thought that salt toxicity from excessive fertilizer application may have accounted for the slightly reduced growth.

Lamhamedi *et al* 2003 studied the effect of different irrigation regimes on the growth of black spruce seedlings to reduce the quantity of water used and the amount of mineral nutrients lost. They used four irrigation regimes (15, 30, 45 and 60%, v/v). They observed that, irrigation regime did not affect growth, root architecture or tissue nutrient contents at the end of the growing season. The losses of mineral nitrogen were 49.7, 35.9, 55.2 and 88.2% respectively, for the 15, 30, 45 and 60% irrigation regimes.

The present work was carried out to study the effect of various irrigation intervals, fertilizer levels of NPK and their interaction on growth of *Cycas revoluta* plants.

MATERIAL AND METHODS

The experimental trials were carried out throughout two periods in 2003 / 2004 at the nursery of Antoniades Research Branch, Hort. Res. Inst., Alexandria, Egypt. It intended to find out the individual and combined effects of different irrigation intervals and fertilizer rates on growth and chemical composition of leaves of *Cycas revoluta*, Thunb.

Plant materials:

One year old seedlings (containing 4 leaves) of *Cycas revoluta* were grown in a mixture of clay, sand and peat-moss (1:1:1 v/v) in clay pots of 30 cm in diameter in a green-house (light intensity of 2500-3000 lux and relative humidity of 75-80% and average temperature of 23.4-38.6 in winter and summer respectively). The chemical analysis of the used medium containing: (N 0.25%, P 24 ppm, K 641 ppm, Fe 7.9 ppm, Zn 3.12 ppm Mn 9.56 ppm and Cu 1.13 ppm) with 1.25 dsm-1 (EC) and 7.1 (pH). The textural class sandy loom.

Irrigation regim and fertilization treatments:

primary experiments were done to determine minimum rate of water irrigation to keep the seedling survive at irrigation interval 4 days in the green-house and the field capacity of the container medium. The results indicated that 400 cm3 of irrigation water is the best rate in winter months and 450 cm3 in summer months per pot. The field capacity was 1350 cm3/pot. Manual drip irrigation system in the green-house was used and organized to emit 400 cm3 or 450 cm3 / pot/h.

The irrigation schedule was three treatments (every 3, 4 or 5 days). The dissolved fertilizer used (NPK-19:19:19). The fertilizer treatments started on March 1st and were repeated once every two weeks as a liquid at levels of 0.0 (control), 1.5g, 3.0g and 4.5g/pot as soil application mixed with irrigation water. Micro elements was added monthly as a liquid to the pot medium at the rate of 0.16 g/l. thus 12 treatments were arranged in three replicates with three plants per experimental unit in a complete randomized block in factorial design throughout each experimental period. The plants were divided into two groups. The data of the first group were taken at the end of May 2004 (after 15 months from starting the treatments). The data of the second group were taken at the end of October 2004 (after 20 months from starting the treatments).

The following data were recorded:

- Number of leaves per plant.
- Leaf length (cm.) (length of the tallest adult leaf). Fresh and dry weights of leaves / plant.
- Number of leaflets per the tallest leaf. Leaflet length (cm.) (length of the middle leaflet of the tallest leaf).
- Stem circumference (cm) (in the middle of stem length), fresh and dry weights of stem, (g.)
- Fresh and dry weights of roots, (g.)
- Total chlorophylls content (mg/g) fresh weight of leaf according to Moran and Porath (1980).
- N and P percent of dry leaves, according to Chapman and Paker, (1961).

Duncan's Multiple Range Test was used for comparison means between the treatments according to Sendecor, and Cochran (1974).

