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DETERMINING WATER REQUIREMENTS FOR *ACALYPHA WILKESIANA* SHRUBS IN RELATION TO GROWING MEDIUM MIXTURE

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ABSTRACT: This study was carried out in the nursery of the Ornamental Plants and Landscape Gardening Res. Dept., Hort. Res. Inst., A.R.C., Giza, Egypt during 2014/2015 and 2015/2016 seasons to find out the response of *Acalypha wilkesiana* grown in different potting mixtures to different irrigation regimes. Five types of equal proportions potting mixtures (v:v) i.e. sand + peat moss (Mix. 1), sand + perlite (Mix. 2), sand + vermiculite (Mix. 3), sand + peat moss + perlite (Mix. 4) and sand + peat moss + vermiculite (Mix. 5), and 4 levels of irrigation water at 25, 50, 75 and 100% of pot water capacity, and their interaction, were applied in this study. Vegetative and root parameters as well as the leaves content of total chlorophyll, carotenoids, anthocyanin and the percentages of total carbohydrate, N, P and K were recorded. The obtained results showed that there was a great influence of the different potting mixtures particularly those containing peat moss on *A. wilkesiana* growth e.g. Mix. 5 resulted in the highest records of plant height, number of leaves, number of branches, leaf area, stem fresh weight, root dry weight and N% in the leaves. On the other hand, irrigation at 25% pot water capacity resulted in the lowest values of almost all studied characters, while, watering at 75% pot water capacity gave rise to the highest plant height, number of leaves, number of branches, leaf area, root length, stem fresh weight, dry weight of leaves, stem and root dry weights, total carbohydrate %, anthocyanin content and percentages of N, P and K. Regarding the interaction treatments, all potting mixtures recorded the highest values in most cases when combined with irrigation regime at 100 or 75% pot water capacity. From the above results and to obtain high quality *Acalypha wilkesiana* shrubs with reducing the amount of irrigation water by 25%, it is recommended to use the Mix. 5 (sand + peat moss + vermiculite) + irrigation at 75% pot water capacity.

Key words: *Acalypha wilkesiana*, potting mixture, irrigation, pot water capacity.

INTRODUCTION

Acalypha wilkesiana Mull. Arg. belongs to the family Euphorbiaceae. *Acalypha* is a genus of about 430 species of evergreen shrubs and trees, and annuals, grown for their beautiful foliage and flowers. They are found in tropical and subtropical regions, from tropical woodland and open savanna. Their alternate leaves are oval to ovate, simple, and toothed. *A. wilkesiana* native to Pacific Islands is spreading shrub reaches to 2 m height and 1-2 m width, with oval, multicolored, mottled, and often variegated leaves (10-20 cm long). Bears catkin-like racemes (10-20 cm long), usually green- or copper-tinted, and often hidden among the leaves, periodically during the year. They are used in borders, for hedging and as specimen plants in the gardens (Brickell, 1997).

Potting soil mixtures are the most important factors for the quality production of in floriculture industry (Kashihara *et al.*, 2011). A balanced rooting medium that contains an adequate supply of nutrients is essential for plants to attain maximum growth and development. Balanced rooting media greatly affect the plant height and availability of growing substrate with the supplement of essential nutrients for attaining maximum plant height (Ikram *et al.*, 2012).

Peat moss (peat) is an organic material composed of partially decomposed plant matter that has been preserved under water. It has a high water-holding capacity, and supplies some nutrients, especially nitrogen (Acquaah, 2009). It is highly acidic, and it uses as a source of organic material to change or amend the acidity of the soil (Ingels, 2010).

Sand is a heavy ingredient in growing mixtures. Its role in the mix is to improve drainage and infiltration; it does not hold a good moisture. Sand does not supply any nutrients to the mix or plants (Acquaah, 2009). Sand has a high bulk density that provides solid support for larger plants to prevent plant bending. The pH of sand is between 7.5 and 8.5 (Biondo and Noland, 2006).

Perlite is a light rock material of volcanic origin. It is essentially heat expanded aluminum silicate rock. Its role in a mix is to improve aeration and drainage. Perlite is neutral in reaction and provides almost no nutrients to the mix except for small amounts of sodium and aluminum (Acquaah, 2009).

Vermiculite is heat-expanded mica. It is very lightweight and has minerals (magnesium and potassium) for enriching the mix, as well as good water-holding capacity. Neutral in reaction (pH), it is available in grades (as fine or course) according to sizes (Acquaah, 2009).

Determining water requirements of each crop is very necessary to increase the water use efficiency in the Egypt's agricultural production. However, there is a lack of available information in this concern especially in the field of ornamental plants. Numerous authors had discussed the problem of diminishing water resources and its impact on floriculture plant production. Valdez-Aguilar *et al.* (2009) stated that scarcity of water for landscape irrigation is a major concern in arid and semiarid regions as a result of the competition with the urban population. Competing claims from urban, agricultural, environmental, and industrial groups leaves less available water for use in landscape maintenance. Iersel *et al.* (2010) reported that more efficient irrigation practices are needed in ornamental plant production to reduce the amount of water used for production as well as fertilizers runoff. Álvarez *et al.* (2013) declared that the irrigation water requirements and sensitivity to water deficits of ornamental plants are of great interest to horticultural producers for planning irrigation strategies.

Therefore, the present experiment was performed aiming to evaluate the performance of *Acalypha wilkesiana* grown in different potting mixtures under different irrigation regimes.

MATERIALS AND METHODS

This study was carried out at the nursery of the Ornamental Plant Research Department, Horticulture Research Institute, Giza, Egypt in June 2014 to June 2015 (first season) and in June 2015 to June 2016 (second one).

The effects of two factors (potting mixtures and irrigation regimes) on growth of *Acalypha wilkesiana* were investigated. The first factor represented the type of potting mixture, i.e. growing substrate. The second one was the amount of water given to plants for irrigation, which was calculated as a percentage of the pot water capacity.

In order to accomplish this goal, a completely randomized design in a factorial experiment was carried out. Acalypha individually transplants of 20 cm tall were purchased in June 2014 and repotted in 25 cm diameter plastic pots filled with one of the following potting mixtures:

1. Sand + peat moss (1:1, v:v).
2. Sand + perlite (1:1, v:v).
3. Sand + vermiculite (1:1, v:v).
4. Sand + peat moss + perlite (1:1:1, v:v:v).
5. Sand + peat moss + vermiculite (1:1:1, v:v:v).

Plants were divided into 5 groups; each one was assigned to a type of potting mixture. Pots in each group potting mixture were divided into 4 sub-groups, where they were subjected to 4 irrigation regimes, i.e. 25, 50, 75 and 100% of pot water capacity/week. These allocations were true for summer (June, July and August) and autumn (September, October and November). In winter (December, January and February), one third of these amounts was deducted, to be given back in spring (March, April and May) to the same treatments in mid week to tolerate for the high summer temperature. Each watering treatment in each location contained 3 replicates, with 3 pots in each replicate. One year later, i.e. June 2015 data were recorded for: plant height (cm), number of leaves, number of branches, leaf area (cm^2) by using ImageJ software as described by Ferreira and Rasband (2012), root length of the longest root (cm), fresh and dry weights of leaves (g), stem fresh and dry weights (g), root fresh and dry weights (g).

Water capacity of the potting mixture was determined as follow: three 25 cm pots filled with a certain potting mixture were watered thoroughly to saturation and weighed. Pots were covered with aluminum foil to prevent evaporation before they were left in a cool shaded place to drain freely for 4 hours. They were weighed again to calculate the mean weight of water held by each potting mixture for each pot. Weight of water held per 1 kg of potting mixture was calculated. Both weights were shown in Table (1). All agricultural practices were done in time as usual.

