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EFFECT OF IRRIGATION INTERVALS AND WATER SALINITY ON GROWTH AND CHEMICAL COMPOSITION OF *Cryptostegia grandiflora* PLANTS

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ABSTRACT

This study was conducted at the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, during the two successive seasons of 2000/2001 and 2001/2002. The aim of the study was to investigate the effect of irrigation intervals and irrigation water salinity on the growth and chemical composition of *Cryptostegia grandiflora* plants. The plants were irrigated (till 100% of field capacity) every 3, 6, 9 or 12 days using tap water (control) or water containing a mixture of NaCl and $CaCl_2$ (1:1 w/w) at concentrations of 1500, 3000, 4500, 6000 or 7500 ppm. Prolonging the irrigation intervals caused steady reductions in the mean survival percentage and the vegetative growth parameters (plant height, stem diameter, number of leaves/plant, number of branches/plant, as well as the fresh and dry weights of leaves, stems and roots/plant), with the survival percentage being significantly reduced by irrigation at the longest intervals (12 days), while the vegetative growth parameters were significantly reduced by irrigation intervals of 9 or 12 days, compared to irrigation every 3 days. Also, prolonging the irrigation intervals from 3 to 6, 9 or 12 days resulted in steady reductions in the leaf contents of total chlorophylls, Na, Cl and Ca, but increased the total carbohydrates and proline contents. Raising the salt concentration in the irrigation water also reduced the survival percentage and vegetative growth characteristics steadily, especially with concentrations of 6000 and 7500 ppm, which gave significantly lower values than the control. In addition, raising the salt concentration caused steady reductions in the total chlorophylls content, but increased the proline, Na, Cl and Ca contents in the leaves. The total carbohydrates content was increased by salt concentrations of 1500 or 3000 ppm, whereas higher salt concentrations (4500-7500 ppm) reduced the total carbohydrates content steadily, compared to the control. A significant interaction was detected between the effects of irrigation intervals and salt concentrations. As a result, *Cryptostegia grandiflora* plants tolerated saline water irrigation at concentrations of up to 7500 ppm, combined with irrigation intervals of up to 6 days, with no significant reduction in survival percentage. With lower salt concentrations, the plants can be irrigated at longer irrigation intervals (up to 12 days, using a salt concentration of 4500 ppm or less) with no significant reduction in survival percentage. Moreover, the adverse effect of salinity on some growth characteristics (such as plant height and stem diameter) was less pronounced when the plants were irrigated at short intervals (every 3 days), but as the irrigation intervals were prolonged, the plants became more susceptible to salinity. In general, the most vigorous growth was obtained when the plants were irrigated every 3 days using tap water. Prolonging the irrigation intervals and/or raising the salt concentration resulted in steady reductions in the values recorded for the different vegetative growth characteristics.

Keywords: *Cryptostegia*, irrigation intervals, salinity.

INTRODUCTION

Within the last few years, there has been a rapidly increasing trend to include relatively large landscape areas in the planning of new urban development projects (such the building of new cities, industrial communities, touristic and coastal resorts). However, such projects are often established in areas where water is scarce, and where the main sources of irrigation water (such as well water or recycled municipal water) usually contain relatively high salinity levels. Water shortage may have adverse effects on plants used in the landscape, since it often results in an osmotic shock to the roots, which causes an immediate reduction in photosynthesis (Hoddinott *et al.*, 1979).

Also, salinity is known to have unfavourable effects on plant growth, which can be attributed to inhibition of water avalability mechanisms, disturbance of hormonal mechanisms within the plant, damage to plant cells and cytoplasmic organelles, and interference with normal metabolism (Meiri and Shalhavet, 1973). It is, therefore, very important to select plant species and varieties with low water requirements, and a high tolerance to salinity.

Several studies have been conducted to investigate the effect of different irrigation regimes on the growth and development of a large number of ornamental plants [Harris and Bassuk (1995) on *Corylus colurna*, Williams *et al.* (1999) on *Rosa X hybrida*, Rizzitelli *et al.* (2000) on *Eunymus japonicus*, *Viburnum tinus*, *Pittosporum tobira* and *Osmanthus heterophyllus*, and Hammam (2002) on *Cassia acutifolia*]. Also, the effects of irrigation water salinity on ornamental plants have been investigated by several researchers, including Darwish (1994) on *Casuarina glauca* and *Populus nigra*, Farahat *et al.* (1995) on *Acalypha macrophylla*, Song *et al.* (1997) on *Hibiscus syriacus* and *H. hamabo*, and Wu *et al.* (2001) on *Pistacia chinensis*, *Nerium oleander*, *Buxus microphylla*, *Liquidambar styraciflua*, *Ceanothus thyrsiflorus*, *Nandina domestica*, *Rosa sp.*, *Jasminum polyanthum* and Mexican Stone Pine.

Cryptostegia grandiflora (Roxb. ex R. Br.) R. BR. (*Nerium grandiflorum*, Roxbg.), a member of the Asclepiadaceae family, is a strong, evergreen (semi-deciduous in Egypt), twining woody climber, which grows to a height of 10 m or more. It has thick-textured, oval, glossy leaves, and funnel-shaped, reddish to lilac-purple flowers which appear in summer. Its stems yield poisonous latex that may cause severe discomfort if ingested (Brickell, 1999). In many parts of the world, it is known as the "rubber plant", and in India it is also known as pulay or palay, and is widely cultivated as an ornamental plant (Bailey, 1930). In addition, extracts of leaves of *Cryptostegia grandiflora* exhibited significant antibacterial activity against *Pseudomonas cepacia*, *Bacillus megatorium*, *B. subtilis*, *B. coagulans*, *Staphylococcus aureus* and *Escherichia coli* (Mukherjee *et al.*, 1999).

In another study, Augustus *et al.* (2000), evaluated *C. grandiflora* as a potential multi-use crop. They found that the plant contained 14.0% protein, 6.5% oil, 6.9% polyphenol, and 2.13% hydrocarbon. The hydrocarbon fraction contains natural rubber. The high proportion of saturated fatty acids and the high oil content (> 5.0%) make *C. grandiflora* a potential source for industrial raw material and alternative for conventional oil.

This study was conducted to investigate the feasibility of growing *Cryptostegia grandiflora* plants under conditions of water shortage, and to determine their tolerance to irrigation water salinity.

MATERIALS AND METHODS

This study was conducted at the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, during the two successive seasons of 2000/2001 and 2001/2002. The aim of the study was to investigate the effect of irrigation intervals and irrigation water salinity on the growth and chemical composition of *Cryptostegia grandiflora* plants.

