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PHYSIOLOGICAL STUDIES ON WASHINGTONIA FILIFERA, WENDL.PLANTS:
I- RELIEFING THE HARMFUL EFFECTS OF WATER STRESS ON SANDY SOIL-GROWN SEEDLINGS BY THE USE OF VAPOR GARD AND ASCORBIC ACID

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ABSTRACT

A pot experiment was conducted during the two seasons of 1999 and 2000 in the Experimental Farm Fac. of Agric., Minia Univ. to study the influence of four irrigation intervals, as well as, vapor gard and ascorbic acid concentrations on growth, chemical composition and leaf water contents of *Washingtonia filifera* seedlings grown in sandy soil.

Obtained results indicated that shortening irrigation intervals (every 3 or 5 days) caused noticeable increase in different vegetative growth characters, namely, plant height, petiole length, leaf blade measurements and number and fresh and dry weights .of leaves/plant, as well as, leaf free or bound and total water contents. While, prolonging irrigation intervals (every 10 days) increased roots fresh and dry weights, photosynthetic pigments and N, P and K leaf %.

Both vapor gard and ascorbic acid treatments caused a gradual increase in all growth, chemical composition and leaf water content measurements by the gradual increase in their concentrations, with the best results being obtained from vapor gard at 3% and ascorbic acid at 500 ppm. It was interesting to observe that exposing *Washingtonia filifera* seedlings to the highest water stress (irrigation every 10 days) with the supplement of vapor gard at 3% or ascorbic acid at 500 ppm gave, almost, equal growth values to the seedlings irrigated at the shortest interval (every 3 days).

INTRODUCTION

Washingtonia filifera, Wendl., *belonging to Fam. Palmaceae,* is one of the most widely used ornamental palms in Egypt. In the last few decades such palm trees were increasingly cultivated along the Egyptian beaches of both Mediterranean and Red Seas because of their tolerance of some adverse conditions such as salinized vapor, drought and sandy soils. At these areas, where sandy and sandy loam soils are prevailed, water supply is very limited and expensive for irrigating landscape plants. Therefore, the present trial was planned to improve and enhance the growth of such important palm trees, at the seedling stage, under limited water supply, by using antitranspirant (vapor gard) and antioxidant (ascorbic acid) substances.

A good number of authors studied the response of different plant species to irrigation supply in sort of amount of irrigation water per unit area, water intervals or soil field capacity, in terms of vegetative growth characters, chemical composition and/or cell water measurements. Burman *et al.*, (1991) on *Azadirachta indica*, Mahfouz (1997) on roselle and Sayed (2001) on *Khaya senegalensis* concluded that increasing water supply augmented different vegetative growth traits but decreased the photosynthetic pigments content and N, P and K% in the leaves. Shehata (1992) on *Cupessus sempervirens* and El-Tantawy *et al* (1993a) on *Eucalyptus camaldulensis* pointed out the role of ample water in stimulating free, bound and total cell water, in addition to vegetative growth characters. Similar results, concerning vegetative growth were obtained also by Farahat (1990), Fotelli *et al* (2000) and Kandeel *et al* (2002) on *Schinus molle*, *Quercus spp.* and *Melia azedarach*, respectively. However, increasing water supply reduced chlorophylls content of *E. camaldulensis* leaves (El-Tantawy *et al*, 1993b) and decreased moghat leaves %of N, P and K (Hassan *et al*, 1986).

Concerning vapor gard, as an antitranspirant agent, it was found to increase vegetative growth parameters, chlorophylls content, N, P and K% and leaf water contents (Attia *et al*, 1991 on *E. citriodora* and Mahfouz, 1997 on roselle plants). Mostafa *et al* (1995) on sour orange seedlings and Abd-Elnasser and El-Gamal (1996) on sweet potato came to similar results concerning vegetative growth. Moreover, the application of vapor gard at various concentrations was found to promote chlorophylls content of codiaeum (Ghitany and Abd-Elhadi, 1989) and mango seedlings (Mehana, 2001) and to increase leaf free bound and total water contents of *Ficus benjamina*, woody plants and mango (Abd-Elhadi and Ghitany, 1989; Hummel, 1990 and Mehana, 2001), respectively.

In regard to ascorbic acid, it was reported to improve various vegetative growth parameters, when applied at different concentrations, on lemongrass (Tarraf *et al*, 1999); grapevines (Ali, 2000); apple (Ahmed and Morsy, 2001 and Ali *et al.*, 2002) and potatoes (Gad-Elhak *et al*, 2002). In addition, Tarraf *et al* (1999) on lemongrass and Ali (2000) on grape vines pointed out that ascorbic acid increased the percentages of N, P and K in the leaves of such plants.

MATERIALS AND METHODS

A pot experiment was conducted during the two successive seasons of 1999 and 2000 at the Experimental Farm, Faculty of Agriculture, Minia University to study the response of *Washingtonia filifera* seedlings, grown in sandy soil, to irrigation frequency, vapor gard and ascorbic acid.