Data were statistically analyzed using analysis of variance as described by Snedecor and Cochran (1989) and means were compared by Duncan critical range at 5% (Duncan, 1955) by means of SAS 1995 computer program.

Samples of leaves from each treatment were collected to determine the total carbohydrate percentage (%) which were carried out according to Herbert *et al.* (1971); total chlorophyll and carotenoids (mg/g f.w.) contents according to Saric *et al.* (1976); anthocyanin (mg/f.w.) according to Mancinelli *et al.* (1975); the percentages of nitrogen, phosphorus, and potassium in dry leaves were determined according to Jackson (1973), in the Central Lab of the Horticulture Research Institute.

Meteorological data of precipitation (precip.), relative humidity (R.H.) maximum (Max.) and minimum (Min.) temperature (temp.) are shown in Table (2).

Table 1. Pot water capacity/ 1 kg for each soil mixture.

Parameters	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5
Mixture dry weight/pot (g)	2280.57	3095.79	3898.55	1678.47	2143.90
Water weight held/pot (g)	840.02	318.01	627.17	940.31	1189.24
Pot water capacity (ml water/1 kg of mix)	368.34	102.72	160.87	560.22	554.71

Mix. 1: sand + peat moss, Mix. 2: sand + perlite, Mix. 3: sand + vermiculite, Mix. 4: sand + peat moss + perlite, Mix. 5: sand + peat moss + vermiculite.

Table 2. Meteorological data of Giza Governorate, Egypt, during the study period.

Months	Precip. (mm day^{-1})			R.H. (%)			Max. Temp. (°C)			Min. Temp. (°C)		
	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
Jan.	3.89	7.08	19.32	58.17	53.61	62.20	21.35	19.12	18.31	8.71	7.05	6.79
Feb.	17.36	8.14	1.52	61.73	50.47	53.60	22.33	20.33	24.04	8.32	7.48	9.38
Mar.	4.12	2.10	5.64	45.15	48.84	44.88	26.14	25.89	26.32	10.46	10.81	11.37
Apr.	0.12	20.18	1.43	39.43	44.14	34.46	30.99	28.34	33.84	13.90	11.75	15.14
May	3.23	0.21	0.00	36.65	36.89	35.56	34.32	34.33	34.79	18.02	16.96	17.58
Jun.	0.00	0.00	0.00	36.20	40.59	32.32	37.57	35.71	40.07	20.04	19.26	21.71
Jul.	0.00	0.00	0.00	39.93	38.28	40.63	38.55	38.60	38.72	21.38	21.34	22.12
Aug.	0.00	0.00	0.00	42.30	40.07	43.68	38.76	40.30	38.23	22.17	24.12	22.04
Sep.	0.73	0.11	2.21	45.54	43.13	46.20	35.81	38.03	35.90	20.90	22.54	20.42
Oct.	2.13	6.54	28.44	49.77	53.88	57.39	30.96	32.23	31.94	17.41	19.41	17.80
Nov.	5.70	14.32	126.82	58.05	63.24	60.37	25.71	26.12	25.91	13.63	14.81	13.69
Dec.	0.24	4.86	25.79	56.46	64.36	70.83	22.97	21.07	18.41	10.29	10.06	7.58

These parameters were collected and averaged from the data obtained from NASA Power Data Access Viewer Program (https://power.larc.nasa.gov).

RESULTS

Effect of potting mixtures, irrigation treatments and their interaction on:

1. Vegetative growth and root characteristecs:

Plant height (cm):

The effect of potting mixture on plant height was significant in both seasons (Table, 3). The tallest plants were those grown in mixtures 1, 4 or 5, (69.88, 66.29 and 64.24 cm, in the first season; 55.78, 58.33 and 55.26 cm, in the second season, respectively), without significant difference among the 3 mixtures. The shortest plants were a result of growing in either mixture 2 or 3 (61.96 and 62.13 cm in the first season; 51.04 and 53.53 cm in the second one, respectively).

The effect of irrigation treatments on plant height was significant in both seasons (Table, 3). The tallest plants were those irrigated with either 75 or 100% of pot water capacity (69.15 and 70.07 cm, in the first season; 58.18 and 59.78 cm in the second one, respectively). The shortest ones were recorded when plants received 25% pot water capacity (56.40 and 47.09 cm, in the first and second seasons, respectively).

The effect of interaction between potting mixtures and irrigation treatments was significant in both seasons (Table, 3). The tallest plants were those grown on mixture 1 and watered with 100% pot water capacity (78.17 and 66.10 cm, in the first and second seasons, respectively) and plants grown in mixture 4 and irrigated with 75% pot water capacity (73.93 and 67.60 cm, in the first and second seasons, respectively), as well as those grown on either mixture 1 and watered with 75% pot water capacity or mixture 5 and watered with 100% pot water capacity (73.83 cm and 71.03 cm, in the first season, respectively).

The shortest plants were those watered with 25% pot water capacity and grown in either mixture 4 (51.57 cm) in the first season, or in mixture 1 (43.67 cm) in the second one.

Number of leaves:

The effect of potting mixture on the number of leaves was significant in both seasons (Table, 3). The highest record in this concern was a result of using mixture 5 in both seasons (131.83 and 141.58 leaves, in the first and second seasons, respectively). The lowest number of leaves was belonged to plants grown in mixture 1 in the first

Table 3. Effect of potting mixtures, irrigation treatments and their interaction on some growth characteristics of *Acalypha wilkesiana* shrubs during 2014/2015 and 2015/2016 seasons.