Seeds of *Cryptostegia grandiflora* were sown on 15th March 2000 and 2001 (in the first and second seasons, respectively), in a glasshouse in 8-cm plastic pots filled with a 1:1 (v/v) mixture of sand and clay. On 15th May 2000 and 2001, the seedlings (15 cm tall) were transplanted into perforated polyethylene bags (30-cm diameter) filled with a clay loam soil. The physical and chemical characteristics of the soil are shown in Table (A).

On 1st June 2000 and 2001, the seedlings were moved outdoors to a sunny area, and the treatments were initiated 15 days later. The plants were irrigated every 3, 6, 9 or 12 days using tap water (control) or saline water at concentrations of 1500, 3000, 4500, 6000 or 7500 ppm. The different saline water concentrations were prepared using a mixture of NaCl and $CaCl_2$ (1:1, w/w). At each irrigation, the plants were watered until the soil was saturated (100% of soil field capacity), i.e. until water started leaking from the holes in the bottom of the bags. The treatments were applied regularly until the termination of each season. All plants received monthly fertilization using Kristalon NPK fertilizer (19-19-19) at the rate of 5 g/plant starting 15th August, 2000 and 2001 in the two seasons, respectively.

The layout of the experiment was a split-plot design, with the main plots arranged in a randomized complete blocks design, with 3 blocks (replicates). The main plots were assigned to the irrigation intervals, while the sub-plots were assigned to the irrigation water salinity treatments. The study included 24 treatments [4 irrigation intervals X 6 salt concentrations (including the control)], with each block consisting of 240 plants (10 plants/treatment).

On 1st July, 2001 and 2002 (in the two seasons, respectively), the experiment was terminated and the survival percentage was determined. Also, vegetative growth parameters were recorded, including plant height, stem diameter (at 20 cm above soil surface), number of branches/plant, number of leaves/plant, as well as fresh and dry weights of stems, leaves and roots/plant. In addition, chemical analysis of fresh leaf samples was conducted to determine their total chlorophyll content using the method described by Saric *et al.* (1967), while the content of total carbohydrates in dried leaf samples was determined using the method described by Herbert *et al.* (1971).

Table (A): Physical and chemical characteristics of the soil used for growing *Cryptostegia grandiflora* during the 2000/2001 and 2001/2002 seasons.

Physical characteristics								
Soil texture	Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)	$CaCO_3$ (%)	EC (mmhos/cm)	Field capacity (%)	CEC (meq/100 g)
Clay loam	8.2	31.6	26.7	33.5	2.4	0.34	61.9	34.5

Chemical characteristics				
pH	Organic matter (%)	Available macro-nutrients (ppm)		
		N	P	K
7.6	1.34	42.0	9.2	387.0

Also, nutrients were extracted from samples of dried leaves, using the method described by Piper (1947). The contents of Na and Ca in the extract were determined by using a Pye Unicam Model SP 1900 Atomic Absorption Spectrophotometer with a boiling air-acetylene burner, while the Cl content was determined using the method described by Higinbothan *et al.* (1967). The proline content in fresh leaves was also determined using the method recommended by Bates *et al.* (1973).

The data on the vegetative growth characteristics were subjected to statistical analysis of variance, and the means were compared using the "Least Significant Difference (L.S.D.)" test at the 5% level, as described by Steel and Torrie (1980). The survival percentage data was arc-sin transformed, and the transformed data was statistically analysed.

RESULTS AND DISCUSSION

I- Survival percentage

The results recorded in the two seasons (Table 1) show that prolonging the irrigation intervals from 3 to 6 days caused no significant reduction in the mean survival percentage of *Cryptostegia grandiflora* plants in both seasons. Also, no significant reduction in the mean survival percentage was detected in the first season with prolonging the irrigation intervals to 9 days, but in the second season, plants irrigated every 9 days had a significantly lower mean survival percentage than those irrigated every 3 days. In both seasons, longer irrigation intervals (12 days) reduced the recorded values significantly, compared to those obtained with irrigation every 3 days. This reduction in survival percentage is in agreement with the findings of Humphries *et al.* (1982) on *Betula pendula*, and El-Khateeb *et al.* (1991) on *Schinus molle*, who reported that mortality of seedlings increased by water deficit. No significant difference was detected between the mean survival percentage of plants irrigated every 6 days and that of plants irrigated every 9 days (in both seasons). Also, no significant difference was detected between the mean values recorded with irrigation every 9 or 12 days.

Regarding the effect of irrigation water salinity, the data in Table (1) show that raising the salt concentration from 0 (control) to 1500, 3000 or 4500 ppm had no significant effect on the mean survival percentage. On the other hand, higher salt concentrations (6000 or 7500 ppm) reduced the survival percentage significantly, compared to the control. In both seasons, the greatest reduction in the survival percentage was recorded with the highest salt concentration (7500 ppm). The adverse effect of high salinity levels on the survival percentage may be attributed to the toxicity caused by one or more specific ions, osmotic inhibition of water absorption, or the combination of the two factors (Seatz *et al.*, 1958). Similar reductions in the survival percentage as a result of high salt concentrations have been reported by El-Khateeb *et al.* (1991) on *Schinus molle*, and Song *et al.* (1997) on *Hibiscus syriacus* and *H. hamabo*.

The data presented in Table (1) also show that significant differences were recorded between the survival percentages of plants treated with the different combinations of irrigation intervals and salt concentrations. In both seasons, the effect of prolonging the irrigation intervals depended on the salt concentration that was used. With salt concentrations of 0, 1500, 3000 or 4500 ppm, prolonging the irrigation intervals from 3 to 6, 9 or 12 days did not cause any reduction in the survival percentage. Also, with a salt concentration of 6000 ppm, no reduction in the survival percentage was detected when the irrigation intervals were prolonged from 3 to 6 or 9 days. On the other hand, plants irrigated using a salt concentration of 6000 or 7500 ppm were generally susceptible to drought, with plants irrigated every 12 days having a significantly lower survival percentage, compared to those irrigated every 3 or 6 days.

It is also clear from the data in Table (1) that the effect of the salt concentrations depended on the irrigation intervals that were used. With irrigation every 3 or 6 days, raising the salt concentration from 0 to 1500, 3000, 4500, 6000 or 7500 ppm caused no significant reduction of the survival percentage. On the other hand, plants irrigated every 9 days showed a significant reduction in their survival percentage when the highest salt concentration (7500 ppm) was used, compared to values recorded with salt concentrations of 0, 1500 or 3000 ppm (in both seasons). Plants irrigated every 12 days were even more susceptible to salinity, with the two highest salt concentrations (6000 and 7500 ppm) causing significant reductions in the survival percentage, compared to those of plants receiving salt concentrations of 0, 1500 or 3000 ppm. In both seasons, the greatest reduction in the survival percentage was obtained as a result of irrigation at the longest intervals (12 days) using the highest salt concentration (7500 ppm). These results are in agreement with the findings of El-Khateeb *et al.* (1991), who reported that the survival percentage of *Schinus molle* plants was decreased by combining long irrigation intervals with high salt concentrations in the irrigation water. The above results can be easily explained, since the long irrigation intervals allow the soil to dry out and, consequently, the concentration of soil solution becomes much higher than the original concentration of the irrigation water. This increase in the concentration of the soil solution may cause partial plasmolysis of the root cells, thus affecting their ability to perform their physiological functions of absorption of water and nutrients.