Two years old seedlings were potted in 40 cm clay pots (one seedling/pot) filled with sandy soil on the first week of February of both seasons. Physical and chemical analysis of the used soil are shown in Table (a). The seedlings were kept for four weeks under lath-house conditions and irrigated as needed. On the first week of March 1999 and 2000, the most healthy and uniform potted seedlings were translocated out of the lath house and the treatments were started. A split plot design with three replicates was followed where four irrigation frequencies were assigned to the main plots and three vapor gard (V.G) concentrations +three ascorbic acid (A.A.) concentrations + control were nominated for the sub-plots. The experimental unit included five pots. Irrigation frequency treatments were performed by supplying each pot with fixed quantity of water (3 liter/pot) every 10, 7, 5 or 3 days. On the other hand, vapor gard (V.G) was applied as foliar spray at 1,2 and 3% and ascorbic acid (A.A) was foliar sprayed at 125, 250 and 500 ppm, till run off, in addition to the control plants which sprayed with tap water. Both V.G. and A.A., as well as, tap water were applied 7 times with 4 week intervals starting March 15th for both seasons. All plants were fertilized with N, P and K at the rate of 15:10: 6 g/pot of ammonium sulphate 20.6% N, calcium superphosphate 15.5% P_2O_5 and potassium sulphate 48% K_2O, respectively. Phosphorus fertilization was added once before planting, while both N and K fertilizer amounts were applied twice on the first week of April and May of both experimental seasons.

On the first week of Dec. of both seasons, the following data were recorded: plant height (cm), number of leaves/plant, petiole length, longitudinal and across length of leaf blade (cm), leaves fresh and dry weights and roots fresh and dry weights (g). In addition, the contents of chlorophyll a, chlorophyll b and carotenoids were estimated according to Fadl and Seri-Eldeen (1978) and nitrogen, phosphorus and potassium % in the leaves were determined following the method described by Page *et al* (1982). Regarding leaf free, bound and total water contents, they were measured as described by Gosef (1960). Obtained data were tabulated and statistically analyzed according to Snedecor and Cochran (1980).

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

Character	Value	Character	Value
Sand %	88.2	Total N	0.08
Silt %	7.2	Avail. P	8.50
Clay %	4.6	Extr. K mg/100 g	2.08
Org. matter %	1.56	Fe	7.20
$CaCO_3$	2.17	DTPA Cu	2.12
pH (1:2.5)	7.74	Extr. ppm Zn	3.16
E.C. mmhos/cm	1.06	Mn	14.82

RESULTS AND DISCUSSION

Vegetative Growth Characteristics: -

Vegetative growth characteristics, namely, plant height, number of leaves, petiole length, longitudinal and across length of leaf blade and fresh and dry weights of the leaves/plant were gradually increased by the gradual shortening of the watering intervals from 10 days and up to 3 days. The differences were significant in the two seasons as indicated in Tables (1, 2 and 3). The highest values for all these traits were occurred when *Washingtonia filifera* seedlings were irrigated every 3 days, however, no significant differences were detected, in both seasons, between the shortest two irrigation intervals (5 and 3 days). On the contrary, fresh and dry weights of roots were sloping downward by the gradual reduction in watering intervals in both seasons, (Table 3). The differences were significant and the heaviest roots fresh and dry weights were obtained due to supplying the seedlings with water every 10 days.

Table (1): Effect of irrigation frequency and vapor gard and ascorbic acid on vegetative growth of *Washingtonia filifera* seedlings during 1999 and 2000 seasons.

V.G and A.A. conc. B	First season					Second season				
	Irrig. Frequency (every..........days) A					Irrig. frequency (every..........days) A				
	10	7	5	3	Mean	10	7	5	3	Mean B
	Plant height (cm)									
Control	53.1	64.5	66.9	67.9	63.1	49.2	59.6	61.8	62.7	58.3
V.G. 1%	58.8	70.3	73.2	74.4	69.2	52.3	65.1	67.5	68.8	63.4
V.G. 2%	61.7	71.8	74.5	76.8	71.2	56.4	66.3	69.0	70.5	65.6
V.G. 3%	63.5	73.6	77.1	79.8	73.5	57.6	68.3	71.5	73.9	67.8
A.A. 125 ppm	60.8	71.0	73.8	75.3	70.2	54.8	66.0	68.6	69.6	64.8
A.A. 250 ppm	61.3	72.5	75.5	78.6	72.0	57.7	68.1	70.1	72.5	67.1
A.A. 500 ppm	62.8	73.6	77.8	81.1	73.8	58.9	69.8	72.4	74.9	69.0
Mean A	60.3	71.0	74.1	76.3		55.3	66.2	68.7	70.4	
L.S.D. 5%	A: 5.2	B: 4.8	AB: 9.6			A: 6.1	B: 5.9	AB: 11.8		
	Number of leaves/plant									
Control	6.67	6.77	6.90	7.09	6.86	6.24	6.36	6.62	7.02	6.56
V.G. 1%	6.83	6.93	7.12	7.40	7.07	6.50	6.63	6.90	7.31	6.84
V.G. 2%	7.00	7.13	7.34	7.71	7.30	6.57	6.70	6.97	7.39	6.91
V.G. 3%	7.11	7.25	7.50	7.92	7.45	6.69	6.82	7.09	7.50	7.03
A.A. 125 ppm	6.83	6.97	7.24	7.68	7.18	6.49	6.62	6.88	7.29	6.82
A.A. 250 ppm	7.04	7.15	7.36	7.74	7.32	6.56	6.69	6.95	7.38	6.90
A.A. 500 ppm	7.01	7.12	7.41	7.78	7.33	6.60	6.73	7.00	7.42	6.94
Mean A	6.93	7.05	7.27	7.62		6.52	6.65	6.92	7.33	
L.S.D. 5%	A: 0.53	B: N.S.	AB: N.S.			A: 0.61	B: N.S.	AB: N.S.		
	Petiole length (cm)									
Control	9.8	10.9	11.6	12.1	11.1	9.2	10.0	10.7	11.2	10.3
V.G. 1%	11.1	12.0	12.6	13.2	12.2	10.2	11.0	11.4	11.9	11.1
V.G. 2%	12.5	13.8	14.4	14.6	13.8	11.1	12.7	13.1	13.2	12.5
V.G. 3%	13.3	14.9	15.4	15.5	14.8	12.2	13.7	14.0	14.1	13.5
A.A. 125 ppm	11.2	12.6	12.7	13.7	12.6	10.4	11.4	11.4	11.9	11.3
A.A. 250 ppm	12.4	13.8	14.5	14.9	13.9	11.5	12.7	13.2	13.4	12.7
A.A. 500 ppm	13.1	14.6	14.9	15.2	14.5	12.1	13.3	13.5	13.4	13.1
Mean A	11.9	13.2	13.7	14.2		11.0	12.1	12.5	12.7	
L.S.D. 5%	A: 1.2	B: 1.0	AB: 2.0			A: 0.8	B: 1 2	AB: 2.4		