Growing mixtures (A)	Pot water capacity (B)									
	25%	50%	75%	100%	Mean (A)	25%	50%	75%	100%	Mean (A)
	1st season					2nd season				
	Plant height (cm)									
Mix. 1	58.83 c-f	68.67 a-c	73.83 ab	78.17 a	69.88 a	43.67 k	51.17 g-j	62.17 a-c	66.10 ab	55.78 ab
Mix. 2	56.33 d-f	63.50 b-e	63.67 b-e	64.33 b-e	61.96 b	45.67 jk	49.17 h-k	52.17 f-j	57.17 c-g	51.04 c
Mix. 3	56.00 ef	59.17 c-f	66.67 b-e	66.67 b-e	62.13 b	45.87 jk	55.00 d-g	53.30 f-i	59.97 b-e	53.53 bc
Mix. 4	51.57 f	69.50 a-c	73.93 ab	70.17 a-c	66.29 ab	46.80 i-k	61.17 a-d	67.60 a	57.73 c-f	58.33 a
Mix. 5	59.27 c-f	59.00 c-f	67.67 a-d	71.03 ab	64.24 ab	53.43 e-h	54.00 e-h	55.67 c-h	57.93 c-f	55.26 ab
Mean (B)	56.40 c	63.97 b	69.15 a	70.07 a		47.09 c	54.10 b	58.18 a	59.78 a	
	Number of leaves									
Mix. 1	72.67 c-e	111.33 a-e	106.67 a-e	60.67 de	87.83 b	130.00 a-d	114.33 a-d	120.33 a-d	84.33 cd	112.25 ab
Mix. 2	50.00 e	85.33 b-e	132.00 a-c	152.67 a	105.00 ab	82.67 d	89.00 cd	136.00 a-d	151.00 a-c	114.67 ab
Mix. 3	83.00 b-e	102.67 a-e	132.67 a-c	106.00 a-e	106.08 ab	81.33 d	107.00 a-d	161.33 ab	121.33 a-d	117.75 ab
Mix. 4	90.00 b-e	112.33 a-d	122.67 a-d	103.33 a-e	107.08 ab	84.67 cd	95.67 b-d	108.00 a-d	113.00 a-d	100.33 b
Mix. 5	77.33 c-e	139.67 ab	154.00 a	156.33 a	131.83 a	109.33 a-d	134.67 a-d	170.33 a	152.00 a-c	141.58 a
Mean (B)	74.60 b	110.27 a	129.60 a	115.80 a		97.60 b	108.13 b	139.20 a	124.33 ab	
	Number of branches									
Mix. 1	15.67 cd	18.00 b-d	21.00 a-d	10.67 d	16.33 b	18.00 cd	24.33 a-d	34.00 ab	14.00 d	22.58 ab
Mix. 2	12.33 d	14.33 cd	25.67 a-c	29.00 ab	20.33 ab	21.00 a-d	23.00 a-d	25.33 a-d	27.00 a-d	24.08 a
Mix. 3	20.00 a-d	22.33 a-d	32.00 a	18.00 b-d	23.08 a	14.67 d	23.33 a-d	35.00 a	20.00 b-d	23.25 ab
Mix. 4	17.67 b-d	20.33 a-d	21.67 a-d	12.67 d	18.08 ab	13.67 d	16.00 d	24.00 a-d	13.00 d	16.67 b
Mix. 5	18.33 b-d	19.67 a-d	20.67 a-d	27.00 a-c	21.42 ab	17.67 cd	22.67 a-d	30.67 a-c	27.33 a-d	24.58 a
Mean (B)	16.80 b	18.93 ab	24.20 a	19.47 ab		17.00 b	21.87 b	29.80 a	20.27 b	
	Leaf area (cm^2)									
Mix. 1	17.98 k	40.87 e-i	44.85 e-h	47.44 d-f	37.79 c	10.65 kl	33.03 d-f	34.38 c-f	29.91 e-g	26.99 c
Mix. 2	33.45 g-j	36.41 f-j	46.15 d-f	45.46 d-h	40.37 bc	18.45 i-k	23.95 g-i	32.15 d-g	30.76 d-g	26.33 c
Mix. 3	24.03 j-k	43.67 e-i	60.20 bc	49.46 c-e	44.34 b	7.70 l	38.82 b-d	42.27 bc	36.40 c-e	31.30 b
Mix. 4	32.99 h-j	45.89 d-g	63.62 b	32.18 ij	43.67 bc	21.17 h-j	32.86 d-f	46.82 ab	27.73 f-h	32.15 b
Mix. 5	36.59 f-i	45.43 d-h	57.38 b-d	76.60 a	54.00 a	15.01 j-l	37.58 c-e	52.40 a	53.33 a	39.58 a
Mean (B)	29.01 c	42.45 b	54.44 a	50.23 a		14.60 c	33.25 b	41.60 a	35.63 b	
	Root length (cm)									
Mix. 1	37.67 c	48.17 a-c	53.00 a-c	49.17 a-c	47.00 a	46.83 a-d	48.17 a-d	50.00 a-d	45.50 a-d	47.63 a
Mix. 2	42.00 c	51.83 a-c	63.67 ab	48.00 a-c	51.38 a	40.50 cd	48.33 a-d	59.17 ab	45.67 a-d	48.42 a
Mix. 3	44.00 bc	48.67 a-c	50.43 a-c	64.17 a	51.82 a	45.00 a-d	48.37 a-d	60.83 a	53.67 a-d	51.97 a
Mix. 4	41.83 c	54.50 a-c	54.67 a-c	53.00 a-c	51.00 a	41.67 b-d	47.83 a-d	57.67 a-c	48.83 a-d	49.00 a
Mix. 5	42.83 c	44.67 a-c	48.50 a-c	47.83 a-c	45.96 a	36.97 d	39.50 d	50.00 a-d	51.77 a-d	44.56 a
Mean (B)	41.67 b	49.57 ab	54.05 a	52.43 a		42.19 b	46.44 b	55.53 a	49.09 ab	

Means with the same letter within a columns or rows are not significantly according to Duncan's Multiple Range (DMRT).

Mix. 1: sand + peat moss, Mix. 2: sand + perlite, Mix. 3: sand + vermiculite, Mix. 4: sand + peat moss + perlite, Mix. 5: sand + peat moss + vermiculite.

season (87.83 leaves) and mixture 4 in the second one (100.33 leaves).

The effect of irrigation treatments on the number of leaves was significant in both seasons. The highest values in this regard were noticed in plants irrigated with 75 of pot water capacity (129.60 and 139.20 leaves in the first and second seasons, respectively) (Table, 3).

Data presented in Table (3) show that the effect of interaction between potting mixture and irrigation treatments was significant in both seasons. The greatest number of leaves was found in plants grown in mixture 5 and watered with 75% pot water capacity (154.00 and 170.33 leaves, in the first and second seasons, respectively). The lowest formation of leaves per plants were observed in plants grown in mixture 2 and irrigated with 25% pot water capacity (50.00 and 82.67 leaves, in the first and second seasons, respectively).

Number of branches:

As shown in Table (3) the effect of potting mixtures on the number of branches per plant was significant in both seasons. The highest number of branches resulted from plants were grown in mixture 3 in the first season (23.08 branches), and in mixtures 2 or 5 (24.08 and 24.58 branches, respectively) in the second one. The lowest values were obtained for plants grown in mixture 1 in the first season (16.33 branches) and in mixture 4 in the second one (16.67 branches).

The effect of irrigation treatments on the number of branches was significant in both seasons. The greatest number of branches was obtained for plants watered at 75% pot water capacity (24.20 and 29.80 branches in the first and second seasons, respectively). The lowest values were belonged to plants irrigated at 25% pot water capacity (16.80 and 17.00 branches in the first and second seasons, respectively) (Table, 3).

The interaction between potting mixtures and irrigation treatments significantly affected the number of branches in both seasons (Table, 3). Growing plants in mixture 3 and watering them at 75% pot water capacity gave the highest number of branches (32.00 and 35.00 in the first and second seasons, respectively). The lowest values in the same concern were recorded in plants watered with 100% pot water capacity and grown in mixture 4 (12.67 and 13.00 branches in the first and second seasons, respectively).

Leaf area (cm^2):

The effect of potting mixtures on leaf area of acalypha plants was significant in both seasons. The largest leaves were obtained in plants grown in mixture 5 (54.00 and 39.58 cm^2, in the first and second seasons, respectively). Plants grown in mixture 1 had the smallest leaves (37.79 and 26.99 cm^2, in the first and second seasons, respectively) (Table, 3).

Data illustrated in Table (3) revealed that the irrigation treatments had a significant effect on leaf area in the two seasons. The largest leaves were observed in plants irrigated with 75% pot water capacity (54.44 and 41.60 cm^2, in the first and second seasons, respectively). On the other hand, the smallest leaves were recorded in plants watered at 25% pot water capacity (29.01 and 14.60 cm^2, in the first and second seasons, respectively).

The effect of interaction between potting mixtures and irrigation treatments on leaf area was significant in both seasons (Table, 3). The largest leaves were a result of growing plants in mixture 5 and watering them at 100% pot water capacity (76.60 and 53.33 cm^2, in the first and second seasons, respectively), in addition to those grown in mixture 5 and watered at 75% pot water capacity (52.40 cm^2) in the second season only. Irrigating plants at 25% pot water capacity and growing them in mixture 1 gave rise to the formation of the smallest leaves

(17.98 and 10.65 cm^2, in the first and second seasons, respectively) and with mixture 3 (24.03 and 7.70 cm^2, in the first and second seasons, respectively).