Table (1): Effect of irrigation intervals and salt concentration in irrigation water on the survival percentage, plant height and stem diameter of *Cryptostegia grandiflora* plants during the 2000/2001 and 2001/2002 seasons.

Irrigation intervals (I)	First season: Salt concentration (S), ppm							Second season: Salt concentration(S), ppm						
	Control	1500	3000	4500	6000	7500	Means	Control	1500	3000	4500	6000	7500	Means
***Survival percentage**														
3 days	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a	90.0 a-c	98.3 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
6 days	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a	90.0 a-c	98.3 a	100.0 a	100.0 a	100.0 a	100.0 a	96.7 a	90.0 ab	97.8 ab
9 days	100.0 a	100.0 a	100.0 a	96.7 ab	93.3 a-c	80.0 cd	95.0 ab	100.0 a	100.0 a	100.0 a	93.3 ab	90.0 a-c	76.7 bc	93.3 bc
12 days	100.0 a	100.0 a	100.0 a	96.7 ab	86.7 bc	70.0 d	92.2 b	100.0 a	100.0 a	100.0 a	90.0 a-c	83.3 bc	70.0 c	90.6 c
Means	100.0 a	100.0 a	100.0 a	98.35 ab	95.0 b	82.5 c	---	100.0 a	100.0 a	100.0 a	95.8 ab	92.5 bc	84.2 c	---
Plant height (cm)														
3 days	190.4	188.1	182.9	180.3	168.8	151.3	177.0	183.3	179.9	178.0	173.8	161.7	148.4	170.9
6 days	186.9	186.2	176.7	171.0	159.3	146.6	171.1	179.5	176.8	171.5	169.7	159.5	141.6	166.4
9 days	180.0	175.8	168.6	155.4	152.0	135.9	161.3	174.2	169.6	162.9	160.1	154.5	130.0	158.6
12 days	176.4	162.4	159.1	148.5	136.0	121.2	150.6	166.7	160.0	159.4	155.5	146.8	123.3	152.0
Means	183.4	178.1	171.8	163.8	154.0	138.8	---	175.9	171.6	168.0	164.8	155.6	135.8	---
L.S.D. (0.05) I	8.4							6.5						
S	12.0							11.8						
I X S	14.8							12.9						
Stem diameter (mm)														
3 days	23.8	23.4	21.8	21.0	20.1	18.0	21.4	21.9	21.5	19.8	18.5	17.9	16.9	19.4
6 days	23.5	22.6	20.5	19.5	18.9	17.5	20.4	20.9	20.8	18.9	17.9	17.5	16.4	18.7
9 days	21.9	21.5	19.0	18.8	18.4	17.5	19.5	20.5	19.1	17.8	16.8	16.5	16.0	17.8
12 days	20.6	19.5	19.0	18.1	17.2	16.8	18.5	19.9	18.6	17.2	16.6	16.0	15.2	17.3
Means	22.5	21.8	20.1	19.4	18.7	17.5	---	20.8	20.0	18.4	17.5	17.0	16.1	---
L.S.D. (0.05) I	1.8							1.5						
S	2.8							2.8						
I X S	3.1							3.2						

* Within the row for salinity treatment means, the column for irrigation interval means, or the means for combinations of the two factors, means sharing one or more letters are insignificantly different at the 5% level, according to the "Least Significant Difference" test.

II- Vegetative growth

The vegetative growth of *Cryptostegia grandiflora* plants showed a negative response to prolonging the irrigation intervals (Tables 1-4). In both seasons, the mean values recorded for the studied growth parameters (plant height, stem diameter, number of leaves/plant, number of branches/plant, as well as the fresh and dry weights of leaves, stems and roots/plant) showed a steady decrease as the irrigation intervals were prolonged from 3 to 6, 9 or 12 days. However, the difference between the mean values recorded with irrigation every 3 or 6 days was insignificant (in most cases). The only exception to this general trend was recorded in the second season, with plants irrigated every 6 days having a significantly lower fresh weight of leaves, compared to plants irrigated every 3 days. On the other hand, longer irrigation intervals (9 or 12 days) resulted in significant reductions in the values recorded for the different growth characteristics, compared to those recorded with irrigation every 3 days. Plants irrigated at the longest intervals (12 days) had the lowest values for the different growth parameters. The reduction in vegetative growth at long irrigation intervals is in agreement with the findings of several resaerchers, including Poole and Conover (1986) on *Cissus rhombifolia* and *Syngonium podophyllum*, and El-Khateeb *et al.* (1991), who reported that the different growth characteristics of *Schinus molle* plants (plant height, stem diameter, as well as the fresh and dry weights of leaves and roots) were decreased by prolonging the irrigation intervals. Reductions in vegetative growth as a result of drought treatments have also been reported by Nash and Graves (1993) on *Acer rubrum*, *Magnolia virginiana*, *Nyssa sylvatica*, *Taxodium distichum* and *Asimina triloba*, Rober and Horn (1993) on *Euphorbia pulcherrima*, Harris and Bassuk (1995) on *Corylus colurna* seedlings, Williams *et al.* (1999) on miniature rose (*Rosa X hybrida*) plants, and Rizzitelli *et al.* (2000) on *Eunymus japonicus*, *Viburnum tinus*, *Pittosporum tobira* and *Osmanthus heterophyllus*.

Raising the salt concentration also had an adverse effect on the vegetative growth of *Cryptostegia grandiflora* plants (Tables 1-4). In both seasons, the mean values recorded for the different growth parameters were decreased steadily as the salt concentration was increased. However, this reduction was insignificant in many cases. For example, the data recorded in the two seasons show that the lowest salt concentration (1500 ppm) had no significant effect on any of the studied growth characteristics. This is in agreement with the results obtained by Wu *et al.* (2001), who reported that salt concentrations of 500 or 1500 mg/litre caused no apparent salt stress symptoms on plants of *Pistacia chinensis*, *Nerium oleander*, *Buxus microphylla*, *Liquidambar styraciflua*, *Ceanothus thyrsiflorus*, *Nandina domestica*, *Rosa sp.*, *Jasminum polyanthum* and Mexican Stone Pine. Moreover, the data in Tables (1-4) also show that no significant reduction in stem diameter, number of leaves/plant or fresh weight of stems/plant was recorded in both seasons when the plants were irrigated with water containing a salt concentration of 3000 ppm, whereas higher salt concentrations (4500-7500 ppm) reduced the recorded values significantly, compared to the control. A similar trend was also detected for plant height and the number of branches/plant in the first season, and for dry weight of stems/plant and fresh weight of roots/plant in the second season.