V.G. = Vapor gard
A.A. = Ascorbic acid
Irrigation Frequency: Factor A
V.G. and A.A. : Factor B

Table (2): Effect of irrigation frequency and vapor gard and ascorbic acid on vegetative growth of *Washingtonia filifera* seedlings during 1999 and 2000 seasons.

V.G and A.A. conc. B	First season					Second season				
	Irrig. frequency (every..........days) A					Irrig. Frequency (every..........days) A				
	10	7	5	3	Mean B	10	7	5	3	Mean B
	Longitudinal length of leaf blade (cm)									
Control	32.9	40.8	45.1	46.5	41.3	30.4	39.5	41.6	42.1	38.4
V.G. 1%	36.7	44.6	47.4	47.6	44.1	33.9	40.1	42.5	43.1	39.9
V.G. 2%	40.0	46.5	48.9	50.3	46.4	37.0	42.9	44.2	45.5	42.4
V.G. 3%	43.6	50.2	53.8	53.6	50.3	40.6	46.8	48.9	49.0	46.3
A.A. 125 ppm	36.9	45.3	48.2	48.5	44.7	34.1	40.9	43.5	43.8	40.6
A.A. 250 ppm	42.0	47.2	51.3	51.9	48.1	38.8	42.6	46.0	46.8	43.6
A.A. 500 ppm	45.8	48.9	53.1	54.0	50.5	41.4	44.2	48.1	49.0	45.7
Mean A	39.7	46.2	49.7	50.3		36.6	42.4	45.0	45.6	
L.S.D. 5%	A:4.1	B:3.9	AB: 7.8			A:3.5	B:3.0	AB: 6.0		
	Across length of leaf blade (cm)									
Control	40.5	46.8	47.5	49.8	46.2	37.4	42.3	43.9	44.2	42.0
V.G. 1%	44.0	49.6	50.0	51.2	48.8	39.6	44.9	45.5	45.7	43.9
V.G. 2%	45.2	52.8	53.7	54.0	51.4	40.8	46.8	47.6	47.8	45.8
V.G. 3%	49.2	54.4	58.1	56.3	54.5	44.8	49.6	51.2	51.3	49.2
A.A. 125 ppm	44.7	50.5	50.7	54.8	50.2	40.1	45.7	45.9	46.7	44.6
A.A. 250 ppm	47.3	53.6	54.2	55.9	52.8	42.9	47.5	48.0	48.7	46.8
A.A. 500 ppm	49.8	54.2	54.8	56.6	53.9	45.0	48.9	48.6	49.8	48.1
Mean A	45.8	51.7	52.7	54.1		41.5	46.5	47.2	47.7	
L.S.D. 5%	A:5.0	B: 4.6	AB:9.2			A: 4.6	B:3.5	AB:7.0		
	Leaves fresh weight/plant (g)									
Control	165.0	198.7	212.6	218.0	198.6	163.3	191.9	206.4	214.3	194.0
V.G. 1%	187.3	223.8	237.3	241.6	222.5	182.7	220.3	235.6	240.2	219.7
V.G. 2%	200.4	232.3	242.8	248.2	230.9	195.8	225.3	240.0	245.1	226.6
V.G. 3%	226.2	259.6	267.6	277.1	257.6	212.6	246.0	258.8	271.6	247.3
A.A. 125 ppm	188.6	221.7	244.7	255.3	227.6	188.3	218.7	236.1	245.4	222.1
A.A. 250 ppm	201.9	237.9	257.9	268.3	241.5	199.6	229.6	245.0	260.8	233.8
A.A. 500 ppm	212.7	246.4	271.9	280.1	252.8	208.3	240.3	258.9	271.9	244.9
Mean A	197.4	231.5	247.8	255.5		192.9	224.6	240.1	249.9	
L.S.D. 5%	A: 16.5	B: 12.9	AB: 25.8			A:22.4	B:18.8	AB: 37.6		

V.G. = Vapor gard
A.A. = Ascorbic acid
Irrigation Frequency: Factor A
V.G. and A.A. : Factor B

Table (3): Effect of irrigation frequency and vapor gard and ascorbic acid on vegetative growth of *Washingtonia filifera* seedlings during 1999 and 2000 seasons.

