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RESPONSE OF *Agave americana* L.CV. MARGINATA PLANT TO DIFFERENT MEDIA AND WATER QUANTITIES

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ABSTRACT

A trial was conducted at Orman Botanical Garden, Giza, Egypt during 2006 and 2007 seasons to find out the effect of weekly twice irrigation with four water quantities (75, 100, 125 and 150 ml/pot), planting in five types of media (sand, loam, san + loam (1:1 by weight), sand +10% chicken manure compost (CMC) and sand + 10% loam + 10% CMC) and their interactions on vegetative and root growth, suckers productivity, water use efficiency (WUE) and chemical composition of one-year old suckers of *Agave americana* L. cv. Marginata grown in 15-cm diameter clay pots under full sun conditions.

The obtained results indicated that plant height (cm), leaf No./plant, leaf length and width (cm), root length (cm), root No./ plant, as well as the vegetative parts and roots fresh and dry weights (g) were significantly increased with elevating irrigation water quantity and improving the quality of composed media in most cases of the two seasons. A similar trend was also gained with regard to number and length of suckers developed around the mother plant, W.U.E. (ml/g D.M), leaves content of chlorophyll a, b and carotenoids (mg/g F.W.) and the percentages of total carbohydrates, N,P and K in the leaves and roots. The highest records for all previous parameters were generally achieved when plants were irrigated with 150 ml of fresh water/pot and raised in the medium composed of sand + 10% loam+ 10% CMC, which is recommended to get the best vegetative and root growth parameters, highest quality and productivity of suckers and best chemical composition with high efficiency of the used water.

INTRODUCTION

Agave americana L. cv. Marginata, century plant or American aloe belongs to Fam. Agavaceae, is native to North America; leaves are spreading in a basal rosette, to 1.5 m long, nearly 25 cm width, curved or reflexed at tip, margins toothed but not horny, yellowish-white to deep yellow; inflorescence paniculate, tall; flowers pale yellow. It is a very large plant with rosettes up to 3.5m wide; usually grown as an ornamental plant in semi-arid regions or in succulent collections; propagates by the suckers which develop around the old plants or by division of the rhizomes (Bailey, 1976). It is used to obtain high-fructose fermentable liquor for making mescal, a distilled alcoholic beverage similar to tequila. A fatty sap extracts from the thick leaf bases are used for making counterirritant and antirheumatic ointment (Huxley *et al.*, 1992). A new application for this plant is the production of inulin. It is an indigestible oligosaccharide (fructan) that can be used as food additive or ingredient for food products (Coussement and Franck, 2005).

Inulin has good fat mimic properties when combined with water and it shows synergetic gelling effects when combined with gelling agents. Inulin is a prebiotic. Recent nutrition research has shown interesting results with regard to calcium absorption and colon cancer prevention by inulin (Ramirez *et al.*, 2005). After inulin extraction, the agave bagasse can be used to obtain

agave fiberboards that have moisture and mechanical properties comparable to medium specific gravity fiberboards made by using aspen fiber (Iniguez – Covarrubias *et al.*, 2001).

Because most cacti and succulent plants differ morphologically and physiologically from most of the other plants and exhibit crassulacean acid metabolism, and hence require less water than conventional crops and often will flourish on soils with low nutrients availability (Nobel, 1988), their use may increase in the future, specially for greening the newly reclaimed soils in arid and semiarid regions. Yet, relatively few studies have been done on commercial cactus and succulents. So, comprehensive information are still little concerning the effect of water deficit and medium components on growth, quality and chemical composition of such plant. In this respect, however, Abdel-Gayed (2001) and Shahin *et al.* (2006) on *Agave sisalana* observed that plant height, leaf No./plant, leaf length and width, as well as the vegetative parts and roots fresh and dry weights were significantly increased with raising either irrigation water amount or fertilization rate. Leaves content of chlorophyll a, b and carotenoids and the percentages of total carbohydrates, N,P and K in the leaves and roots were increased in response to either high water supply or fertilization rate. The different levels of fertilization elevated the water use efficiency, whereas increasing water supply decreased it. Similar observations were also gained by Graham and Nobel (1999) and North and Nobel (2000) on *Agave desertii*, Bacci *et al.*, (2003) on *Cupressus macrocarpa* and *Cornus alba*, Knee *et al.*, (2003) on *Gleditsia triacanthos*, *Gymnocladus dioicus*, *Cercis canadensis* and *Robinia pseudoacacia*, Karam *et al.*, (2004) on *Codiaeum variegatum* and Schuch (2004) on *Ruellia brittoniana*, *Myrtus communis* cv. Compacta and *Sophora secundiflora*, as they all indicated that water use was varied due to the different environments, plant species, container size and medium ingredients.