In the second season, no significant reduction in plant height was recorded with salt concentrations of 1500-4500 ppm, compared to plants irrigated with tap water (control), whereas higher salt concentrations (6000-7500 ppm) resulted in significantly shorter plants than the control. The reduction in plant height as a result of high salt concentrations was explained by Everado *et al.* (1975), who suggested that the inhibitory effect of salinity on plant height might be due to the reduction in cell division and/or the inhibition of both cell elongation and activity of meristematic tissues. This may be attributed to a decrease in the activity levels of auxins and gibberellins within the plant, and/or an increase in the activity of growth inhibitors (Ghazi, 1976). Other explanations were proposed by Yasseen *et al.* (1987) and St. Arnaud and Vincent (1990), who mentioned that the decrease in plant height under saline conditions was probably due to the insufficient uptake of water and nutrients, as well as sodic toxicity. Also, the reduction in the number of branches formed on *Cryptostegia grandiflora* plants irrigated with water containing high salinity levels may be explained by the disturbance in natural hormones, including a reduction in the activity of cytokinins [Ghazi (1976), and Sury and Fluckiger (1983)].

The generally adverse effect of high salt concentrations on vegetative growth is in agreement with the results obtained by Salem (1981) on grape vines, El-Leithy and El-Khateeb (1992) on *Thevetia nereifolia*, El-Khateeb (1994) on *Murraya exotica* seedlings, and Song *et al.* (1997) on *Hibiscus syriacus* and *H. hamabo* plants.

Regarding the effect of different combinations of irrigation intervals and salt concentrations, the data presented in Tables (1-4) show that in both seasons, plants irrigated every 3 days using tap water had the most vigorous vegetative growth, i.e. plants receiving this treatment combination had the highest values for all the studied growth parameters. In most cases, prolonging the irrigation intervals and/or raising the salt concentration resulted in steady reductions in the values recorded for the different vegetative growth characteristics. Accordingly, the lowest values recorded for the studied parameters were obtained from plants irrigated at the longest intervals (12 days) using the highest salt concentration (7500 ppm). These results are similar to those obtained by El-Khateeb *et al.* (1991), who reported that combining long irrigation intervals (12 days) with a high salinity level reduced plant height, stem diameter, as well as the fresh and dry weights of roots of *Schinus molle* plants.

The data recorded in the two seasons also show that some growth parameters (such as plant height and stem diameter) were less sensitive to changes in the irrigation intervals or salt concentrations, compared to other growth parameters. For example, when the plants were irrigated every 3 days, no significant difference in plant height was recorded between plants irrigated using tap water or water containing salt concentrations of 1500, 3000 or 4500 ppm. These results are in agreement with the conclusion reached by Warmenhoven *et al.* (1995), who reported that the reduction in chrysanthemum growth caused by high NaCl concentrations was less

Table (2): Effect of irrigation intervals and salt concentration in irrigation water on the number of leaves/plant and the fresh and dry weights of leaves/plant in *Cryptostegia grandiflora* plants during the 2000/2001 and 2001/2002 seasons.

Irrigation intervals (I)	First season							Second season						
	Salt concentration (S), ppm							Salt concentration(S), ppm						
	Control	1500	3000	4500	6000	7500	Means	Control	1500	3000	4500	6000	7500	Means
	Number of leaves/plant													
3 days	66.2	62.2	56.5	41.4	34.1	32.0	48.7	64.1	61.2	57.9	52.3	38.9	35.4	51.6
6 days	61.0	54.6	51.6	36.2	31.4	29.2	44.0	58.0	55.6	52.7	48.8	36.7	34.0	47.6
9 days	55.9	52.3	48.9	36.8	27.3	26.7	41.3	55.2	51.1	49.9	43.9	36.6	30.4	44.5
12 days	44.0	46.4	46.0	33.6	22.3	20.5	35.5	50.4	46.3	43.8	38.0	32.7	30.5	40.3
Means	56.8	53.9	50.8	37.0	28.8	27.1	---	56.9	53.6	51.1	45.8	36.2	32.6	---
L.S.D. (0.05)														
I	5.1							4.5						
S	6.5							6.2						
I X S	7.9							8.1						
	Fresh weight of leaves/plant (g)													
3 days	27.8	25.9	23.7	18.6	14.7	13.1	20.6	25.5	24.9	22.0	18.1	15.3	12.1	19.7
6 days	25.8	24.5	23.0	17.4	14.9	12.1	19.6	23.2	22.9	20.4	16.5	14.3	10.9	18.0
9 days	24.2	22.7	20.1	16.0	12.7	11.0	17.8	21.4	20.6	17.9	15.1	12.4	9.6	16.2
12 days	22.5	21.4	19.4	13.7	10.2	9.5	16.1	20.5	19.5	17.5	14.1	11.4	8.0	15.2
Means	25.1	23.6	21.6	16.4	13.1	11.4	---	22.7	22.0	19.5	16.0	13.4	10.2	---
L.S.D. (0.05)														
I	1.3							0.8						
S	1.8							0.9						
I X S	1.9							1.3						
	Dry weight of leaves/plant (g)													
3 days	5.5	5.3	4.9	4.0	3.2	2.9	4.3	5.4	5.1	4.7	3.9	3.3	2.8	4.2
6 days	5.2	5.0	4.8	3.7	3.0	2.7	4.1	4.9	4.7	4.3	3.6	3.1	2.6	3.9
9 days	4.9	4.5	4.2	3.4	2.8	2.4	3.7	4.5	4.2	3.8	3.3	2.7	2.3	3.5
12 days	4.6	4.4	4.1	3.0	2.3	2.1	3.4	4.3	4.0	3.8	3.1	2.5	2.0	3.3
Means	5.1	4.8	4.5	3.5	2.8	2.5	---	4.8	4.5	4.2	3.5	2.9	2.4	---
L.S.D. (0.05)														
I	0.5							0.4						
S	0.6							0.5						
I X S	0.9							0.7						

Table (3): Effect of irrigation intervals and salt concentration in irrigation water on the number of branches/ plant and the fresh and dry weights of stems/plant in *Cryptostegia grandiflora* plants during the 2000/2001 and 2001/2002 seasons.