Root length of the longest root (cm):

The effect of potting mixtures on the root length of acalypha plants was insignificant in both seasons as shown in Table (3).

Whereas, the effect of irrigation treatments on the root length was significant in both seasons. The longest roots were belonged to plants watered at 75% pot water capacity (54.05 and 55.53 cm, in the first and second seasons, respectively). The shortest roots resulted when plants were watered at 25% pot water capacity (41.67 and 42.19 cm, in the first and second seasons, respectively) (Table, 3).

The interaction between potting mixtures and irrigation treatments significantly affected the root length (Table, 3). The longest roots were belonged to plants grown on mixture 3 and irrigated at 100% pot water capacity (64.17 cm) in the first season and 75% pot water capacity (60.83 cm) in the second season. The shortest roots were produced by plants grown in mixture 5 and watered at 25% pot water capacity (42.83 and 36.97 cm, in the first and second seasons, respectively).

Leaves fresh weight (g):

According to data illustrated in Table (4) the effect of potting mixtures on fresh weight of leaves was insignificant in both seasons.

But, the effect of irrigation treatments on fresh weight of leaves was significant in both seasons. The heaviest fresh weight of leaves was obtained in plants irrigated at 100% pot water capacity (38.15 and 35.18 g in the first and second seasons, respectively) in addition to those watered at 75% pot water capacity (34.49 g) in the first season only. The lightest fresh weights of leaves were produced in plants irrigated at 25% pot water capacity (12.70 and 12.76 g in the first and second seasons, respectively) (Table, 4).

The effect of interaction between potting mixtures and irrigation treatments on fresh weight of leaves was significant in both seasons (Table, 4). The highest records in this respect resulted from plants were watered at 100% pot water capacity and grown in mixture 4 (45.84 and 35.69 g in the first and second seasons, respectively). The lightest fresh weight leaves were produced in plants grown in mixture 2 and watered at 25% pot water capacity (8.59 and 7.41 g in the first and second seasons, respectively).

Stem fresh weight (g):

The effect of potting mixtures on stem fresh weight was significant in the second season only (Table, 4). However, the heaviest fresh stems were a result of growing plants in the mixture 5 (32.83 g) in the first season, or in the mixtures 1, 3, 4 or 5 (30.81, 30.61, 30.26 and 28.46 g, respectively) in the second one. The lightest fresh stems were formed in plants grown in the mixture 2 (28.50 and 25.28 g in the first and second seasons, respectively).

Data presented in Table (4) demonstrated that the effect of irrigation treatments on stem fresh weight was significant in both seasons. Watering plants at 75 or 100% pot water capacity gave rise to heavier fresh stems (34.12 and 37.60 and 31.97 and 35.64 g, in the first and second seasons, respectively). Then those irrigated at 25 or 50% pot water capacity (22.25 and 28.12 and 22.53 and 26.21 g, in the first and second seasons, respectively).

The effect of interaction between potting mixtures and irrigation treatments on stem fresh weight was significant in both seasons (Table, 4). The highest values of this character resulted from plants were watered at 100% pot water capacity and grown in mixtures 4 or 5 (44.20 and 41.56 g, respectively) in the first season; and on mixture 3 (38.37 g) in the second one. The lowest stems fresh weight was obtained when mixture 2 and irrigation at 25% pot water capacity were used (17.20 and 16.60 g, respectively in the first and second seasons).

Table 4. Effect of potting mixtures, irrigation treatments and their interaction on leaves, stems and roots fresh weights (g) of *Acalypha wilkesiana* shrubs during 2014/2015 and 2015/2016 seasons.

Growing mixtures (A)	Pot water capacity (B)									
	25%	50%	75%	100%	Mean (A)	25%	50%	75%	100%	Mean (A)
	1st season					2nd season				
					Leaves f.w. (g)					
Mix. 1	12.84 de	25.08 a-e	29.18 a-e	32.85 a-d	24.99 a	14.00 h-j	25.14 b-h	29.74 a-e	34.90 ab	25.95 ab
Mix. 2	8.59 e	26.01 a-e	44.57 a	34.58 a-d	28.44 a	7.41 j	17.07 f-j	24.04 b-h	33.61 ab	20.53 b
Mix. 3	12.68 de	16.83 c-e	31.03 a-d	35.56 a-c	24.03 a	9.27 ij	19.47 d-j	27.34 b-g	40.69 a	24.19 ab
Mix. 4	17.00 c-e	18.53 c-e	33.43 a-d	45.84 a	28.70 a	17.81 e-j	28.46 b-f	32.88 a-c	35.69 ab	28.71 a
Mix. 5	12.37 de	22.10 b-e	34.22 a-d	41.92 ab	27.65 a	15.34 g-j	21.25 c-i	24.76 b-h	31.00 a-d	23.09 ab
Mean (B)	12.70 b	21.71 b	34.49 a	38.15 a		12.76 d	22.28 c	27.75 b	35.18 a	
					Stems f.w. (g)					
Mix. 1	27.57 b-e	32.39 a-d	33.49 a-d	31.62 a-d	31.27 a	23.06 g-j	30.69 a-g	35.62 a-c	33.88 a-d	30.81 a
Mix. 2	17.20 e	27.78 b-e	33.01 a-d	36.00 ab	28.50 a	16.60 j	21.18 ij	29.91 b-h	33.42 a-d	25.28 b
Mix. 3	23.60 b-e	27.95 b-e	35.22 a-c	34.61 a-c	30.35 a	23.67 e-j	28.80 b-i	31.61 a-f	38.37 a	30.61 a
Mix. 4	20.72 de	20.56 de	33.20 a-d	44.20 a	29.67 a	25.97 d-i	28.42 c-i	31.04 a-g	35.62 a-c	30.26 a
Mix. 5	22.16 c-e	31.91 a-d	35.68 ab	41.56 a	32.83 a	23.34 f-j	21.94 h-j	31.65 a-e	36.90 ab	28.46 ab
Mean (B)	22.25 b	28.12 b	34.12 a	37.60 a		22.53 b	26.21 b	31.97 a	35.64 a	
					Roots f.w. (g)					
Mix. 1	26.95 b-e	33.48 b-d	36.15 a-d	50.59 a	36.79 a	21.93 b-d	22.42 b-d	34.83 a-c	37.28 ab	29.12 a
Mix. 2	10.92 e	27.45 b-d	27.96 b-d	33.23 b-d	24.89 b	16.98 d	31.77 a-d	28.76 a-d	27.78 a-d	26.32 a
Mix. 3	21.51 de	25.19 c-e	42.56 ab	42.10 ab	32.84 ab	22.32 b-d	31.33 a-d	40.62 a	39.57 a	33.46 a
Mix. 4	20.64 de	34.74 a-d	34.37 a-d	27.88 b-d	29.41 ab	26.82 a-d	30.46 a-d	30.84 a-d	36.96 ab	31.27 a
Mix. 5	21.46 de	30.60 b-d	32.01 b-d	40.22 a-c	31.07 ab	20.01 cd	29.27 a-d	35.97 a-c	40.64 a	31.47 a
Mean (B)	20.30 c	30.29 b	34.61 ab	38.80 a		21.61 c	29.05 b	34.20 ab	36.44 a	

Means with the same letter within a columns or rows are not significantly according to Duncan's Multiple Range (DMRT).
Mix. 1: sand + peat moss, Mix. 2: sand + perlite, Mix. 3: sand + vermiculite, Mix. 4: sand + peat moss + perlite, Mix. 5: sand + peat moss + vermiculite.