V.G and A.A. conc. B	First season					Second season				
	Irrig. frequency (every.........days) A					Irrig. Frequency (every.........days) A				
	10	7	5	3	Mean	10	7	5	3	Mean B
	Leaves dry weight/plant (g)									
Control	36.6	40.5	43.1	44.0	41.1	36.1	39.1	41.7	43.2	40.0
V.G. 1%	39.4	43.6	45.2	46.7	43.7	38.4	43.0	45.6	46.2	43.3
V.G. 2%	42.1	44.9	46.2	47.7	45.2	41.1	43.5	45.9	47.1	44.4
V.G. 3%	44.2	46.9	48.1	50.9	47.5	42.8	45.7	48.0	49.9	46.6
A.A. 125 ppm	37.0	41.1	44.8	45.7	42.1	36.9	40.0	44.9	44.5	41.6
A.A. 250 ppm	39.7	42.0	45.6	46.9	43.6	38.7	41.4	45.5	46.2	43.0
A.A. 500 ppm	40.3	43.2	46.8	48.8	44.8	39.4	43.1	46.5	47.4	44.1
Mean A	39.9	43.2	45.7	47.2		39.1	42.3	45.4	46.4	
L.S.D. 5%	A:4.1		B:3.6		AB:7.2	A:4.6		B:3.3		AB:N.S.
	Roots fresh weight/plant (g)									
Control	45.3	43.1	39.4	38.6	41.6	44.3	41.7	36.8	32.4	38.8
V.G. 1%	52.6	50.8	45.6	41.8	47.7	50.2	46.2	41.6	38.4	44.1
V.G. 2%	53.8	51.6	46.8	43.3	48.9	52.4	50.3	44.8	40.0	46.9
V.G. 3%	58.6	55.5	48.0	45.7	52.0	55.7	52.5	47.5	42.3	49.5
A.A. 125 ppm	52.3	50.0	43.8	42.0	47.0	49.9	44.7	42.2	36.9	43.4
A.A. 250 ppm	53.9	51.2	44.9	43.1	48.3	54.0	46.8	44.5	42.0	46.8
A.A. 500 ppm	55.7	53.8	47.7	44.2	50.4	55.3	51.0	46.8	42.7	49.0
Mean A	53.2	50.9	45.2	42.7		51.7	47.6	43.5	39.2	
L.S.D. 5%	A:5.1		B: 4.4		AB: 8.8	A:4.8		B:4.6		AB: 9.2
	Roots dry weight/plant (g)									
Control	18.1	17.4	16.0	16.4	17.0	18.1	17.0	15.4	13.9	16.1
V.G. 1%	20.7	20.3	18.3	17.6	19.2	20.5	19.7	17.0	15.8	18.3
V.G. 2%	21.2	20.5	18.7	18.1	19.6	20.8	20.4	18.4	16.4	19.0
V.G. 3%	22.8	21.8	19.3	19.2	20.8	22.7	21.3	20.0	17.4	20.4
A.A. 125 ppm	20.4	20.0	17.7	17.6	18.9	20.4	18.8	17.5	15.0	17.9
A.A. 250 ppm	20.9	20.3	18.0	18.0	19.3	20.9	19.3	18.2	17.4	19.0
A.A. 500 ppm	21.6	20.8	18.8	18.3	19.9	21.1	20.4	18.7	17.7	19.5
Mean A	20.8	20.2	18.1	17.9		20.6	19.6	17.9	16.2	
L.S.D. 5%	A:1.5		B:1.2	AB:2.4		A:1.3		B:1.9		AB:3.8

V.G . = Vapor gard
A.A. = Ascorbic acid
Irrigation Frequency: Factor A
V.G. and A.A. : Factor B

Many investigators revealed that the role of increasing water supply or soil water contents in augmenting seedling height and different leaf measurements such as Farahat (1990) on *Schinus molle*, Burman *et al* (1991) on *Azadirachta indica*, El-Tantawy *et al* (1993a) on *Eucalyptus camaldulensis*, Fotelli *et al* (2000) on *Quercus spp.*, Sayed (2000) on *Khaya seneglaensis* and Kandeel *et al* (2002) on *Melia azedarach*. However, the stimulation of root growth in limited water supply of sandy soil-grown seedlings was observed on *Azadirachta indica* (Burman *et al*, 1991); *Khaya senegalensis* (Sayed, 2001) and *Melia azedarach* (Kandeel *et al*, 2002).

Concerning the other factor (antitranspirant and antioxidant substances), all studied growth traits, except leaves number/plant, were significantly augmented due to the use of either vapor gard (V.G.) or ascorbic acid (A.A.) in the two seasons in comparison with those of control plants. The improve in different growth traits was gradual and parallel to the increase in the concentration of V.G. or A.A. in both seasons. The best results were obtained due to the use of the high concentration of V.G. (3%) and A.A. (500 ppm) as shown in Tables (1, 2 and 3).

In agreement with these results concerning V.G. were those revealed by Attia *et al* (1991) on *E.citriodora*, Mostafa *et al* (1995) on sour orange, Abd-Elnasser and El-Gamal (1996) on sweet potato and Mahfouz (1997) on roselle. While, the role of A.A. in improving vegetative growth was reported by Tarraf *et al* (1999) on lemongrass, Ali (2000) on grape vines, Ahmed and Morsy (2001) and Ali *et al* (2002) on apple and Gad-Elhak *et al* (2002) on potato.