Irrigation intervals (I)	First season							Second season						
	Salt concentration (S), ppm							Salt concentration(S), ppm						
	Control	1500	3000	4500	6000	7500	Means	Control	1500	3000	4500	6000	7500	Means
	Number of branches/plant													
3 days	11.8	11.5	10.6	10.1	9.6	7.5	10.2	10.4	9.8	8.9	8.5	8.0	7.0	8.8
6 days	11.3	10.8	10.0	9.0	9.1	6.4	9.4	10.0	9.5	8.4	8.0	7.4	6.1	8.2
9 days	10.5	10.4	9.2	8.5	7.8	4.2	8.4	9.6	8.8	7.9	7.5	7.2	5.0	7.7
12 days	9.6	9.5	8.6	7.4	6.9	3.7	7.6	8.9	8.2	7.1	6.8	6.2	4.2	6.9
Means	10.8	10.6	9.6	8.8	8.4	5.5	---	9.7	9.1	8.1	7.7	7.2	5.6	---
L.S.D. (0.05)														
I	0.9							0.8						
S	1.5							1.1						
I X S	1.8							1.5						
	Fresh weight of stems/plant (g)													
3 days	60.0	58.2	55.4	45.0	38.6	34.6	48.6	63.3	61.5	58.0	52.7	45.4	40.1	53.5
6 days	57.1	54.0	50.9	42.6	36.5	29.3	45.1	58.1	58.0	56.9	48.3	43.0	37.2	50.3
9 days	52.4	48.6	45.7	40.4	32.0	26.9	41.0	55.0	51.6	46.8	44.6	36.4	32.0	44.4
12 days	51.1	46.3	50.8	40.4	28.3	21.6	39.8	45.4	48.8	45.1	40.3	35.7	30.9	42.5
Means	55.2	51.8	50.7	42.2	33.9	28.1	---	57.7	55.0	51.7	46.5	40.1	35.1	---
L.S.D. (0.05)														
I	3.8							4.1						
S	5.1							6.2						
I X S	6.5							7.4						
	Dry weight of stems/plant (g)													
3 days	13.8	12.8	11.5	9.5	7.6	6.1	10.2	13.0	12.6	11.8	10.1	8.7	8.0	10.7
6 days	12.4	11.8	10.5	8.6	7.0	5.8	9.4	12.1	11.6	11.2	9.4	8.3	7.1	10.0
9 days	11.4	10.6	9.6	8.0	6.4	5.2	8.5	11.3	10.5	9.6	8.6	7.0	6.4	8.9
12 days	11.0	10.2	9.4	7.6	5.6	4.0	8.0	10.8	9.8	9.4	8.0	6.8	6.0	8.5
Means	12.2	11.4	10.3	8.4	6.7	5.3	---	11.8	11.1	10.5	9.0	7.7	6.9	---
L.S.D. (0.05)														
I	0.9							0.9						
S	1.2							1.5						
I X S	1.6							1.8						

Table (4): Effect of irrigation intervals and salt concentration in irrigation water on the fresh and dry weights of roots/plant in *Cryptostegia grandiflora* plants during the 2000/2001 and 2001/2002 seasons.

Irrigation intervals (I)	First season							Second season						
	Salt concentration (S), ppm							Salt concentration(S), ppm						
	Control	1500	3000	4500	6000	7500	Means	Control	1500	3000	4500	6000	7500	Means
Fresh weight of roots/plant (g)														
3 days	51.9	49.9	47.4	40.9	35.0	32.1	42.9	54.0	52.0	51.1	48.4	41.6	37.8	47.6
6 days	48.2	46.2	45.5	38.7	33.4	26.9	39.8	49.2	50.9	50.3	44.4	39.5	35.2	44.9
9 days	45.7	42.4	41.3	36.9	29.5	25.0	36.8	48.3	46.2	41.7	41.5	34.2	30.3	40.4
12 days	42.0	40.4	39.1	32.4	25.8	20.1	33.3	46.6	44.7	40.9	37.7	33.7	29.5	38.9
Means	47.0	44.7	43.3	37.2	30.9	26.0	---	49.5	48.6	46.0	43.0	37.3	33.2	---
L.S.D. (0.05)														
I				3.2							3.4			
S				3.5							3.8			
I X S				3.9							4.5			
Dry weight of roots/plant (g)														
3 days	13.8	13.4	12.8	10.5	8.4	7.3	11.0	13.8	12.9	11.9	9.3	7.5	7.0	10.4
6 days	12.9	12.7	12.6	10.0	8.1	6.9	10.5	12.9	12.4	11.4	8.6	7.0	6.4	9.8
9 days	12.5	11.8	10.8	9.1	7.4	6.6	9.7	11.9	10.9	10.3	8.1	6.5	5.5	8.9
12 days	11.9	11.4	10.5	7.9	6.9	5.9	9.1	10.9	10.4	9.9	7.0	5.5	4.8	8.1
Means	12.8	12.3	11.7	9.4	7.7	6.7	---	12.4	11.7	10.9	8.3	6.6	5.9	---
L.S.D. (0.05)														
I				0.7							0.7			
S				0.8							0.9			
I X S				0.9							0.9			

Table (5): Effect of irrigation intervals and salt concentration in irrigation water on the total chlorophylls, total carbohydrates and proline contents in leaves of *Cryptostegia grandiflora* plants during the 2000/2001 and 2001/2002 seasons.

Irrigation intervals (I)	First season							Second season						
	Salt concentration (S), ppm							Salt concentration(S), ppm						
	Control	1500	3000	4500	6000	7500	Means	Control	1500	3000	4500	6000	7500	Means
	Total chlorophylls content (mg/g fresh matter)													
3 days	2.68	2.58	2.44	2.01	1.73	1.63	2.18	2.98	2.94	2.85	2.71	2.54	2.41	2.74
6 days	2.54	2.38	2.28	1.83	1.67	1.54	2.04	2.86	2.81	2.71	2.50	2.32	2.00	2.53
9 days	2.44	2.24	2.12	1.63	1.56	1.48	1.91	2.71	2.69	2.55	2.30	2.01	1.77	2.34
12 days	2.31	2.14	2.04	1.57	1.47	1.43	1.83	2.64	2.56	2.39	2.13	1.86	1.59	2.20
Means	2.49	2.34	2.22	1.76	1.61	1.52	---	2.80	2.75	2.63	2.41	2.18	1.94	---
	Total carbohydrates content (% dry matter)													
3 days	15.4	17.1	17.9	12.6	10.9	10.6	14.1	15.3	16.5	14.1	12.0	10.6	10.0	13.1
6 days	15.9	18.5	18.5	14.9	14.6	12.4	15.8	16.4	17.8	14.7	13.6	11.8	10.5	14.1
9 days	16.5	19.1	19.3	15.6	15.0	13.2	16.5	18.2	20.2	15.5	14.1	12.4	11.0	15.2
12 days	16.9	19.6	19.9	16.0	15.5	14.4	17.1	17.5	22.2	15.9	15.0	12.9	10.8	15.7
Means	16.2	18.6	18.9	14.8	14.0	12.7	---	16.9	19.2	15.1	13.7	11.9	10.6	---
	Proline content (μ moles/g fresh matter)													
3 days	2.65	2.98	3.41	3.69	4.02	4.14	3.48	2.44	2.72	3.62	4.17	4.59	5.28	3.80
6 days	4.18	4.50	5.16	5.53	5.68	6.09	5.19	4.27	4.53	4.85	5.52	5.75	5.95	5.15
9 days	5.75	5.84	6.69	8.20	10.20	11.70	8.06	4.98	5.77	11.09	12.28	12.78	14.19	10.18
12 days	10.46	13.79	17.64	19.98	21.63	23.03	17.76	8.30	10.55	15.86	17.35	19.23	19.86	15.19
Means	5.76	6.78	8.23	9.35	10.38	11.24	---	5.00	5.89	8.86	9.83	10.59	11.32	---