Roots fresh weight (g):

Data presented in Table (4) show that the effect of potting mixtures on roots fresh weight was significant in the first season only. However, the heaviest fresh roots were belonged to plants grown in mixture 1 (36.79 g) in the first season, while the lightest ones were obtained in mixture 2 (24.89 and 26.32 g, respectively in the first and second seasons).

The effect of irrigation treatments on the roots fresh weight was significant in both seasons. Data presented in Table (4) showed that the highest records in this regard were produced in plants watered at 100% pot water capacity (38.80 and 36.44 g, in the first and second seasons, respectively). The lowest roots fresh weights were formed in plants irrigated at 25% pot water capacity (20.30 and 21.61 g in the first and second seasons, respectively).

The effect of interaction between potting mixture and irrigation treatments on roots fresh weight was significant in both seasons Data presented in Table (4) showed that the greatest values of roots fresh weight were obtained for plants grown in mixture 1 and watered at 100% pot water capacity in the first season (50.59 g), or those grown on mixture 3 and watered at either 75 or 100%

pot water capacity (40.62 and 39.57 g, respectively) in addition to plants grown in mixture 5 and watered at 100% pot water capacity (40.64 g). On the other hand, the lowest records rsulted from using mixture 2 and applying irrigation at 25% pot water capacity (10.92 and 16.98 g in the first and second seasons, respectively).

Leaves dry weight (g):

Data presented in Table (5) showed that the effect of potting mixture on dry weight of leaves was significant in the second season only. Irrespective of these results, the heaviest dry leaves were obtained from plants grown in mixture 4 (7.20 and 6.66 g in the first and second seasons, respectively), in addition to those grown in the mixtures 1, 3 and 5 (6.46, 6.06 and 6.48 g, respectively) in the second season. The lightest dry leaves were belonged to plants grown in mixtures 3 or 2 (5.96 and 4.82 g in the first and second seasons, respectively).

The effect of irrigation treatments on dry weight of leaves was significant in both seasons as presented in Table (5). The highest values of dry weight of leaves were obtained from plants watered at 75 or 100% pot water capacity (8.42 and 8.44 g in the first season; and 7.38 and 7.70 g in the second season, respectively). The lowest value of dry leaves resulted when irrigation at 25% pot water capacity was applied giving 3.74 and 3.57 g in the first and second seasons, respectively.

The effect of interaction between potting mixture and irrigation treatments on dry weight of leaves was significant in both seasons (Table, 5). The highest records in this respect were a result of watering plants at 75% pot water capacity and growing them in mixture 2 (9.49 g), or watering plants at 100% pot water capacity and growing them in either mixture 4 or 5 (9.58 and 9.50, respectively), in the first season; or watering plants at 100% pot water capacity and growing them in mixture 3 (8.81 g) in the second one. Using mixture 2 and irrigating plants at 25% pot water capacity gave rise to the lowest values of this trait (2.72 and 1.89 g in the first and second seasons, respectively).

Stem dry weight (g):

The effect of potting mixtures on stem dry weight was significant in the second season only (Table, 5). However, the heaviest dry stems were belonged to plants grown in mixture 5 (11.51 and 10.13 g in the first and second seasons, respectively), in addition to those grown in mixture 1 or 4 (11.26 and 10.10 g respectively, in the second season only). The lightest weights were a result of growing plants in mixture 2 (10.02 and 7.96 g in the first and second seasons, respectively).

The effect of irrigation treatments on stem dry weight was significant in both seasons (Table, 5). The highest records in this concern were obtained when irrigation at 75% pot water capacity was applied (12.79 and 11.53 g in the first and second seasons, respectively). The lowest values were a result of watering at 25% pot water capacity (8.24 and 7.74 g in the first and second seasons, respectively).

The effect of interaction between potting mixtures and irrigation treatments on stem dry weight was significant in both seasons (Table, 5). The heaviest stem dry weight was belonged to plants irrigated at 75% pot water capacity and grown in mixture 5 (14.48 g) in the first season and mixture 1 (13.16 g) in the second one, while the lowest ones were noticed on plants watered at 25% pot water capacity and grown in mixture 2 (6.11 and 5.03 g in the first and second seasons, respectively).

Roots dry weight (g).

Data presented in Table (5) show that the effect of potting mixture on the roots dry weight was significant in the second season only. Despite this, the heaviest dry roots were belonged to plants grown in mixture 5 (12.73 and 12.41 g in the first and second seasons, respectively). The lightest ones were a result of using mixture 2 (9.58 and 8.55 g in the first and second seasons,

Table 5. Effect of potting mixtures, irrigation treatments and their interaction on leaves, stems and roots dry weights (g) of *Acalypha wilkesiana* shrubs during 2014/2015 and 2015/2016 seasons.

Growing mixtures (A)	Pot water capacity (B)									
	25%	50%	75%	100%	Mean (A)	25%	50%	75%	100%	Mean (A)
	1st season					2nd season				
	Leaves d.w. (g)									
Mix. 1	3.50 de	6.82 a-e	8.04 a-d	7.75 a-d	6.53 a	3.70 fg	6.17 c-e	7.73 a-c	8.24 ab	6.46 a
Mix. 2	2.72 e	6.39 a-e	9.49 a	7.53 a-d	6.53 a	1.89 h	3.98 fg	6.21 cd	7.18 a-c	4.82 b
Mix. 3	3.93 c-e	4.39 b-e	7.68 a-d	7.83 a-d	5.96 a	3.31 gh	5.27 d-f	6.85 b-d	8.81 a	6.06 a
Mix. 4	4.99 a-e	6.01 a-e	8.24 a-c	9.58 a	7.20 a	4.54 e-g	6.26 cd	8.37 ab	7.46 a-c	6.66 a
Mix. 5	3.55 de	6.85 a-e	8.66 ab	9.50 a	7.14 a	4.43 fg	6.89 b-d	7.75 a-c	6.84 b-d	6.48 a
Mean (B)	3.74 c	6.09 b	8.42 a	8.44 a		3.57 c	5.71 b	7.38 a	7.70 a	
	Stems d.w. (g)									
Mix. 1	9.71 b-d	11.88 ab	12.50 ab	10.34 a-d	11.11 a	9.46 a-d	11.10 a-d	13.16 a	11.34 a-d	11.26 a
Mix. 2	6.11 d	9.45 b-d	13.29 ab	11.23 a-c	10.02 a	5.03 e	7.31 de	9.71 a-d	9.81 a-d	7.96 b
Mix. 3	7.11 cd	9.92 a-d	12.56 ab	11.36 a-c	10.24 a	7.48 c-e	9.96 a-d	10.74 a-d	11.42 a-d	9.90 ab
Mix. 4	9.46 b-d	11.06 a-c	11.12 a-c	10.64 a-d	10.57 a	8.25 c-e	10.42 a-d	12.53 ab	9.18 a-e	10.10 a
Mix. 5	8.79 b-d	10.38 a-d	14.48 a	12.38 ab	11.51 a	8.46 b-e	10.31 a-d	11.51 a-c	10.25 a-d	10.13 a
Mean (B)	8.24 c	10.54 b	12.79 a	11.19 ab		7.74 b	9.82 a	11.53 a	10.40 a	
	Roots d.w. (g)									
Mix. 1	9.64 bc	11.08 bc	12.78 a-c	12.22 a-c	11.43 a	6.70 fg	7.60 e-g	9.02 c-g	10.11 b-g	8.36 b
Mix. 2	6.57 c	7.72 bc	11.94 a-c	12.07 a-c	9.58 a	7.68 e-g	8.19 d-g	8.27 d-g	10.05 b-g	8.55 b
Mix. 3	9.66 bc	10.51 bc	12.86 a-c	11.54 bc	11.14 a	8.42 d-g	9.47 c-g	14.96 a-c	13.00 a-f	11.46 ab
Mix. 4	7.94 bc	8.83 bc	18.71 a	14.16 ab	12.41 a	7.09 e-g	9.31 c-g	16.14 ab	13.49 a-e	11.51 ab
Mix. 5	10.01 bc	12.42 a-c	14.40 ab	14.09 ab	12.73 a	6.47 g	11.61 a-g	17.10 a	14.48 a-d	12.41 a
Mean (B)	8.77 c	10.11 bc	14.14 a	12.81 ab		7.27 b	9.24 b	13.10 a	12.23 a	