RESULTS AND DESCUSSION

1- Number of leaves / plant

Insignificant effects were recorded on leaf number due to using the different irrigation periods in both experimental trials as indicated in Table (1). Such effect reveals a great economic value in this concern. This result may be related to constant conditions in the green-house specially the high rate of humidity (70-80%) and thick and hard leaflets that are covered by cutin layers causing low transpiration rate resulted in low up take rate of water. These results are in harmony with those of Lamhamedi *et al* (2003) on black spruce, and Sheikh, (1985) on rooted cuttings of poplar clones who stated that,

nonsignificant differences were recorded in growth as response to water treatments.

All chemical fertilization rates showed an increment in the number of leaves / plant in both plantations. The lowest rate was the best treatment in this respect. This means that this treatment was of paramount importance for its great economic effect. These results may be attributed to the negative effects of high fertilization rate on both plant growth and Cyanobacterial nitrogenase activity, wherease lower rates increased symbiosis efficiency (in terms of good plant development and high nitrogenase activity values) in comparison with the control (Rinaldi and Margheri, 1993). These results are in agreement with the findings of Favilli *et al* (1988).

Referring the interaction between chemical fertilization rates and irrigation schedule it is clear from the obtained values that the great influence of receiving the plants irrigation treatments every either 3 or 4 days and treated with the lowest rate of chemical fertilization (1.5g /plant) as shown in Table (1) in both experimental trials. The contrary action was detected due to receiving the plant irrigation treatment every 4 days without applying chemical fertilization.

2- Leaf length

No significant differences on leaf length were recorded from using the different irrigation treatments in both cultivations. This result may be related to the habit growth of this plant. This result is in agreement with that obtained by Poole and Conover (1987) on *Dracaena surculosa* and Sheikh, (1985) on poplar rooted cuttings. Concerning the effect of chemical fertilization, it is obvious from the tabulated data that the great effect of using the lowest rate of chemical fertilization in both plantations. This treatment increased the values to 46.06 and 58.14 cm against to 44.25 and 50.75 cm produced from control in both periods respectively. However, the effect reached only the level of significance in the second period. These results may be attributed to the activity of Cyanobacteria in fixing N with the lowest rate of fertilization.

This result agreed with that of Rinaldi and Margheri (1993) on *Cycas revoluta*.

The interaction showed that plants irrigated every 3 or 4 days and received the lowest rate of chemical fertilizer (1.5g/plant) had the longest leaves in both experimental trials.

3- Fresh weight of leaves

Evidently, data in Table (1), show insignificant effect on fresh weight of leaves from using the different irrigation intervals in both plantations. This result may be ascribed to structural and metabolic derangement rather than direct limitation (Fogg 1972). It is known the importance of water supply on the amount of photosynthesis. This result supports the observation of Burman *et al* (1991) on *Azadirachta indica* that average application of equal to (FC) per plant at 2 weeks interval led to maximum growth and biomass production.

Applying the different chemical fertilization rates increased fresh weight of leaves in both periods. In this respect receiving the plants the lowest rate (1.5g/plant) proved its superiority for producing the heaviest fresh weight in both plantations; as a considerable increment on the obtained values were detected in both cultivations. It is known that lower rates of

nitrogen fertilization increased symbiosis efficiency in terms of good plant development and high nitrogenase activity values of Cyanobacteria (Rimaldi and Margheri 1993). The sufficient amount of nitrogen by nitrogen fixing bacteria and chemical fertilizer stimulated leaves number and length, thereby increasing the size of photosynthesizing surface, then reflected on increasing in leaves fresh weight. This result agreed with that of EL-Gendy *et al.* (1995) on *Dracaena draco.*

With respect to the interaction between chemical fertilization and irrigation intervals, it is clear from the tabulated data that the great influence of receiving the plants irrigation treatments every 4 days with supplying them with the lowest rate of chemical fertilization treatment (1.5g/plant). This treatment increased the values up to 86.81 and 110.08g against to 44.45 and 70.52g resulted from untreated plants with chemical fertilization and irrigated every 5 days in first and second periods respectively.

Table (1): Effect of irrigation, fertilizer treatments and their interaction on number of leaves / plant, leaf length and fresh weight of leaves of *Cycas revoluta* during the two experimental periods.