marked with a high irrigation frequency. Also, with plants irrigated using tap water, no significant reduction in plant height was detected when the irrigation intervals were prolonged up to 12 days (in the first season) or up to 9 days (in the second season). In addition, plants irrigated every 6 days using salt concentrations of 0, 1500 or 3000 ppm were not significantly shorter than those irrigated every 3 days using tap water (in both seasons). In contrast, some growth characteristics were extremely sensitive to changes in the irrigation intervals or the salt concentrations. For example, the fresh weight of leaves/plant and the dry weight of roots/plant were significantly higher in plants irrigated every 3 days using tap water, compared to plants treated with most of the other treatment combinations.

III- Chemical composition

1- Total chlorophylls content

The results recorded in the two seasons (Table 5) show that irrigation intervals had a marked effect on the total chlorophylls content in leaves of *Cryptostegia grandiflora*. In both seasons, plants irrigated at the shortest intervals (3 days) had the highest mean total chlorophylls content (2.18 and 2.74 mg/g fresh matter, in the first and second season, respectively). Prolonging the irrigation intervals to 6, 9 or 12 days caused a steady decrease in the recorded mean values, with plants irrigated at the longest intervals (12 days) having the lowest total chlorophylls content (1.83 and 2.20 mg/g fresh matter, in the two seasons, respectively). The decrease in the chlorophylls content as a result of prolonging the irrigation intervals is similar to that obtained by Hammam (2002) on *Cassia acutifolia*.

Salinity of the irrigation water also had a considerable effect on the total chlorophylls content. In both seasons, plants irrigated using tap water (control) gave the highest values (2.49 and 2.80 mg/g in the first and second seasons, respectively). Raising the salt concentration resulted in a gradual reduction in the total chlorophylls content, with the highest salt concentration (7500 ppm) giving the lowest values (1.52 and 1.94 mg/g fresh matter in the two seasons, respectively). Similar reductions in the chlorophyll content as a result of irrigation with saline water were reported by Farahat (1990) on *Schinus molle*, *S. terebinthifolius* and *Myoporum acuminatum*, Shehata (1992) on *Cupressus sempervirens* and *Eucalyptus camaldulensis*, and El-Khateeb (1994) on *Murraya exotica*.

Regarding the interaction between the effects of irrigation intervals and salt concentrations, the data presented in Table (5) show that large variations were recorded between the total chlorophyll contents of plants treated with different combinations of these two factors. In both seasons, the highest values (2.68 and 2.98 mg/g fresh matter in the first and second seasons, respectively) were obtained from plants irrigated at the shortest intervals (3 days) using tap water (control). On the other hand, prolonging the irrigation intervals and/or raising the salt concentration reduced the recorded values. As a result, the lowest values (1.43 and 1.59 mg/g fresh matter in the two seasons, respectively) were recorded when long irrigation intervals (12 days) were combined with the highest salt concentration (7500 ppm).

2- Total carbohydrates content

The data presented in Table (5) show that the synthesis and accumulation of total carbohydrates in leaves of *Cryptostegia grandiflora* were enhanced by subjecting the plants to water stress, i.e. by prolonging the irrigation intervals. In both seasons, plants irrigated at the shortest intervals had the lowest mean total carbohydrates content. The recorded values were increased steadily by prolonging the irrigation intervals, with plants irrigated at the longest intervals (12 days) having the highest values (in both seasons). This increase in the content of carbohydrates in leaves of plants irrigated at relatively long intervals (i.e. drought conditions) may be attributed to a reduction in the translocation of carbohydrates from leaves to other plant parts and/or a reduction in the consumption of carbohydrates in the leaves [El-Khateeb *et al.* (1991) on *Schinus molle*].

In the first season, the total carbohydrates content was also increased steadily by raising the salt concentration from 0 ppm (control) to 1500 or 3000 ppm, with plants irrigated using the 3000 ppm concentration giving the highest mean value. On the other hand, higher salt concentrations caused steady reductions in the recorded values, with the highest salt concentration (7500 ppm) giving the lowest mean value. In the second season, a generally similar trend was recorded, but the highest total carbohydrates content was obtained at a salt concentration of 1500 ppm, whereas salt concentrations of 3000-7500 ppm reduced the recorded values steadily. From the above results, it can be concluded that using a salt concentration of 1500 ppm increased the total carbohydrates content in leaves of *Cryptostegia grandiflora* (in both seasons), while concentrations of 4500-7500 ppm decreased it, compared to the control.

The increase in the total carbohydrates content that was detected as a result of using a salt concentration of 1500 ppm may be explained by the assumption that the accumulation of carbohydrates in the plants grown under these conditions was more rapid than its utilization for the different metabolic processes. Similar increases in the total carbohydrates content of leaves as a result of salinity treatments were obtained by Downton and Loveys (1981) on grapevine, and Darwish (1994) on *Casuarina glauca*. On the other hand, the reduction in the total carbohydrates content of plants irrigated using high salt concentrations (4500-7500 ppm) may be attributed to the relatively high production of energy by increasing respiration to overcome the relatively low availability of water under saline conditions (Moursi *et al.*, 1976). Similar reductions in the total carbohydrates content as a result of irrigation with saline water have been recorded by El-Khateeb *et al.* (1991) on *Schinus molle* plants.

Large variations in the total carbohydrates content were also detected as a result of the interaction between the irrigation intervals and the salt concentrations. Combining short irrigation intervals (3 days) with the highest salt concentration (7500 ppm) gave the lowest total carbohydrates contents recorded in both seasons (10.6% and 10.0% in the first and second seasons, respectively). On the other hand, the highest values were obtained when the plants were irrigated every 12 days using a salt concentration of 3000 ppm (in the first season) or 1500 ppm (in the second season).

Table (6): Effect of irrigation intervals and salt concentration in irrigation water on the Na, Cl and Ca contents in leaves of *Cryptostegia grandiflora* plants during the 2000/2001 and 2001/2002 seasons.