Means with the same letter within a columns or rows are not significantly according to Duncan's Multiple Range (DMRT).

Mix. 1: sand + peat moss, Mix. 2: sand + perlite, Mix. 3: sand + vermiculite, Mix. 4: sand + peat moss + perlite, Mix. 5: sand + peat moss + vermiculite.

respectively), in addition to those grown in mixture 1 (8.36 g) in the second season only.

The effect of irrigation treatments on the roots dry weight was significant in both seasons (Table, 5). The highest records of this character were obtained when irrigation at 75% pot water capacity was used (14.14 and 13.10 g in the first and second seasons, respectively). The lowest values were a result of irrigation at 25% pot water capacity (8.77 and 7.27 g in the first and second seasons, respectively).

The effect of interaction between potting mixtures and irrigation treatments on the roots dry weight was significant in both seasons (Table, 5). The heaviest dry roots were produced when irrigation at 75% pot water capacity was applied combined with mixture 4 (18.71 g) in the first season and mixture 5 (17.10 g) in the second one, while the lightest ones were obtained from plants watered at 25% pot water capacity and grown in mixture 2 (6.57 g) in the first season and mixture 5 (6.47 g) in the second one.

2. Chemical composition:

Total carbohydrate (%):

Data exhibited in Table (6) show that plants grown in mixture 1 achieved the highest total carbohydrate (8.24 %), while those grown in mixture 2 had the lowest one (6.16 %).

Table 6. Effect of potting mixtures, irrigation treatments and their interaction on total carbohydrates (%) and pigments content of *Acalypha wilkesiana* shrubs.

Growing mixtures (A)	Pot water capacity (B)									
	25%	50%	75%	100%	Mean (A)	25%	50%	75%	100%	Mean (A)
	Total carbohydrates (%)					Total chlorophylls (mg/g f.w.)				
Mix. 1	2.95	13.80	14.53	1.68	8.24	0.94	1.31	1.24	0.57	1.02
Mix. 2	2.29	6.27	7.56	8.52	6.16	0.99	1.45	1.48	1.02	1.24
Mix. 3	3.09	11.23	6.14	6.68	6.79	1.12	1.60	1.28	0.89	1.22
Mix. 4	4.56	5.36	9.71	8.83	7.12	0.52	0.90	1.29	1.15	0.97
Mix. 5	1.70	5.48	9.67	9.86	6.68	1.00	1.61	1.05	0.54	1.05
Mean (B)	2.92	8.43	9.52	7.11		0.91	1.37	1.27	0.83	
	Carotenoids content (mg/g f.w.)					Anthocyanin content (mg/g f.w.)				
Mix. 1	0.05	0.08	0.07	0.03	0.06	0.03	0.06	0.10	0.14	0.08
Mix. 2	0.01	0.02	0.07	0.05	0.04	0.08	0.15	0.36	0.41	0.25
Mix. 3	0.02	0.04	0.06	0.08	0.05	0.04	0.09	0.18	0.05	0.09
Mix. 4	0.03	0.16	0.03	0.03	0.06	0.17	0.21	0.45	0.36	0.30
Mix. 5	0.02	0.04	0.05	0.07	0.04	0.01	0.09	0.07	0.03	0.05
Mean (B)	0.03	0.07	0.05	0.05		0.07	0.12	0.23	0.20	

Irrigating plants at 75% pot water capacity gave rise to the highest total carbohydrates % (Table, 6), while 25% pot water capacity watering resulted in the lowest (9.52 and 2.92 %, respectively).

Plants grown in mixture 1 and watered at 75% pot water capacity had the highest of total carbohydrates (14.53 %). On the contrary, those grown in mixture 5 and watered at 25% pot water capacity had the lowest record (1.70 %) in Table (6).

Total chlorophyll content (mg/g f.w.):

Data exhibited in Table (6) show that using mixture 2 and mixture 4 gave rise to the highest and lowest total chlorophyll content (1.24 and 0.97 mg/g f.w., respectively).

Data presented in Table (6) show that watering at 50 or 100% pot water capacity resulted in the highest and lowest values of total chlorophyll content (1.37 and 0.83 mg/g f.w., respectively).

Plants grown in mixture 3 and watered at 50% pot water capacity got the highest content of total chlorophyll content (Table, 6), while those grown in mixture 4 and watered at 25% pot water capacity achieved the lowest record in the same regard (1.60 and 0.52 mg/g f.w., respectively).

Carotenoids content (mg/g f.w.):

Data exhibited in Table (6) show that using either mixture 1 or 4 led to the highest content of carotenoids (0.06 mg/g f.w. for both treatments). On the contrary, both mixtures 2 and 5 resulted in the lowest content (0.04 mg/g f.w. for both treatments).

Watering plants at 50 or 25% pot water capacity gave rise to the highest and the lowest record in this regard (0.07 and 0.03 mg/g f.w., respectively) as shown in Table (6).

Plants grown in mixture 4 and irrigated at 50% pot water capacity had the highest carotenoids content (Table, 6), while those grown in mixture 2 and irrigated at 25% pot water capacity obtained the lowest one (0.16 and 0.01 mg/g f.w., respectively).

Anthocyanin content (mg/g f.w.):

Data presented in Table (6) show that the highest anthocyanin content was found in plants grown in mixture 4, while the lowest one was detected in plants grown in mixture 5 (0.30 and 0.05 mg/g f.w., respectively).

Irrigation at 75% pot water capacity induced the highest content in the same manner (Table, 6), while irrigating plants at 25% pot water capacity resulted in the lowest content of anthocyanin (0.23 and 0.07 mg/g f.w., respectively).

Plants grown in mixture 4 and watered at 75% pot water capacity had the highest anthocyanin content (Table, 6), while those grown in mixture 5 and watered at 25% pot water capacity had the lowest value of the same trait (0.45 and 0.01 mg/g f.w., respectively).

Nitrogen (%):

Data recorded in Table (7) show that the highest N% was detected in plants grown in mixture 5, while the lowest value was a result of growing plants in mixture 4 (1.33 and 1.13%, respectively).

Watering plants at 75% and at 25% pot water capacity gave rise to the highest and the lowest percentage of N (1.57 and 1.00%, respectively) as shown in Table (7).