Fertilizer	First period				Second period			
	Irrigation schedule				Irrigation schedule			
	3 days	4 days	5 days	(B)mean	3 days	4 days	5 days	(B)mean
	Number of leaves / plant							
0.0g	7.73abc	7.33abc	6.66c	7.11c	7.00cd	6.00d	6.00d	6.33c
1.5g	8.16abc	9.33a	8.00abc	8.50a	11.33a	9.76abc	10.17ab	10.59a
3.0g	8.50abc	8.33abc	7.33abc	8.05ab	10.60ab	8.83abcd	9.00abc	9.48a
4.5g	8.83ab	6.66c	6.83bc	7.44bc	9.00abc	8.00bcd	7.73bcd	8.28b
(A)mean	8.24a	7.92a	7.21a		9.48a	8.13a	8.25a	
	Leaf length (cm.)							
0.0g	37.42c	42.17abc	44.17abc	41.45a	48.33b	54.33ab	49.50b	50.72b
1.5g	48.75ab	47.75abc	41.67abc	46.06a	55.67ab	54.92ab	63.83a	58.14a
3.0g	40.33bc	45.33abc	51.07a	45.78a	52.50ab	55.17ab	57.33ab	55.00ab
4.5g	47.50abc	38.67bc	44.83abc	43.66a	51.33ab	52.33ab	51.33ab	51.78b
(A)mean	43.50a	43.48a	45.38a		52.04a	54.19a	55.50a	
	Fresh weight of leaves (g.)							
0.0g	57.10c	41.48c	44.45c	47.68b	74.50a	80.37a	70.52a	75.13b
1.5g	62.35bc	86.81a	82.84ab	77.33a	98.08a	110.08a	99.67a	102.61a
3.0g	58.78bc	64.10abc	50.00c	57.63b	109.29a	101.33a	96.76a	102.46a
4.5g	53.53c	47.50c	49.63c	50.22b	91.89a	97.45a	78.35a	89.23ab
(A)mean	57.94a	59.97a	56.73a		93.44a	97.31a	88.33a	

Means of each factor designated by the same letter are not significantly different at 5% level using Duncan's Multiple Range Test.
A = Irrigation schedule B = Fertilizer rates

4- Dry weight of leaves /plant

Dry weight of leaves was not affected by the different irrigation intervals in both trials as seen in Table (2). This result may be related to little transpiration rate of the plant and other vital processes, that controlled plant up take of irrigation water and the effectiveness of water on photosynthetic production and mineral accumulation in the leaves. This result is in accordance to that obtained by Lamhamedi *et al* (2003) on black spruce seedlings.

A clear increment on dry weight of leaves was detected due to the different fertilization treatments in both plantations. However, it could be mentioned that using the lowest rate (1.5g/plant) revealed a great influence on the obtained values. Such treatment increased dry weight of leaves to 25.36 and 35.02g against to 16.56 and 25.93g resulted from control in the first and second periods, respectively. This result may be related to increasing nitrogen availability by Cyanobacterial nitrogen fixation which affected plant growth and minerals accumulation in the leaves and photosynthetic efficiency, thereby increasing carbohydrates in the leaves (James and Allan, 1988). This result is agreed with that of Rinaldi and Morgheri (1993) on *Cycas revoluta*.

5- Leaflet length and number /leaf

It is clear from the tabulated data presented in Table (2), that all irrigation intervals and chemical fertilization treatments as well as their interaction revealed insignificant effect on leaflets length and number /leaf in both plantations. However, in this concern Lamhamedi *et al* (2003) found that irrigation regime did not affect growth and losses of mineral nitrogen were increased with increasing irrigation rates, thereby increasing fertilization rates did not affect growth of black spruce.

Table (2): Effect of irrigation, fertilizer treatments and their interaction on dry weight of leaves, number of leaflets / leaf and leaflet length of *Cycas revoluta* during the two experimental periods.