Irrigation intervals (I)	First season							Second season						
	Salt concentration (S), ppm							Salt concentration(S), ppm						
	Control	1500	3000	4500	6000	7500	Means	Control	1500	3000	4500	6000	7500	Means
	Na content (% dry matter)													
3 days	0.23	0.31	0.34	0.39	0.43	0.47	0.36	0.22	0.34	0.35	0.42	0.45	0.55	0.39
6 days	0.23	0.30	0.34	0.35	0.41	0.45	0.35	0.20	0.31	0.33	0.37	0.43	0.47	0.35
9 days	0.22	0.27	0.29	0.33	0.37	0.42	0.32	0.19	0.28	0.30	0.33	0.41	0.43	0.32
12 days	0.21	0.25	0.25	0.31	0.33	0.40	0.29	0.17	0.26	0.28	0.31	0.38	0.40	0.30
Means	0.22	0.28	0.31	0.35	0.39	0.44	---	0.20	0.28	0.32	0.36	0.42	0.46	---
	Cl content (% dry matter)													
3 days	0.21	0.35	0.44	0.49	0.57	0.69	0.45	0.27	0.35	0.47	0.53	0.59	0.68	0.48
6 days	0.20	0.29	0.40	0.45	0.54	0.64	0.42	0.23	0.32	0.42	0.46	0.55	0.62	0.43
9 days	0.20	0.29	0.37	0.41	0.52	0.60	0.40	0.22	0.30	0.37	0.42	0.54	0.59	0.41
12 days	0.20	0.24	0.30	0.38	0.44	0.54	0.35	0.18	0.29	0.35	0.36	0.51	0.56	0.38
Means	0.20	0.29	0.38	0.43	0.52	0.58	---	0.23	0.35	0.40	0.44	0.55	0.61	---
	Ca content (% dry matter)													
3 days	0.30	0.41	0.50	0.56	0.62	0.72	0.52	0.35	0.44	0.48	0.59	0.62	0.70	0.53
6 days	0.34	0.41	0.45	0.53	0.58	0.68	0.50	0.29	0.37	0.44	0.51	0.59	0.67	0.48
9 days	0.27	0.36	0.41	0.47	0.56	0.64	0.44	0.28	0.35	0.42	0.47	0.52	0.59	0.44
12 days	0.26	0.32	0.38	0.44	0.47	0.56	0.41	0.26	0.32	0.39	0.43	0.51	0.59	0.42
Means	0.29	0.38	0.44	0.50	0.56	0.65	---	0.30	0.37	0.43	0.50	0.56	0.64	---

3- Proline content

Both irrigation intervals and salt concentrations had considerable effects on the proline content in leaves of *Cryptostegia grandiflora* (Table 5). In both seasons, plants irrigated at the shortest intervals (3 days) had the lowest mean proline content. Prolonging the irrigation intervals to 6, 9 or 12 days caused steady increases in the recorded mean values, with plants irrigated at the longest intervals (12 days) having a proline content that was approximately 4-5 times higher than that of plants irrigated every 3 days. The increase in the proline content of plants irrigated at long intervals (i.e. under water stress conditions) is in agreement with the findings of El-Khateeb *et al.* (1991) on *Schinus molle*, and Rober and Horn (1993) on *Euphorbia pulcherrima*. This increase in the proline content confirms the role of proline in the physiological mechanisms involved in stress tolerance, and as an indicator of water stress.

Raising the salt concentration in the irrigation water also resulted in steady increases in the mean proline content. In both seasons, plants irrigated using tap water had the lowest mean proline content, whereas irrigation with water containing the highest salt concentration (7500 ppm) approximately doubled the recorded values, compared to the control. Similar results were reported by El-Khateeb (1994) on *Murraya exotica*. The considerable enhancement of proline accumulation in plants irrigated using high salt concentrations may lead to the conclusion that proline plays a role in plant tolerance to salinity. This role was explained by Greenway and Munns (1980), who mentioned that proline can be considered as a stabilizer of osmotic pressure within the cell. Also, Maraim (1990) and Marcum and Murdoch (1994) concluded that proline can make a substantial contribution to cytoplasmic osmotic adjustment.

Considerable differences in the proline content were also obtained between plants treated with different combinations of irrigation intervals and salt concentrations. In both seasons, plants irrigated with tap water (control) every 3 days had the lowest proline content, compared to plants treated with any other combination of irrigation intervals and salt concentrations. Prolonging the irrigation intervals and/or raising the salt concentration caused marked increases in the proline content. Accordingly, combining the longest irrigation intervals (12 days) with the highest salt concentration (7500 ppm) gave the highest proline contents (23.03 and 19.86 µ moles/g fresh matter in the first and second seasons, respectively), which were higher by 769% and 714% (in the first and second seasons, respectively), compared to those of plants irrigated every 3 days using tap water (2.65 and 2.44 µ moles/g fresh matter in the two seasons, respectively).

4- Contents of Na, Cl and Ca

The results presented in Table (6) show that the irrigation intervals had a considerable effect on the Na, Cl and Ca contents in leaves of *Cryptostegia grandiflora*. In both seasons, the highest contents of these three elements were found in the leaves of plants irrigated at the shortest intervals (3 days).

on *Schinus molle*. This reduction in the contents of the three nutrients (Na, Cl and Ca) with long irrigation intervals can be explained by the increase in the concentration of the soil solution that occurs as a result of the dryness of the soil. This increase in the concentration of the soil solution may cause partial plasmolysis of the root cells, thus reducing their ability to perform their function of absorption and translocation of nutrients into the plant. Moreover, the water shortage in the soil (caused by long irrigation intervals) results in a decrease of the absorption rate of minerals, since these minerals are normally dissolved in the soil solution. Another possible explanation of the reduction in the content of the three nutrients as aresult of long irrigation intervals is the reduction in the quantity of salts that are added to the soil with long irrigation intervals, compared to the quantity of salts added with frequent irrigation (i.e. short irrigation intervals), since the salts are dissolved in the irrigation water. Thus, the amounts of the three nutrients available to the plants are lower with long irrigation intervals than with short intervals.

Salinity of the irrigation water also had a marked effect on the Na, Cl and Ca contents. Raising the salt concentration in the irrigation water resulted in a steady increase in the leaf contents of these three minerals, i.e. the lowest values were obtained from plants irrigated using tap water, whereas the highest values were obtained from plants irrigated with water containing the highest salt concentration (7500 ppm). This increase in the Na, Cl and Ca contents of plants irrigated using high salt concentrations may account for the reduction in the survival percentage under these conditions (as previously mentioned), since the accumulation of these elements at high concentrations may interfere with the mechanisms responsible for the closure of stomata, thus resulting in an increase in the rate of transpiration from the plant. This may eventually lead to plant wilting or death (Meidner and Mansfield, 1968). Similar increases in the Na, Cl and Ca contents with increasing the salinity level have been reported by El-Mahrouk (1980) on *Lantana camara* and *Myoporum pictum*, El-Mahrouk *et al.* (1992) on *Dodonaea viscosa*, El-Khateeb (1994) on *Murraya exotica*, and Farahat *et al.* (1995) on *Acalypha macrophylla*.