Application of both mixture 5 and irrigation at 75% pot water capacity resulted in the highest value of this percentage (1.77%). On the other hand, plants irrigation at 25% pot water capacity and growing in mixture 1 or 4, in addition to those grown in mixture 4 and watered at 50% pot water capacity had the same lowest N %, i.e. 0.88% (Table, 7).

Phosphors (%):

Data recorded in Table (7) show that the highest P % was detected in plants grown in mixture 4, while the lowest values were a result of using mixture 1 or 2 (0.76, 0.48 and 0.48%, respectively).

In the same Table irrigation at 75 or 25% pot water capacity resulted in the highest and lowest records of P% (0.69 and 0.47%, respectively).

Combining between mixture 4 and irrigation at 50% pot water capacity from as well as mixture 3 and irrigation at 100% pot water capacity on the other side gave rise to the highest and lowest P% (1.13 and 0.17, respectively) as shown in Table (7).

Potassium (%):

Data recorded in Table (7) show that the highest K % was detected in plants grown in mixture 4, while the lowest value was a result of growing plants in mixture 1 (1.56 and 1.03%, respectively).

Watering plants at 75% and at 25% pot water capacity gave rise to the highest and the lowest percentages of K (1.57 and 1.00%, respectively) as presented in Table (7).

Application of both mixture 5 and irrigation at 75% pot water capacity resulted in the highest value of this percentage (1.87%). On the other hand, plants irrigated at 25% pot water capacity and grown in mixture 5 had the lowest K %, i.e. 0.32% (Table, 7).

From the above results the use of mixture 5 (sand + peat moss + vermiculite, 1:1:1, v:v:v) in addition to irrigation at 75% pot water capacity for *Acalypha wilkesiana* shrubs resulted in high quality of plant and reduced the amount of water irrigation by 25%.

DISCUSSION

According to the obtained results, potting mixtures containing peat moss produced the highest values for most studied traits, this was in line with Mehmood *et al.* (2013) who demonstrated that growing substrate containing peat moss showed positive results for vegetative and reproductive growth of *Antirrhinum majus* L. ‘Floral Shower’. Also, Gad (2003) on *Ficus benjamina* revealed that using peat moss as a growing mixture increased plant height, stem diameter, number of branches and leaves, fresh weight of leaves, branches and roots, leaf size, total leaf area per plant and shoot : root ratio followed by peat +

Table 7. Effect of potting mixtures, irrigation treatments and their interaction on N, P and K (%) of *Acalypha wilkesiana* shrubs.

Growing mixtures (A)	Pot water capacity (B)														
	25%	50%	75%	100%	Mean (A)	25%	50%	75%	100%	Mean (A)	25%	50%	75%	100%	Mean (A)
	N %					P %					K %				
Mix. 1	0.88	1.00	1.66	1.66	1.30	0.26	0.42	0.46	0.79	0.48	0.52	1.44	1.15	1.01	1.03
Mix. 2	1.11	1.11	1.44	1.33	1.24	0.49	0.48	0.54	0.43	0.48	1.15	1.52	1.64	1.78	1.52
Mix. 3	1.11	1.11	1.33	1.11	1.16	0.53	0.56	0.74	0.17	0.50	1.41	1.50	1.64	1.64	1.55
Mix. 4	0.88	0.88	1.66	1.11	1.13	0.59	1.13	0.78	0.52	0.76	1.58	1.81	1.55	1.29	1.56
Mix. 5	1.00	1.55	1.77	1.00	1.33	0.51	0.55	0.92	0.67	0.66	0.32	1.44	1.87	1.70	1.33
Mean (B)	1.00	1.13	1.57	1.24		0.47	0.63	0.69	0.52		1.00	1.54	1.57	1.48	

vermiculite. El-Deeb and Sourour (2002) found that using the combination of agricultural media (1 sand:1 peat moss:1 vermiculite) increased the survival percentages of Zaghloul date palm plantlets up to 95%. The longest plantlets (10 cm) improved all the studied parameters. El-Sallami and Mahros (1997) reported that the medium containing peat moss + vermiculite showed the best growth of *Thuja orientalis* seedlings. The positive role of the addition of peat moss to the growing mixture could be interpreted by that, peat moss has light bulk density, good moisture holding ability, good air space qualities for the exchange of gases, adequate cation exchange capacity and a stable pH that is usually between 3.5 and 4.5 (Biondo and Noland, 2006). On the other hand, to explain the superior effect of vermiculite addition to pot mixture as reported in this study, Malandrino *et al.* (2006) reported that vermiculite has very high cation exchange capacity (120-150 meq/100 g), potassium is the principal exchangeable ion present in interlayer of this clay, as confirmed by its high percentage in the chemical composition of vermiculite besides possible coordinating cations (Al, Fe, and Mg). In this concern vermiculite as one of the clay minerals is well known for its water retention properties (Okada *et al.,* 2008).

A lot of conflicting arguments could be found in the literature dealing with irrigation. Some researchers claimed that higher levels of irrigation are in favor of plant height. For example, Chylinski *et al.* (2007) noticed that in impatiens (*Impatiens walleriana*) grown at 30% of soil water content, plant height was reduced by drought as compared to those grown at 80% of soil water content. Kazaz *et al.* (2010) determined the effects of different watering amounts (0.25, 0.50, 0.75, 1.00 and 1.25 crop-pan coefficients) on carnation (*Dianthus caryophyllus* cv. Turbo) grown in soil under greenhouse conditions. They noted that the significantly longest stems were determined in 1.25 and 1.00 kcp. Singh (2011) remarked that the increase in irrigation level (from 18.1 to 20.2, 26.5 and 36.2 mm/plant) enhanced the height of one-year-old *Eucalyptus camaldulensis* plants, it was the tallest at 36.2 mm. Álvarez *et al.* (2013) subjected *Pelargonium* × *hortorum* plants to irrigation treatments (75 and 100 % of water field capacity). They stated that plant height depends on the amount of water applied. However, many workers reported the advantages of the moderate level of irrigation which surpassed that of higher ones as described by Blanusa and Cameron (2009) on *Petunia hybrida* cv. Hurrah White and *Impatiens* cv. Cajun Violet. Also, Garas (2011) found that supplying some *Hibiscus rosa-sinensis* cultivars with the moderate irrigation level (0.75 liter/pot) was the best for increasing plant height, compared to the other irrigation levels. Meanwhile, applying the highest level (1 liter/pot) occupied the second position in the same regard.

Although, Scheiber *et al.* (2008) reported that irrigation quantity did not affect the final height or growth indices of *Solenostemon scutellarioides* (coleus), whereas Hansen and Petersen (2004) and D'souza and Devaraj (2011) found that drought stress reduced plant height of *Hibiscus rosa-sinensis* and *Dolichos lablab*, respectively.

On the other hand, deficit irrigation had a negative impact on plant weight as shown by Shimizu and YanWen (2007) on *Betula ermanii* plant and D'souza and Devaraj (2011) who found that drought stress reduced both dry and fresh weights of *Dolichos lablab* (HA-4 cultivar). On the contrary, Scheiber *et al.* (2008) observed that irrigation quantity did not affect final dry weights of shoot and root of *Solenostemon scutellarioides* (coleus). However, Fascella *et al.* (2011) observed that two potted *Euphorbia* x *lomi* hybrids (cvs. Nam Chok and Udom Sab) plants with deficit irrigation showed higher top and root dry weight than control plants.

Regarding the effect of watering level on number of branches, the high level of watering was preferred for growth in some papers. El-Shakhs *et al.* (2002) on *Dahlia pinnata* stated that increasing quantity of water improved the number of branches/plant. Garas (2011) reported that using the highest irrigation level (1 liter/pot) for some *Hibiscus rosa-sinensis* cultivars was the best for increasing the number of branches/plant.