Fertilizer	First period				Second period			
	Irrigation schedule				Irrigation schedule			
	3 days	4 days	5 days	(B)mean	3 days	4 days	5 days	(B)mean
Dry weight of leaves (g.)								
0.0g	18.19abc	15.61bc	15.89bc	16.56c	24.78c	26.26bc	26.75bc	25.93b
1.5g	20.94abc	28.78a	26.35ab	25.36a	32.66abc	38.63a	33.76abc	35.02a
3.0g	25.12abc	19.11abc	21.06abc	21.76ab	36.40ab	33.78abc	32.77abc	34.32a
4.5g	17.54bc	13.41c	22.64abc	17.86bc	30.53abc	29.66abc	26.75bc	28.98b
(A)mean	20.49a	19.23a	21.49a		31.09a	32.08a	30.01a	
Number of leaflets / leaf								
0.0g	58.67	65.33	72.00	65.33a	6.80	70.00	59.00	65.67b
1.5g	71.67	65.67	65.33	67.56a	81.33	72.00	71.00	74.78a
3.0g	69.33	59.00	69.00	65.78a	62.67	67.00	73.00	62.56ab
4.5g	69.00	66.00	61.00	65.33a	66.67	59.33	72.00	66.00b
(A)mean	76.17a	64.00a	66.83a		69.67a	67.08a	68.75a	
Leaflet length (cm.)								
0.0g	11.38	12.75	12.83	12.32a	13.33	14.17	14.08	13.86a
1.5g	13.67	12.92	13.75	13.44a	13.58	15.17	16.08	14.94a
3.0g	13.42	12.67	14.00	13.36a	12.42	16.00	15.83	14.75a
4.5g	13.17	13.33	12.67	13.06a	14.17	15.00	14.00	14.39a
(A)mean	12.91a	12.92a	13.31a		13.38a	15.08a	15.00a	

Means of each factor designated by the same letter are not significantly different at 5% level using Duncan's Multiple Range Test.
A = Irrigation schedule B = Fertilizer rates

6- Stem circumference

Slight effect was observed on stem circumference resulted from applying the different irrigation treatments. However, it could be concluded that receiving the plants irrigation treatment every 5 days in the first period and every 3 days in the second one were the best treatments in this concern. This might be due to the increase in metabolism process, which closely associated with the capacity of the soil to provide moisture (Mooney *et al.*, 1978 and Specht and Specht, 1989). Also, gains in stem diameter within irrigation treatments could be attributed to the increase of cambial zone and the tracheid diameter in the cell expanding as well were greater in trees irrigated every day than in trees irrigated every 3 days (Abe and Nakai, 1999).

The different rates of chemical fertilizer resulted in an increment on stem circumference in both cultivations; the effect was obvious in the second period than the first one. Moreover, it is clear from the data that the great influence of using the lowest rate (1.5g/plant) in application as indicted in Table (3). The effect of NPK treatments on the stem circumference may reflect the necessity of NPK fertilization for building up more metabolites and producing more cells in cambium zone, and enlargement of the cells of the parenchematous tissue which increases in bulk (Haberlandt, 1941). These results are similar to Rinaldi and Morgheri (1993) on *Cycas revoluta* seedlings and EL-Baha (1990) on *Eucalyptus camaldulensis* trees who mentioned that fertilization had given a marked increase in stem diameter. The interaction showed the superiority of receiving the plants irrigation treatment every 4 days with treating the plants with the lowest rate of chemical fertilize (1.5g/plant) in both trials as seen in Table (3).

7- Fresh weight of stem

Evidently data in Table (3), showed that the great effect of receiving the plants irrigation treatment every 3 days for increasing fresh weight of stem in both periods. In this concern, Papadopol, (1982) on Poplus species found that irrigation treatments increasing stem volume growth by 12-16%. And Burman *et al.*, (1991) on *Azadirachta indica* seedlings mentioned that application of field capacity (F.C) per plant at 2 weeks interval led to maximum growth and biomass production.