The components of medium, that agaves are grown on may affect fertility, porosity, water holding capacity, bulk density, pH and conductivity of the medium, and consequently affect growth and flourishness of such plants. In this concern, Huxley *et al.*, (1992) stated that agaves need a soil of mostly loam and sand with good drainage. Badano and Pugnaire (2004) revealed that agave plant actually invaded the Southeast of Spain with high growth rate in sandy soils.

The use of organic compost, as a cheap substitute for peat moss whose price continuously increases, in the formulation of media used for the commercial production of container grown ornamental has been investigated by many workers. In this regard, Marfa *et al.* (2002) reported that the following peat – substitutes: cattle manure compost, forest waste compost, pine bark compost, yard compost and raw coir improved growth of *Nerium oleander*, *Euonymus japonicus* and *Viburnum tinus* due to release of nutrients, especially nitrates, during the growing period. Gad (2003) on *Ficus benjamina* found among the following potting mixtures: clay, clay+straw, clay+ sawdust, peat moss, peat+clay, peat+vermiculite, peat+sand, vermiculite, vermiculite+straw, vermiculite+sawdust, sand+straw and sand+sawdust that peat moss alone produced the best vegetative and root growth, followed by peat+vermiculite and vermiculite+straw. High leaf

contents of N, P, K, chlorophylls a and b and carotenoids were closely correlated with the best growth obtained with the most suitable media. On the same line, were those findings revealed by Singh and Sidhu (2002) on *Asparagus plumosus*, *Aglaonema costatum*, *Maranta bicolor* and *Nephrolepis exaltata*, Strojny and Nawak (2004) on *Tagetes erecta*, *Salvia splendens*, *Scaevola aemula* and *Verbena hybrida*, Verhagen (2004) on *Guinea impatiens*, Hernandez-Apaolaza *et al.*, (2005) on *Pinus pinea*, *Cupressus arizonica* and *C. sempervirens*, Chen and Li (2006) on Spathiphyllum and Benito *et al.* (2006) who reported that pruning waste compost is the acceptable component of a substrate for *Lolium perenne* and *Cupressus sempervirens*.

The present work aims to detect the beneficial effects of addition of loam, chicken manure compost or both to sand on the growth of *Agave americana* L. cv. Marginata under different irrigation water quantities.

MATERIALS AND METHODS

A study was consummated at Orman Botanical Garden, Giza, Egypt throughout 2006 and 2007 seasons to determine the optimum water quantity and the best medium components suitable for growing century plant (*Agave americana* L. cv. Marginata).

One-year old suckers of about 8-10cm long with 3-4 small leaves were planted on March, 15th for both seasons in 15 cm diameter clay pots filled with 1.5 kg of one type of the following media: sand, loam (physical and chemical properties of both are shown in Table a), a mixture of equal parts of sand and loam, by weight, a mixture of sand+ 10% of chicken manure compost (CMC) by weight (chemical analyses of CMC are shown in Table b), and a mixture of sand + 10% loam + 10% CMC.

Table (a): Physical and chemical properties of sandy and loamy textures used in the study.

Soil	S.P	EC	pH	Particle size distribution (%)				Cations (meq/L)				Anions (meq/L)		
texture		dS/m		C. sand	F. sand	clay	silt	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{2-}
Sandy	20	6.5	8.00	8.60	4.55	4.70	4.75	27.50	15.25	39.37	0.53	6.50	38.19	37.96
loamy	39	4.1	7.70	25.10	40.50	16.00	18.40	20.50	8.00	11.88	0.19	1.56	14.07	24.94

Table (b): Chemical analyses of the chicken manure compost (CMC) used in the study.