The interaction between watering intervals and both V.G. and A.A. substances was significant for all vegetative growth traits except that of leaves dry weight in the second season. The best results for plant height, petiole length, longitudinal and across length of leaf blade and fresh and dry weights of leaves were obtained due to irrigating the seedlings every 3 days and spraying them with V.G. at 3% or A.A. at 500 ppm, while the heaviest roots fresh and dry weights were obtained due to the same V.G. or A.A. concentrations with the irrigation every 10 days as clearly shown in Tables (1, 2 and 3).

A physiological explanation to the previous vegetative growth results in regard to irrigation treatments might be due to the fact that the amount of growth the plant makes is controlled to a greater extent by the water supply. The essential factor in plant-water relationships is the maintenance of a sufficiently high water content, or turgidity, to permit normal functioning of physiological processes and growth. Kramer and Kozlowski (1979) summarized the important roles of water in the woody plant life as a constituent of protoplasm, as an essential reagent in photosynthesis, as a solvent for gases and salts and in maintaining cell turgidity where a certain minimum degree of turgidity is essential for cell enlargement and growth. Cell turgidity also is important in the maintenance of the leaves form and other slightly lignified structures, in stomatal opening and in leaf petioles and structures governed by the turgidity of cells. Kramer (1969) added that adequate supply of water is the most important single factor for tree growth which is probably limited by internal water deficits, which in turn reduces vegetative growth, as well as, almost every process occurring in a tree. Thereby leaves become smaller, stems are shorter, shoot and diameter growth are reduced. Concerning the trend of extending root growth by prolonging water intervals, it might be due to the fact that the lack of water supply, especially under sandy conditions, forced the root system to penetrate faster and longer with more secondary roots searching for water and nutrients support.

Concerning the antitranspirant effects, Gale and Hagan (1966) reported that vapor gard may form a film coating the leaf surface, leading to an increase in diffusive resistance of water vapor from stomata. Pair and Still (1982) suggested that due to the fact that vapor gard remains for a long time on plant foliage, it had the ability of reducing transpiration, saving water, and thus, alleviating the adverse effects of water imbalance, therefore, more turgid cells resulting in increasing the growth of leaves, stem and root system. The enhancing effect of ascorbic acid, as an antioxidant compound on different vegetative growth characters is due to the fact that it has an auxinic action, thereby, stimulating cell division and enlargement, promoting nutritional status and other physiological processes.

Photosynthetic Pigments Content:-

Table (4) shows that the contents of the three photosynthetic pigments, chlorophyll a and b and carotenoids were gradually reduced parallel to the gradual increase in water supply (reduction in watering intervals) in the two seasons. The differences were significant between the treatment of 10-day intervals and both 5 and 3-day intervals for chlorophyll a, and between both 10 and 7-day interval treatments on one hand and those of 5 and 3-day intervals on the other hand for chlorophyll b and carotenoids. In harmony with these results were those revealed by Burman *et al* (1991), El-Tantawy *et al* (1993b), Mahfouz (1997) and Sayed (2001) on *Azadirachta indica, E. camaldulensis*, roselle and *Khaya senegalensis*, respectively.

Table (4): Effect of irrigation frequency and vapor gard and ascorbic acid on photosynthetic pigments of *Washingtonia filifera* seedlings during 1999 and 2000 seasons.

V.G and A.A. conc. B	First season					Second season				
	Irrig. frequency (every..........days) A					Irrig. Frequency (every.........days) A				
	10	7	5	3	Mean	10	7	5	3	Mean
	Chlorophyll a content mg/g F.W.									
Control	2.773	2.692	2.620	2.607	2.673	2.803	2.748	2.631	2.594	2.694
V.G. 1%	2.884	2.797	2.711	2.699	2.773	2.890	2.813	2.730	2.697	2.783
V.G. 2%	2.942	2.872	2.772	2.754	2.835	2.934	2.872	2.794	2.778	2.845
V.G. 3%	2.970	2.900	2.817	2.781	2.867	2.956	2.915	2.830	2.814	2.879
A.A. 125 ppm	2.838	2.775	2.715	2.673	2.750	2.901	2.844	2.764	2.722	2.808
A.A. 250 ppm	2.866	2.792	2.746	2.726	2.783	2.925	2.877	2.758	2.725	2.821
A.A. 500 ppm	2.895	2.838	2.764	2.735	2.808	2.944	2.891	2.786	2.751	2.843
Mean A	2.881	2.809	2.735	2.711		2.908	2.851	2.756	2.726	
L.S.D. 5%	A:0.121 B:0.106 AB:N.S.					A:0.115 B:0.102 AB:N.S.				
	Chlorophyll b content mg/g F.W.									
Control	0.932	0.897	0.824	0.796	0.862	0.951	0.893	0.804	0.767	0.854
V.G. 1%	1.002	0.959	0.886	0.850	0.924	1.017	0.956	0.857	0.835	0.916
V.G. 2%	1.006	0.966	0.892	0.856	0.930	1.030	0.971	0.865	0.854	0.930
V.G. 3%	1.001	0.967	0.899	0.874	0.935	1.038	0.976	0.871	0.862	0.937
A.A. 125 ppm	0.965	0.914	0.865	0.823	0.892	0.998	0.973	0.839	0.817	0.907
A.A. 250 ppm	0.968	0.938	0.888	0.836	0.908	1.007	0.958	0.858	0.830	0.913
A.A. 500 ppm	0.975	0.943	0.892	0.858	0.917	1.014	0.964	0.862	0.838	0.920
Mean A	0.978	0.941	0.878	0.842		1.008	0.956	0.851	0.829	
L.S.D. 5%	A:0.062 B:0.056 AB:N.S.					A:0.074 B:0.053 AB:0.106				
	Carotenoids content mg/g F.W.									
Control	1.083	1.067	0.973	0.929	1.013	1.109	1.072	1.081	0.922	1.046
V.G. 1%	1.222	1.202	1.100	1.063	1.147	1.242	1.203	1.109	1.058	1.153
V.G. 2%	1.240	1.228	1.118	1.091	1.169	1.267	1.226	1.127	1.085	1.176
V.G. 3%	1.248	1.236	1.126	1.108	1.180	1.282	1.240	1.136	1.103	1.190
A.A. 125 ppm	1.206	1.185	1.091	1.060	1.136	1.233	1.229	1.100	1.050	1.153
A.A. 250 ppm	1.215	1.200	1.108	1.073	1.149	1.247	1.228	1.118	1.071	1.166
A.A. 500 ppm	1.227	1.209	1.123	1.082	1.160	1.252	1.233	1.127	1.078	1.173
Mean A	1.206	1.190	1.091	1.058		1.233	1.204	1.114	1.052	
L.S.D. 5%	A:0.062 B:0.055 AB:0.110					A:0.080 B:0.044 AB: 0.088				