All chemical fertilization rates increased fresh weight of stem when compared with untreated plants in both cultivations. It was also observed that applying chemical fertilization treatment at the lowest rate (1.5g/plant) was the best treatment in this concern. Such treatment revealed a clear increment in the obtained value when compared with that obtained from control plants or the other fertilization treatments. This result may be related to increase the values of stem circumference as affected by the fertilizer rate of 1.5g/plant and the effect of nitrogen and phosphorus that stimulated growth rate, rate of photosynthesis and phytomass production. These results are similar to those of Rinaldi and Margheri (1993) on *Cycas revoluta* seedlings, and Poole and Conover (1987) on *Cissus* plants.

The interaction, showed the great influence of receiving the plants irrigation treatments at either 3 or 4 days intervals with applying chemical

fertilization at the lowest rate (1.5g/plant) in both cultivations as it is clear from the data of Table (3).

8- Dry weight of stem

Dry weight of stem was not significantly affected by the different irrigation treatments in both plantations as indicated in Table (3). This result may be attributed to the limited water requirements of *Cycas* plants which limit the quantity of water up take by the plant either with high rate of water or low rate. This result is in agreement with that of Poole and Conover (1987) on *Dracaena surculosa*.

Using all chemical fertilization rates resulted in an increment on the obtained values when compared with the control in both plantations. In this respect, applying the lowest rate of chemical fertilizer (1.5g/plant) revealed its superiority for producing the heaviest stems in both plantations.

These results are agreed with those of Zhurova and Patial (1988) on Scots pine seedlings, they mentioned that, the fertilizer treatments increased the dry matter content in all provinces, and EL-Fawakhry *et al* (2004) on three species of *Ficus*, since they stated that half dose of NPK (1.0g/plant) in presence of biofertilizer resulted in the highest values of shoot dry weight.

The interaction indicated the greatest influence of applying irrigation treatment at the shortest duration (every 3 days) with receiving the plants the lowest rate of chemical fertilizer for increasing dry weight of stem in both periods as it seen in Table (3).

Table (3): Effect of irrigation, fertilizer treatments and their interaction on stem circumference and fresh and dry weights of stem of *Cycas revoluta* during the two experimental periods.

Fertilizer	First period				Second period			
	Irrigation schedule				Irrigation schedule			
	3 days	4 days	5 days	(B)mean	3 days	4 days	5 days	(B)mean
Stem circumference (cm.)								
0.0g	16.83de	16.75de	19.25e	17.61b	15.42de	4.95de	14.42e	14.92d
1.5g	19.91a	20.50bc	18.50ab	19.64a	22.25a	19.17bc	20.75ab	20.72a
3.0g	18.42ab	16.83cd	19.25cde	18.17b	21.00ab	17.42cd	17.25cde	18.56b
4.5g	18.08bc	18.00cde	17.00de	17.69b	18.92bc	17.00cde	16.08de	17.33c
(A)mean	18.31a	18.02a	18.50a		18.72a	17.13b	17.13b	
Fresh weights of stem g.								
0.0g	83.20bc	71.57c	99.70abc	84.82b	102.46ab	91.75ab	72.81b	89.01a
1.5g	108.47ab	119.78a	91.89abc	106.71a	117.49a	83.15ab	91.22ab	97.29a
3.0g	111.17ab	86.33bc	83.99bc	94.01ab	124.71a	90.05ab	63.47b	92.74a
4.5g	99.90abc	88.47bc	93.33abc	93.90ab	92.75ab	93.27ab	89.47ab	91.83a
(A)mean	100.82a	91.54a	92.23a		109.35a	89.56ab	79.24b	
Dry weights of stem (g.)								
0.0g	31.89ab	18.50b	38.80a	29.73a	20.78	19.58	18.62	19.66a
1.5g	44.26a	30.34ab	33.73ab	36.11a	27.44	25.40	22.19	25.01a
3.0g	35.59ab	42.78a	29.47ab	35.95a	26.47	27.65	15.24	23.12a
4.5g	40.98a	31.02ab	34.41ab	35.47a	16.59	26.15	19.53	20.76a
(A)mean	38.18a	30.66a	34.10a		22.82a	24.70a	18.90a	