Regarding the interaction between the effects of irrigation intervals and salt concentrations on the Na, Cl and Ca contents, the data in Table (6) show that the highest contents of the three elements were obtained when short irrigation intervals (3 days) were combined with the highest salt concentration (7500 ppm). In contrast, the lowest Na, Cl and Ca contents were obtained in the leaves of plants irrigated at the longest intervals (12 days) using tap water (control). In general, the effect of prolonging the irrigation intervals was not very considerable in plants irrigated using tap water, i.e. the difference between the values obtained from plants irrigated using tap water every 3, 6, 9 or 12 days was only slight. On the other hand, as the salt concentration was raised, the plants became more sensitive to prolonging the irrigation intervals, i.e. plants irrigated with water containing high salinity levels showed pronounced reductions in their Na, Cl and Ca contents in response to prolonging the irrigation intervals.

CONCLUSION

From the above results, it can be concluded that *Cryptostegia grandiflora* plants are relatively tolerant to drought and salinity. They can tolerate saline water irrigation at concentrations of up to 7500 ppm, combined with irrigation intervals of up to 6 days, with no significant reduction in survival percentage. With lower salt concentrations, the plants can be irrigated at longer irrigation intervals (up to 12 days, using a salt concentration of 4500 ppm or less) with no significant reduction in survival percentage. Moreover, most of the vegetative growth chracteristics of the surviving plants were not significantly affected by salt concentrations of up to 1500-3000 ppm, whereas higher concentrations (4500-7500 ppm) reduced plant growth significanlty. Also, plant vegetative growth was not significantly affected by prolonging the irrigation intervals from 3 to 6 days, but longer irrigation intervals (9 or 12 days) caused significant reductions in most of the recorded growth parameters.

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تأثير فترات الرى و ملوحة ماء الرى على النمو و التركيب الكيميائى لنباتات الكريبتوستيجيا (*Cryptostegia grandiflora*)

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أجرى هذا البحث فى مشتل التجارب بقسم بساتين الزينة، كلية الزراعة، جامعة القاهرة، خلال الموسمين المتتاليين ٢٠٠٠/٢٠٠١ و ٢٠٠١/٢٠٠٢. و إستهدف البحث دراسة تأثير فترات الرى و ملوحة ماء الرى على النمو و التركيب الكيميائى لنباتات الـ *Cryptostegia grandiflora*. تم رى النباتات (وصولاً إلى ١٠٠% من السعة الحقلية) كل ٣، ٦، ٩ أو ١٢ يوم باستخدام ماء الصنبور (كنترول)، أو ماء يحتوى على خليط من أملاح كلوريد الصوديوم و كلوريد الكالسيوم (١:١ وزناً) بتركيزات ١٥٠٠، ٣٠٠٠، ٤٥٠٠، ٦٠٠٠ أو ٧٥٠٠ جزء فى المليون. و قد أدت إطالة فترات الرى إلى إنخفاض طردى فى متوسط النسبة المئوية لبقاء النباتات، و إلى إنخفاض قياسات النمو الخضرى (إرتفاع النبات، قطر الساق، عدد الأوراق/نبات، عدد الأفرع/نبات، و الأوزان الطازجة و الجافة للأوراق و السيقان و الجذور/نبات)، حيث كان النقص فى النسبة المئوية للبقاء معنوياً عند الرى على أطول فترات (١٢ يوم)، بينما إنخفضت صفات النمو الخضرى معنوياً عند الرى كل ٩ أو ١٢ يوم، و ذلك بالمقارنة بالنباتات التى تم ريها كل ٣ أيام. كذلك فقد أدت إطالة فترات الرى من ٣ أيام إلى ٦ أو ٩ أو ١٢ يوم إلى إنخفاض طردى فى محتوى الأوراق من الكلوروفيلات الكلية و الصوديوم و الكلور و الكالسيوم، إلا أنها زادت من محتوى الكربوهيدرات الكلية و البرولين. زيادة تركيز الأملاح فى مياه الرى أدت أيضاً إلى إنخفاض طردى فى النسبة المئوية لبقاء النباتات و فى صفات النمو الخضرى، خاصة عند تركيزى ٦٠٠٠ و ٧٥٠٠ جزء فى المليون، اللذان أعطيا قيماً أقل معنوياً من الكنترول. كما أدى رفع تركيز الملوحة إلى إنخفاض طردى فى محتوى الكلوروفيلات الكلية، إلا أنه زاد من محتوى البرولين و الصوديوم و الكلور و الكالسيوم فى الأوراق. أما محتوى الكربوهيدرات الكلية فقد زاد عند إستخدام تركيزات ١٥٠٠ أو ٣٠٠٠ جزء فى المليون من الأملاح فى ماء الرى، فى حين أن التركيزات الأعلى من ذلك (٤٥٠٠-٧٠٠٠ جزء فى المليون) تسببت فى إنخفاض طردى فى محتوى الكربوهيدرات الكلية مقارنة بالكنترول. هذا و كان لنباتات الـ *Cryptostegia grandiflora* القدرة على تحمل الرى بتركيزات ملوحة تصل إلى ٧٥٠٠ جزء فى المليون مع فترات رى تصل إلى ٦ أيام، و ذلك دون إنخفاض معنوى فى النسبة المئوية للبقاء. و عند الرى بتركيزات أقل، كانت النباتات قادرة على تحمل الرى على فترات تزيد عن ٦ أيام (وصلت إلى ١٢ يوم عند الرى بتركيز ملوحة ٤٥٠٠ جزء فى المليون أو أقل) بدون حدوث إنخفاض معنوى فى النسبة المئوية للبقاء. كذلك فإن التأثير الضار للملوحة على بعض صفات النمو الخضرى (مثل إرتفاع النبات و قطر الساق) كان أقل وضوحاً عند الرى على فترات متقاربة (كل ٣ أيام)، و لكن مع إطالة فترات الرى فإن النباتات أصبحت أكثر حساسية للملوحة. و بصفة عامة فقد تم الحصول على أقوى نمو خضرى عند رى النباتات كل ٣ أيام بإستخدام ماء الصنبور، فى حين أن إطالة فترات الرى و/أو زيادة تركيز الملوحة أدت إلى إنخفاض طردى فى القيم المسجلة لصفات النمو الخضرى المختلفة.