V.G. = Vapor gard
A.A. = Ascorbic acid
Irrigation Frequency: Factor A
V.G. and A.A. : Factor B

Concerning vapor gard and ascorbic acid treatments, they caused significant increase in the three pigments content in the two seasons as indicated in Table (4). The highest values in both seasons among V.G. concentrations were obtained from 3% and among A.A. from 500 ppm. Obtained results regarding V.G. are in accordance with those of Ghitany and Abd-Elhadi (1989) on codiaeum, Attia *et al* (1991) on *E. citriodora*, Mahfouz (1997) on roselle and Mehana (2001) on mango seedlings.

The interactions between the two studied factors, irrigation intervals and V.G. - A.A. treatments were significant for chlorophyll b in the second season and for carotenoids content in both seasons. The highest pigment contents were obtained due to the use of the longest irrigation interval (every 10 days) in combination with V.G. at 2 and 3% and A.A. at 500 ppm as shown in Table (4).

Leaves Nitrogen, Phosphorus and Potassium Percentage: -

Results obtained in Table (5) show that increasing water supply by the gradual shortening of irrigation intervals caused a gradual reduction in the percentages of N, P and K in the leaves with significant differences being obtained in both seasons. These findings are in agreement with those found by Hassan *et al* (1986) on moghat, Burman *et al* (1991) on *Azadirachta indica*, Mahfouz (1997) on roselle and Sayed (2001) on *Khaya senegalensis* seedlings.

Table (5): Effect of irrigation frequency and vapor gard and ascorbic acid on leaves % of N, P and K of *Washingtonia filifera* seedlings during 1999 and 2000 seasons.

V.G and A.A. conc. B	First season					Second season				
	Irrig. frequency (every..........days) A					Irrig. frequency (every..........days) A				
	10	7	5	3	Mean	10	7	5	3	Mean
	Leaves nitrogen %									
Control	1.706	1.637	1.613	1.502	1.615	1.463	1.407	1.224	1.204	1.325
V.G. 1%	1.917	1.874	1.760	1.527	1.770	1.520	1.560	1.431	1.283	1.449
V.G. 2%	1.963	1.910	1.777	1.556	1.802	1.617	1.627	1.468	1.390	1.526
V.G. 3%	2.090	1.996	1.842	1.628	1.889	1.623	1.653	1.477	1.423	1.554
A.A. 125 ppm	1.957	1.923	1.751	1.530	1.790	1.562	1.460	1.383	1.323	1.432
A.A. 250 ppm	2.033	1.941	1.837	1.552	1.841	1.628	1.516	1.339	1.366	1.462
A.A. 500 ppm	2.042	1.953	1.851	1.562	1.852	1.668	1.562	1.461	1.371	1.516
Mean A	1.958	1.891	1.776	1.551		1.583	1.541	1.398	1.337	
L.S.D. 5%	A:0.062		B:0.095	AB:0.190		A:0.084		B:0.081	AB:0.162	
	Leaves phosphorus %									
Control	0.219	0.217	0.214	0.206	0.214	0.220	0.216	0.212	0.202	0.213
V.G. 1%	0.229	0.225	0.223	0.217	0.224	0.231	0.224	0.221	0.213	0.222
V.G. 2%	0.232	0.228	0.227	0.219	0.227	0.234	0.227	0.224	0.215	0.225
V.G. 3%	0.230	0.234	0.229	0.223	0.229	0.235	0.229	0.227	0.220	0.228
A.A. 125 ppm	0.234	0.230	0.230	0.215	0.227	0.233	0.226	0.225	0.216	0.225
A.A. 250 ppm	0.236	0.233	0.231	0.218	0.230	0.235	0.230	0.228	0.220	0.228
A.A. 500 ppm	0.238	0.234	0.232	0.220	0.231	0.237	0.233	0.231	0.219	0.230
Mean A	0.231	0.229	0.227	0.217		0.232	0.226	0.224	0.215	
L.S.D. 5%	A:0.011		B:0.009	AB:N.S.		A:0.014	B:N.S.		AB:N.S.	
	Leaves potassium %									
Control	1.903	1.851	1.710	1.646	1.778	1.744	1.621	1.461	1.328	1.539
V.G. 1%	2.082	1.976	1.892	1.710	1.915	1.928	1.765	1.583	1.427	1.676
V.G. 2%	2.167	2.128	1.920	1.728	1.986	1.946	1.782	1.597	1.441	1.692
V.G. 3%	2.182	2.131	1.924	1.727	1.991	1.975	1.794	1.616	1.437	1.706
A.A. 125 ppm	2.174	2.080	1.943	1.705	1.976	1.969	1.788	1.604	1.446	1.702
A.A. 250 ppm	2.232	2.157	1.951	1.731	2.018	1.980	1.812	1.623	1.452	1.717
A.A. 500 ppm	2.238	2.210	1.964	1.762	2.044	1.986	1.825	1.636	1.460	1.727
Mean A	2.140	2.076	1.901	1.716		1.933	1.770	1.589	1.427	
L.S.D. 5%	A:0.128		B:0.094	AB:0.188		A:0.096	B:0.081		AB:0.162	