Means of each factor designated by the same letter are not significantly different at 5% level using Duncan's Multiple Range Test.
A = Irrigation schedule B = Fertilizer rates

9- Fresh weight of roots

It is obvious from the tabulated data that fresh weight of roots was not significantly affected by using different irrigation intervals in both experimental periods (Table 4). However, it could be mentioned that using the shortest intervals of 3 and 4 days were the best treatments in this concern. There are a relationship between root characters and vegetative growth as stem diameter or stem weight. Therefore, roots characters had the same behavior of stem characters.

This result supports the observation of Lamhamedi *et al* (2003) on black spruce and Burman *et al.*, (1991) on *Azadirachta indica* seedlings.

Applying chemical fertilization treatments showed a great increment in the obtained values when compared with the control in both trials. In this respect, it could be concluded that, using the lowest rate of 1.5g/plant significantly and considerably increased fresh weight of roots compared with that recorded from control or the other treatments as seen in Table (4). This result may be attributed to mineral accumulation rate by the plant. Our results agreed with that of EL-Gendy *et al* (1995) on *Dracaena draco* and Zhurova and Patial (1988) on *Scots pine*, who mentioned that fertilizer treatments improved root length and weight and biomass accumulation.

The interaction indicated that receiving the plants irrigation treatment every 4 days with applying chemical fertilization at 1.5g/plant had a great influence on fresh weight of roots in both plantations. Such treatment considerably and significantly increased the values than the other treatments in both experimental trials.

10- Dry weight of roots

Data in Table (4) show the insignificant effect of the different irrigation intervals on dry weight of roots in both periods. The same result was detected by Pool and Conover (1987) on *Dracaena surculosa*, and Lamhamedi *et al* (2003) on black spruce seedlings.

Applying the different chemical fertilization rates revealed an increment in the obtained values in both cultivations, with great influence by using the lowest rate (1.5g/plant). Such treatment increased dry weight of roots than that recorded from untreated plants or the other chemical fertilization treatments as seen in Table (4). The increases of root character might be attributed to the rate of Cyanobacteria (like biofertilizer) in decreasing soil density and increased microbial activity in the rhizosphere of soil (Oliveira, et al. 1986). These results are in agreement with EL-Fawakhry *et al* (2004) on three *Ficus* species.

Referring the interaction, it is evident from the obtained values that the superiority of receiving the plants irrigation treatment every 4 days with applying chemical fertilizer rate at 1.5g/plant for increasing dry weight of roots in both experimental trials.

11- Total chlorophylls content

Although the data in Table (4) show the insignificant effect of different irrigation treatments on total chlorophylls content in both trials, it could be pointed out that receiving the plants irrigation treatment at 3 days intervals was the best treatment for increasing total chlorophylls content in both trials. It is known that the water quantity can ever be a directly limiting factor in

chlorophylls content. Water quantity is important in increasing the availability of nitrogen and other minerals and increasing its absorption by the plant so increasing total chlorophylls content in the leaves.

Applying the different chemical fertilizer treatments revealed a clear increment in total chlorophylls content when compared with the control in both cultivations. However, using the lowest rate (1.5g/plant) was the best treatment for increasing the values when compared with the control or the other fertilizer treatments.

This result might be attributed to the role of Cyanobacteria to gain an enhancement in total chlorophylls content. In addition, increasing the availability of nitrogen, consequently increasing its absorption by the plant. It is well known that nitrogen is present in chlorophyll molecule, so that total chlorophylls content in the leaves increased. Similar trend of results was recorded by EL-Fawakhry *et al.* (2004) on *Ficus sp.*

The interaction, showed the superiority of receiving the plants irrigation treatment at 3 days intervals with applying chemical fertilizer at the lowest rate (1.5 g / plant) in both trials as shown in Table (4).