Sample	O.M. (%)	N (%)	P_2O_5 (%)	K_2O (%)	Ca (%)	Mg (%)
CMC	30.7	0.96	0.50	0.83	0.42	2.00

One sucker was raised in each pot in the open field under the full sun and was weekly twice irrigated with the following amounts of fresh water: 75, 100, 125 and 150 ml/pot beginning on March, 15th until the final harvest on October, 30th. The amount of irrigation water was not added as a percent of field capacity (F.C.) due to the variability in it for the different media used in this study, which makes the addition of irrigation water as a percent of F.C. more difficult and more subjected to fall in error.

All irrigation quantities were combined with each medium mentioned before to form twenty interaction treatments.

Split plot design was used during both seasons, as the main plot was the medium type and the sub-plot was devoted to water quantity, with three replicates as each replicate contained six plants (Das and Giri, 1986).

At the end of October, the following data were recorded: plant height (cm) from soil surface in the pot to the farthest point of the leaves, leaf No./plant, leaf length and width (cm) for the fifth leaf from the base and upward, length of the longest root (cm), root No./plant, as well as fresh and dry weights (g) of vegetative parts and roots. Number of suckers developed around the mother plant and their lengths (cm) were also registered. Total amount of water (ml)/ plant/ season was computed by multiplying number of irrigation times throughout the season, which was 64 times, by the amount of water (ml) used in each time for the different irrigation treatments. Water use efficiency (W.U.E) was calculated by dividing the total amount of water (ml)/ plant/ season by the total amount of dry matter (g)/ plant/ season to determine the quantity of water necessary for producing 1g of dry matter by century plant under various media used in the present work. In fresh leaf samples taken from the various treatments in the second season, photosynthetic pigments content (chlorophyll a, b and carotenoids as mg/g F.W.) was measured according to the method of Moran (1982), while in vegetative and root dry samples, the percentages of total carbohydrates (Herbert *et al.*, 1971), as well as N,P and K content (Jackson, 1973) were determined.

Data were statistically analyzed as described by SAS program (1994) using Duncan's Multiple Range Test (1955) for elucidating the significancy level among means of the different treatments.

RESULTS AND DISCUSSION

Effect of different media, water quantities and their interactions on:
a- vegetative and root growth:

According to data presented in Tables (1), (2) and (3), it is clear that plant height (cm), leaf No./plant, leaf length and width (cm), root length (cm), root No./plant, as well as the vegetative parts and roots fresh and dry weights (g) were generally improved in response to increasing water amount with various significance levels, specially for plants cultivated in mixture 3, followed by those grown in loam when compared to means of plants grown in the sandy medium in both seasons. Cultivating plants in mixtures No. 1 and 2 slightly improved the previous characters with few exceptions in both seasons. Best vegetative and root growth, however, was obtained from planting in mixture 3, which consists of sand + 10 % loam+ 10 % CMC, and irrigating at the level of 150 ml/pot, as this combined treatment gave, in general the utmost high averages for all previous traits in all cases of the two seasons.

Table (1): Effect of media, water quantities and their interactions on some vegetative growth traits of *Agave americana* L. cv. Marginata plant during 2006 and 2007 seasons.