V.G. = Vapor gard
A.A. = Ascorbic acid
Irrigation Frequency: Factor A
V.G. and A.A. : Factor B

On the other hand, the use of either V.G. or A.A. significantly increased N, P and K leaves % (except P % in the second season) in comparison with those of control plants as clearly shown in Table (5). Among V.G. or A.A. treatments the higher the concentration the most effective was the applied substance. Different authors pointed out the role of V.G. in stimulating N, P and K% such as Attia *et al* (1991) on *E. citriodora* and Mahfouz (1997) on roselle. While, Tarraf *et al* (1999) on lemongrass and Ali (2000) on grapevines revealed that A.A. increased N, P and K in the leaves.

The interactions between water supply and V.G. or A.A. were significant for leaves nitrogen and potassium % in the two seasons. The highest values were obtained due to the use of 10 day-irrigation interval and V.G. at 3% or A.A. at 500 ppm.

Leaf Water Contents: -

The three leaf water measurements, free, bound, as well as, total leaf water contents, were sloping upward by increasing, gradually, the water supply with significant differences being detected in the two seasons as shown in Table (6). The highest values were obtained due to supplying the plants with water every three days. Such results are in close agreement with the findings revealed by Shehata (1992) on *Cupressus sempervirens*, El-Tantawy *et al* (1993a) on *E. camaldulensis* and Mahfouz (1997) on roselle. In regard with V.G. and A.A., data in Table (6) indicate that such substances at all tested concentrations caused significant increase in the leaf free, bound and total water contents in the two seasons in comparison with those of control plants. These three leaf water measurements were gradually increased by the gradual increase in the concentration of either V.G. or A.A. as shown in Table (6). A good number of researchers detected the effectiveness of V.G. in increasing different leaf water contents such as Abd-Elhadi and Ghitany (1989) on *F. benjamina*, Hummel (1990) on woody plants, Attia *et al.* (1991) on *E. citriodora*, Mahfouz (1997) on roselle and Mehana (2001) on mango seedlings.

An interpretation to the reduction in the leaves contents of the photosynthetic pigments, as well as, N, P and K% due to increasing water supply might be referred to the fact that different leaf measurements, number, area and fresh and dry weights were increased by increasing water supply and such increase in leaves number, area and weight was relatively, much more higher than the expected increase in the prementioned chemical constituents. Therefore, the percent of such chemical constituents appeared to be decreased in relation to the high increase in the leaves growth. Concerning vapor gard, Davenport (1977) suggested that it could form a layer above the leaf surface, impermeable to water vapor, thus reduced the water loss from leaves and increased the free and bound water contents of plant tissues. And the increase in both free and bound water content was met by the increase in total water content.

The increase in photosynthetic pigments under vapor gard treatments might be attributed to the enlargement of leaf cells as the leaf water contents increased, thus more chloroplasts might be produced within leaf tissues. While, the increase in N, P and K% might be due to the fact that sufficient water content within plant tissues led to increasing photosynthates and N, P and K uptake and translocation, consequently, overall increase in N, P and K% in the leaves. On the other hand, the role of ascorbic acid in stimulating photosynthates, N, P and K leaves content, as well as, leaf free, bound and total water contents might be attributed to its function as a natural plant growth regulator and a component partially responsible for the biosynthesis of carbohydrates, and controlling various disorders, (Ali *et al*, 2002).