Table (4): Effect of irrigation, fertilizer treatments and their interaction on fresh and dry weights of roots and total chlorophylls contents of *Cycas revoluta* during the two experimental periods.

Fertilizer	First period				Second period			
	Irrigation schedule				Irrigation schedule			
	3 days	4 days	5 days	(B)mean	3 days	4 days	5 days	(B)mean
Fresh weight of roots (g.)								
0.0g	44.30bc	33.86c	37.34c	38.50b	46.15cd	40.34d	43.45cd	43.31c
1.5g	56.60abc	74.22a	63.21ab	64.68a	94.43ab	12.28a	92.47ab	102.39a
3.0g	39.31bc	50.87bc	34.69c	41.62b	74.15bc	59.95cd	66.76bcd	66.95b
4.5g	47.76bc	34.66c	37.75c	40.06b	67.35bcd	48.81cd	54.01cd	56.78b
(A)mean	46.99a	48.40a	43.25a		70.56a	67.35a	64.17a	
Dry weight of roots (g.)								
0.0g	9.05b	9.17b	7.54b	8.59b	8.41def	7.08ef	6.40f	7.30c
1.5g	10.86ab	15.46a	12.54ab	12.95a	16.82ab	20.51a	15.66bc	17.66a
3.0g	10.64ab	7.61b	8.86b	9.04b	13.27bcd	10.67def	11.77cde	11.90b
4.5g	11.27ab	8.35b	7.35b	8.99b	12.78bcd	9.40def	9.20def	10.46b
(A)mean	10.96a	10.15a	9.07a		12.82a	11.91a	10.75a	
Total chlorophylls contents (mg/g F.W)								
0.0g	0.67b	0.53b	0.61b	0.61b	0.55b	0.54b	0.58b	0.56b
1.5g	1.61a	0.61b	0.59b	0.94a	1.60a	0.75b	0.73b	1.03a
3.0g	0.75b	0.80b	0.67b	0.74ab	0.53b	0.81b	0.81b	0.75b
4.5g	0.62b	0.73b	0.83b	0.73ab	0.73b	0.62b	0.65b	0.67b
(A)mean	0.91a	0.87a	0.68a		0.85a	0.68a	0.69a	

Means of each factor designated by the same letter are not significantly different at 5% level using Duncan's Multiple Range Test.
A = Irrigation schedule B = Fertilizer rates

12- Nitrogen content (%) in the leaves

Irrigation treatments either every 4 or 5 days significantly increased nitrogen percent in the leaves to the highest values as it shown in Table (5). On the other hand irrigation treatment every 3 days gave the low nitrogen percent in the leaves. These results may be related to the losses of mineral

nitrogen with leaching of excessive irrigation water (every 3 days). This result is in harmony with the findings of Lamhamedi *et al* (2003) on black spruce.

Concerning fertilizer treatments, a gradual increase of nitrogen content of the leaves was observed with increasing fertilizer rates. This increase may be attributed and vacuoles to the excessive nitrogen content in the growing medium with using high rates of fertilizer. Thereby, accumulation rate of nitrogen had increased more than the requirements, then stored it in the vacuoles of leaf cell. This result is in harmony with that of EL-Baha (1991) on *Eucalyptus camaldulensis,* who found that N, P, K, Ca and Mg % in the leaves were increased with increasing nitrogen fertilization.

The interaction showed that plants irrigated every 4 or 5 days and received the highest rates of fertilizer (3.0 or 4.5 g) had the highest nitrogen contents in the leaves.

13- Phosphorus content (%) in the leaves

As it shown in Table (5), phosphorus content in the leaves was not affected by irrigation treatments. The same result was observed by Lamhamedi *et al* (2003) on black spruce increase.