	Plant height (cm)					Leaf No. /plant					Leaf length (cm)					Leaf width (cm)				
Type of	Water quantity (ml)					Water quantity (ml)					Water quantity (ml)					Water quantity (ml)				
medium	75	100	125	150	Mean	75	100	125	150	Mean	75	100	125	150	Mean	75	100	125	150	Mean
	First season: 2006																			
Sandy	11.20e	11.63e	13.10d	15.38b	12.83d	5.50fe	6.67ef	8.00de	10.00c	7.54c	11.38f	12.88e	16.73d	21.15cb	15.54c	2.7d	3.0c	3.4b	3.5b	3.15b
Loamy	14.17c	14.25c	15.13bc	17.20ba	15.19b	8.00de	8.00de	10.75cb	12.00b	9.69b	17.88dc	20.75c	26.0ab	25.0ba	22.41a	3.4b	3.5b	3.7ba	4.5a	3.78ab
Mixture 1	15.83b	13.28d	14.67cb	16.86ba	15.16b	7.33e	8.25d	11.25bc	11.00bc	9.46b	16.17d	17.63dc	25.25ba	23.50b	20.64ba	3.5b	3.5b	4.0ba	4.3ab	3.83a
Mixture 2	12.36de	13.63cd	13.76cd	17.67ab	14.34c	8.00de	8.90d	10.00c	10.67cb	9.39b	16.00de	16.86d	21.88cb	23.00b	19.44b	3.0c	3.2bc	3.5b	4.0ba	3.43ba
Mixture 3	14.33c	16.67ba	15.30b	21.00a	16.83a	8.67d	10.33c	12.50b	14.50a	11.50a	17.50dc	20.33c	26.10a	27.75a	22.92a	3.5b	3.7ba	4.3ab	4.7a	4.05a
Mean	13.58c	13.89c	14.38bc	17.62a		7.50c	8.43cb	10.50ba	11.64a		15.79c	17.69b	23.19a	24.08a		3.22c	3.38c	3.78b	4.20a	
	Second season: 2007																			
Sandy	11.42e	11.56e	12.76de	15.00cb	12.69d	5.00f	6.40e	8.00d	10.00c	7.35c	12.51e	13.71ed	16.56cd	20.70bc	15.87c	2.5d	2.8c	3.3bc	3.5b	3.03c
Loamy	14.50c	14.80c	15.48bc	17.48ab	15.57ba	7.33ed	8.00d	11.00cb	12.33b	9.67b	16.78cd	21.00b	24.17ba	26.00a	21.99a	3.3bc	3.4b	3.8ba	4.5a	3.75a
Mixture 1	12.86de	13.55cd	14.50c	17.00ba	14.48c	7.50de	8.00d	12.25b	11.67bc	9.93b	15.36d	18.11c	23.80ba	25.33ab	20.65ba	3.1cb	3.3bc	3.8ba	4.5a	3.68ba
Mixture 2	12.65de	13.26d	13.61cd	16.78ba	14.08c	7.00e	7.36de	10.50cb	11.67bc	9.13b	15.10d	17.00c	22.00b	23.11ba	19.30b	3.0cb	3.1cb	3.4b	3.9ba	3.35b
Mixture 3	15.00cb	15.93b	16.33b	19.76a	16.76a	8.50dc	10.00c	12.67b	14.33a	11.38a	17.21c	21.80b	25.90a	26.87a	22.95a	3.3bc	3.5b	4.2ab	4.8a	3.95a
Mean	13.29c	13.82c	14.54bc	17.20a		7.07c	7.95c	10.89ba	12.00a		15.39c	18.33b	22.49ab	24.40a		3.04c	3.22c	3.70b	4.24a	

* Mixture1: a mixture of sand + loam (1:1, w/w), Mixture2: a mixture of sand + 10% chicken manure compost (CMC) and mixture 3: a mixture of sand + 10% loam + 10% CMC.

* Means having the same letters within a column or row are not significantly different at 5% level according to Duncan's Multiple Range Test.

This may indicate the role of enough water in preventing the synthesis of abscisic acid (ABA), which negatively affects root growth, induces defoliation, lowers absorption of minerals and then inhibiting plant growth (Hoffman *et al.*, 1999). Moreover, Dosmann *et al.*, (1999) concluded that Katsura ornamental tree as a drought avoider that abscises its leaves to reduce transpirational water loss, is capable of quick refolation after water becomes available due to increasing levels of auxins and gibberellins and reducing of ABA level, which might activate meristems and encourage cell division, elongation and enlargement with increasing metabolites in the plant which are reflected on more growth and heavier weight of plant parts. On the other hand, the presence of loam granules combined with manure compost (as done in mixture 3) may improve structure and texture of the medium, increase cation exchange capacity and fertility, beside raising the water holding capacity of the mixture and consequently, water up ake by plants, which leads finally to activate vital processes to produce mo e constituents necessary for more growth and high quality (Verhagen, 2004). Such results are in harmony with those found by North and Nobel (2000) on *Agave desertii*, Abdel-Gayed (2001) and Shahin *et al.* (2006) on *Agave sisalana*, Bacci *et al.* (2003) on *Cupressus macrocarpa* and *Cornus alba*, Karam *et al.* (2004) on *Codiaeum variegatum* and Chen and Li (2006) on Spathiphyllum.