Table (6): **Effect of irrigation frequency and vapor gard and ascorbic acid on leaf free, bound and total water contents of *Washingtonia filifera* seedlings during 1999 and 2000 seasons.**

V.G and A.A. conc. B	First season					Second season				
	Irrig. frequency (every..........days) A					Irrig. Frequency (every..........days) A				
	10	7	5	3	Mean	10	7	5	3	Mean
	Leaf free water content (%)									
Control	9.52	10.20	11.21	12.48	10.85	9.28	9.96	10.64	11.35	10.31
V.G. 1%	10.49	11.16	12.02	13.41	11.77	9.96	10.88	11.85	12.16	11.21
V.G. 2%	10.78	11.51	12.41	13.75	12.11	10.36	11.17	12.23	12.31	11.52
V.G. 3%	11.03	11.75	12.57	13.91	12.32	10.68	11.45	12.44	12.48	11.76
A.A. 125 ppm	10.29	11.26	12.71	13.37	11.91	10.07	10.77	11.75	12.09	11.17
A.A. 250 ppm	10.50	11.44	12.88	13.51	12.08	10.20	11.06	12.02	12.18	11.37
A.A. 500 ppm	10.65	11.58	13.04	13.58	12.21	10.39	11.12	12.14	12.29	11.49
Mean A	10.47	11.27	12.41	13.43		10.13	10.92	11.87	12.12	
L.S.D. 5%	A:0.73		B:0.71		AB:1.42		A:0.86	B:0.77	AB:1.54	
	Leaf bound water content (%)									
Control	40.92	42.65	47.64	49.09	45.08	42.40	44.42	49.61	51.29	46.93
V.G. 1%	45.55	47.24	51.96	53.62	49.59	46.99	49.05	52.28	55.95	51.07
V.G. 2%	45.61	47.27	52.01	53.66	49.64	47.04	49.11	52.49	56.13	51.19
V.G. 3%	45.86	47.31	51.82	53.69	49.67	47.21	49.19	52.44	56.27	51.28
A.A. 125 ppm	45.71	47.45	51.43	53.10	49.42	47.12	49.26	52.37	55.39	51.04
A.A. 250 ppm	45.99	47.47	51.79	53.24	49.62	47.32	49.51	52.78	55.48	51.27
A.A. 500 ppm	46.35	47.51	51.94	53.42	49.81	47.62	49.72	53.06	55.63	51.51
Mean A	45.14	46.70	51.23	52.83		46.53	48.61	52.15	55.16	
L.S.D 5%	A:3.12		B:2.70		AB:5.40		A:3.36	B:3.18	AB:6.36	
	Leaf total water content (%)									
Control	50.44	52.85	58.85	61.57	55.93	51.68	54.38	60.25	62.64	57.24
V.G. 1%	56.04	58.40	63.98	67.03	61.33	56.95	59.93	64.13	68.11	62.28
V.G. 2%	56.39	58.78	64.42	67.41	61.75	57.40	60.28	64.72	68.44	62.71
V.G. 3%	56.89	59.06	64.39	67.60	61.99	57.89	60.64	64.88	68.75	63.04
A.A. 125 ppm	56.00	58.71	64.14	66.47	61.33	57.19	60.03	64.12	67.48	62.21
A.A. 250 ppm	56.49	58.91	64.67	66.75	61.71	57.52	60.57	64.80	67.66	62.64
A.A. 500 ppm	57.00	59.09	64.98	67.00	62.02	58.01	60.84	65.20	67.92	62.99
Mean A	55.61	57.97	63.63	66.26		56.66	59.52	64.01	67.29	
L.S.D. 5%	A:4.44		B:4.06		AB:8.12		A:5.13	B:4.15	AB:8.30	

V.G. = Vapor gard
A.A. = Ascorbic acid
Irrigation Frequency: Factor A
V.G. and A.A. : Factor B

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دراسات فسيولوجيه على نباتات البرنتشارديا
١- تخفيف التأثير الضار للإجهاد المائى على الشتلات النامية فى الأراضى الرملية باستعمال فابورجارد وحامض الاسكوربيك

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أجريت تجربة أصص خلال موسمى ١٩٩٩و ٢٠٠٠بالمزرعة التجريبية بكلية الزراعة جامعة المنيا لدراسة تأثير أربعة فترات رى وفابورجارد وحامض الاسكوربيك بتركيزات مختلفة على النمو والتركيب الكيماوى والمحتوى المائى للأوراق لشتلات البرنتشارديا فيليفرا النامية فى الأراضى الرملية

أظهرت النتائج أن تقصير فترات الرى (كل ٣أو ٥أيام) قد سبب زيادة ملحوظة فى الصفات الخضرية المختلفة وهى طول النبات، وقياسات عنق ونصل الأوراق وعدد الأوراق ووزنها الطازج والجاف للنبات وكذلك محتوى الأوراق من الماء الحر والماء المرتبط والماء الكلى . بينما إطالة فترات الرى (كل ١٠أيام) قد سببت زيادة في الوزن الطازج والجاف للجذور وصبغات التمثيل الضوئى ونسبة النتروجين والفوسفور والبوتاسيوم بالأوراق

أدت معاملات الفابورجارد وحامض الاسكوربيك إلى زيادة تدريجية فى الصفات الخضرية والمكونات الكيماوية والمحتوى المائى للأوراق نتيجة للزيادة التدريجية فى تركيزات المادتين المضافتين ، وقد تم الحصول على أفضل النتائج باستعمال الفابورجارد بتركيز ٣% وحامض الاسكوربيك بتركيز ٥٠٠ جزء فى المليون . ولقد اتضح أن تعريض شتلات البرنتشارديا لأقصى إجهاد مائى (الرى كل ١٠أيام) مع إمداد الشتلات بالفابورجارد بتركيز ٣% اوحامض الاسكوربيك بتركيز ٥٠٠جزء فى المليون قد أعطى قيما خاصة بالنمو مساوية تقريباً لتلك الناتجة من رى الشتلات كل ٣ ايام دون الاستعانه بالفابورجارد أو حامض الاسكوربيك .