In regard to the effect of watering amounts on the number of leaves, many authors noticed that water deficit associated with increasing soil moisture tension led to deterioration in the formation of leaves produced by plant. D'souza and Devaraj (2011) found that drought stress reduced leaf number of *Dolichos lablab* (HA-4 cultivar). The positive effect of adopting the highest irrigation level in increasing the number of leaves was mentioned by various authors such as El-Hanafy *et al.* (2006) on *Ornithogalum thrysoides* and Garas (2011) on some *Hibiscus rosa-sinensis* cultivars.

The major impact of irrigation amount might be its influence on weight of the vegetative growth of the plant. Using higher amounts of water was beneficial to some plants as reported by Kafi *et al.* (2010) on *Kochia scoparia* cvs. Sabzevar and Borujerd, Kazaz *et al.* (2010) on carnation plants (*Dianthus caryophyllus* cv. Turbo) and Singh (2011) on *Eucalyptus camaldulensis* plants. However, other workers found that moderate irrigation amounts were more preferable as recorded by Mortimer *et al.* (2003) on *Protea hybrida* plants, El-Boraie *et al.* (2009) on *Hibiscus sabdariffa*, Iersel *et al.* (2010) on petunia (*Petunia* x *hybrida*), Amoroso *et al.* (2011) on potted *Thuja plicata* 'Martin' and Garas (2011) on some *Hibiscus rosa-sinensis* cultivars.

In connection to the effect of irrigation treatments on root length, some researchers observed that the more water was available to plant, the longer its roots will grow. On the other hand, D'souza and Devaraj (2011) found that drought stress reduced root length of *Dolichos lablab*.

On the contrary, excess watering affected the root length negatively as mentioned by Chylinski *et al.* (2007) on impatiens and geranium**,** Fascella *et al.* (2011) on potted *Euphorbia* x *lomi* hybrids (cvs. Nam Chok and Udom Sab) and Woods *et al.* (2011) on *Larrea tridentata*.

Moderate amounts of watering were preferred by some plants to encourage root growth. Garas (2011) stated that using the moderate irrigation level (0.75 liter/pot) proved its mastery in increasing fresh and dry weights of roots of some *Hibiscus rosa-sinensis* cultivars.

In regard to the effect of watering amount on content of carbohydrate, it was found that low levels of irrigation resulted in more carbohydrates as reported by Garas (2011) on some *Hibiscus rosa-sinensis* cultivars. However, some reports are in favor of moderate or high irrigation levels. El-Shakhs *et al.* (2002) reported that increasing quantities of water improved the percentage of carbohydrates in the leaves of *Dahlia pinnata*.

In respect of the influence of irrigation regime on photosynthetic pigments, many authors observed the negative effect of water deficit on the content of chlorophyll and carotenoids as reported by Chylinski *et al.* (2007) they found that the reduction in the total chlorophyll concentration in leaves of impatiens was significantly stress-dependent, while no reaction in geranium was observed. D'souza and Devaraj (2011) found that drought stress reduced total chlorophyll of *Dolichos lablab*. Caser *et al.* (2012) subjected rooted cuttings of *Salvia dolomitica*, *S. sinaloensis* and *Helichrysum petiolare* to five watering treatments (20-100% of container water capacity), they mentioned that chlorophyll concentration decreased as water stress increased.

CONCLUSION

In conclusion and according to the results mentioned above, growing *Acalypha wilkesiana* shrubs in Mix. 5 (sand + peat moss + vermiculite, 1:1:1 by volume) + irrigation at 75% pot water capacity was recommended to reduce the amount of irrigation water by 25% with obtaining high quality plants.

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تقدير الإحتياجات المائية لشجيرات الأكاليفا وعلاقته بمخلوط بيئة الزراعة

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** قسم بحوث نباتات الزينة وتنسيق الحدائق، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر

أجريت هذه الدراسة فى مشتل قسم بحوث نباتات الزينة وتنسيق الحدائق، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر. من شهر يونيو ٢٠١٤ حتى يونيو ٢٠١٥ (موسم أول) ومن يونيو ٢٠١٥ حتى يونيو ٢٠١٦ (موسم ثانى) وذلك لدراسة استجابة شتلات الأكاليفا النامية في مخاليط مختلفة من بيئة الزراعة ومستويات مختلفة من ماء الرى. حيث تم استخدام خمسة مخاليط متساوية الحجم من بيئة الزراعة (مخلوط (١): رمل + بيتموس ، مخلوط (٢): رمل + بيرليت ، مخلوط (٣): رمل + فيرمكيوليت، مخلوط (٤): رمل + بيتموس + بيرليت ، مخلوط (٥): رمل + بيتموس + فيرمكيوليت) وتم الرى بأربعة مستويات من ماء الرى (٢٥، ٥٠، ٧٥، ١٠٠٪ من سعة حفظ مخلوط الزراعة للماء بالأصيص) وأيضاً تم دراسة تأثير التفاعل بين العاملين السابقين. وقد تم تسجيل القياسات فى يونيو ٢٠١٥ ويونيو ٢٠١٦ وتمثلت فى قياسات المجموع الخضرى والجذرى وتقدير محتوى الأوراق من النسبة المئوية للكربوهيدرات الكلية والمحتوى الكلي للكلوروفيل والكاروتينويدات والأنثوسيانين والنسبة المئوية للنيتروجين والفوسفور والبوتاسيوم. وقد أظهرت النتائج أن هناك تأثير معنوى لمخاليط الزراعة خاصة المحتوية على البيتموس على معظم الصفات تحت الدراسة. حيث أدى استخدام مخلوط (٥) للحصول على أعلى القيم لصفات إرتفاع النبات وعدد الأوراق وعدد الأفرع ومساحة الورقة والوزن الطازج للساق والوزن الجاف للجذور والنسبة المئوية للنيتروجين. ومن ناحية أخرى أدى استخدام الرى بمعدل ١٠٠ و٧٥٪ من سعة حفظ مخلوط الزراعة للماء بالأصيص للحصول على أعلى القيم لصفات إرتفاع النبات وعدد

الأوراق وعدد الأفرع ومساحة الورقة وطول الجذور والوزن الطازج للأوراق والسيقان والجذور والوزن الجاف للأوراق والسيقان والجذور والنسبة المئوية للكربوهيدرات الكلية ومحتوى الأنثوسيانين والنسبة المئوية للنيتروجين والفوسفور والبوتاسيوم فى حين أدى استخدام الرى بمعدل ٢٥٪ من سعة حفظ مخلوط الزراعة للماء بالأصيص للحصول على أدنى القيم لمعظم الصفات تحت الدراسة. وعند دراسة التفاعل بين المعاملات وجد أن استخدام أياً من مخاليط الزراعة الخمسة + الرى بمعدل ١٠٠ أو ٧٥٪ من سعة حفظ مخلوط الزراعة للماء بالأصيص أدى للحصول على أعلى القيم لمعظم الصفات تحت الدراسة. من النتائج سابقة الذكر وللحصول على شجيرات الأكاليفا بجودة عالية مع تقليل كمية المياه اللازمة للري بنسبة ٢٥٪، فإنه يُوصى باستخدام مخلوط (٥) (رمل + بيتموس + فيرمكيوليت، ١:١:١ حجماً) + الري بمعدل ٧٥٪ من سعة حفظ مخلوط الزراعة للماء بالأصيص.