Concerning fertilizer treatments, a slight was observed on phosphorus contents of the leaves due to using different fertilizer treatments compared to control (non-fertilized). This result may be attributed to the buffer capacity of *Cycas* roots that limits up take of phosphorus by the plant. This result is agreed with that observed by EL-Baha (1991) on *Eucalyptus camaldulensis.*

Concerning the interaction, it can concluded that, the plants irrigated every 3 days and received the lowest rate (1.5g/plant) of fertilizer gave the highest phosphorus content in the leaves.

Table (5): Effect of irrigation, fertilizer treatments and their interaction on nitrogen and phosphorus % of the leaves of *Cycas revoluta* after the second period during 2003/2004 season.

Fertilizer	Nitrogen %				Phosphorus %			
	Irrigation schedule				Irrigation schedule			
	3 days	4 days	5 days	(B)mean	3 days	4 days	5 days	(B)mean
0.0g	1.00d	1.13cd	0.97d	1.03d	0.09d	0.08de	0.09cd	0.09b
1.5g	1.30c	1.50b	1.50b	1.43c	0.12a	0.10bc	0.09cd	0.10a
3.0g	1.50b	1.60b	1.80a	1.63b	0.11ab	0.10bc	0.11ab	0.11a
4.5g	1.77a	1.83a	1.83a	1.81a	0.07e	0.11ab	0.11ab	0.10a
(A)mean	1.39a	1.52a	1.53a		0.10a	0.10a	0.10a	

Means of each factor designated by the same letter are not significantly different at 5% level using Duncan's Multiple Range Test.
A = Irrigation schedule B = Fertilizer rates

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تأثير الفترات المختلفة للرى بالتنقيط ومعدلات السماد الكامل السائل على نمو نباتات السيكس

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نفذ هذا العمل لدراسة تأثير فترات الرى المختلفة (كل ٣، ٤، ٥ يوم) للرى بالتنقيط ومعدلات التسميد المختلفة بالسماد الكامل (NPK١٩:١٩:١٩) ١,٥ و ٣ و ٤,٥ جرام / نبات كل أسبوعين كسماد مذاب مع مياه الرى وذلك على نمو شتلات نبات السيكس خلال فترتى التجربة (١٥ و ٢٠ شهرا) فى ٢٠٠٣ / ٢٠٠٤ بالصوبة بفرع البحوث بحديقة انطونيادس. معهد بحوث البساتين الإسكندرية.

وقد أظهرت النتائج أن الفواصل المختلفة بين مرات الرى لم يكن لها تأثير معنوى على نمو شتلات السيكس خلال فترتى التجربة (١٥، ٢٠ شهرا) ومع ذلك فقد كانت أعلى القيم لصفه الساق قد لوحظت مع فترتى الرى كل ٣ أو ٤ أيام فى نهاية العشرون شهرا. بالنسبة لمعدلات التسميد الكيماوى فقد كانت النتائج الجيدة لنمو شتلات السيكس قد لوحظت مع استخدام المعدل المنخفض من السماد وهو ١,٥ جرام /نبات مرة كل أسبوعين خلال موسم النمو.

مع ملاحظة أن معدلات التسميد العالية كانت سلبية التأثير على النمو وذلك لوجود السيانوباكتيريا (نوستك) والتى تعيش تكافليا مع نباتات السيكس خلال وجودها فى الجذور المتحورة والتى تسمى الجذور المرجانية حيث تقوم بتثبيت النيتروجين الجوى.

عموما زراعة شتلات السيكس داخل الصوبة مع ريها بنظام الرى بالتنقيط مرة كل أربعة أيام بمعدل يساوى ثلث السعة الحقلية للأصيص مع تسميدها كل أسبوعين بمعدل ١,٥ جرام بالسماد الكيماوى الكامل السائل خلال موسم النمو تعتبر أفضل المعاملات لنمو شتلات السيكس.