Table (2): Effect of media, water quantities and their interactions on length and number of roots of *Agave americana* L. cv. Marginata plant during 2006 and 2007 seasons.

Type of medium	Root length (cm)					Number of roots/plant				
	Water quantity (ml)					Water quantity (ml)				
	75	100	125	150	Mean	75	100	125	150	Mean
	First season: 2006									
Sandy	20.50g	29.00ed	32.00dc	40.33b	30.46d	7.36f	8.43e	11.00d	12.00dc	9.70d
Loamy	26.67e	24.00fe	27.0e	34.00c	27.92c	9.21ed	10.00d	12.27cd	14.50c	11.50cb
Mixture 1	22.17f	23.78fe	31.67dc	36.67bc	28.57c	9.00ed	12.78cd	13.80c	16.33b	12.98b
Mixture 2	25.33ef	30.17d	36.0cb	34.18c	31.42b	8.76e	9.76de	11.67dc	12.78cd	10.74c
Mixture 3	26.50e	42.50ba	44.00a	47.50a	37.63a	13.46c	13.98c	16.00b	20.17a	15.90a
Mean	24.24d	29.89c	34.13b	38.54a		9.56c	10.99cb	12.95b	15.16a	
	Second season: 2007									
Sandy	24.10f	27.93e	31.76d	38.26c	30.51d	8.00fe	8.67ef	10.38de	12.50dc	9.89d
Loamy	27.00e	28.80de	29.82d	40.00cb	31.41c	9.46e	10.33de	13.20c	15.41bc	12.10cb
Mixture 1	26.64ef	28.13de	31.10d	37.00cd	30.72c	9.78ed	11.96d	14.33cb	16.76b	13.21b
Mixture 2	27.36e	29.56d	36.00dc	41.04bc	33.49b	9.00e	10.00ed	12.80cd	14.00cb	11.45c
Mixture 3	30.00d	36.76dc	42.00b	46.80a	38.89a	12.86cd	14.00cb	17.43b	21.20a	16.37a
Mean	27.02d	30.24dc	34.14bc	40.62a		9.82d	10.99c	13.63b	15.98a	

*** Mixture1: a mixture of sand + loam (1:1, w/w), Mixture2: a mixture of sand + 10% chicken manure compost (CMC) and mixture 3: a mixture of sand + 10% loam + 10% CMC.**

*** Means having the same letters within a column or row are not significantly different at 5% level according to Duncan's Multiple Range Test.**

Table (3): Effect of media, water quantities and their interactions on vegetative parts and roots fresh and dry weights of *Agave americana* L. cv. Marginata plant during 2006 and 2007 seasons.

	Vegetative parts F.W. (g)					Vegetative parts D.W. (g)					Roots F.W. (g)					Roots D.W. (g)				
Type of	Water quantity (ml)					Water quantity (ml)					Water quantity (ml)					Water quantity (ml)				
medium	75	100	125	150	Mean	75	100	125	150	Mean	75	100	125	150	Mean	75	100	125	150	Mean
	First season: 2006																			
Sandy	54.85g	83.43f	149.80d	192.87dc	120.24d	5.45g	7.67f	19.42d	28.40bc	15.24c	5.17g	5.28g	17.37dc	15.30d	10.78d	1.71g	2.18fg	7.31d	6.38ed	4.40d
Loamy	136.9de	101.76ef	214.40cb	246.9bc	174.98b	10.84fe	11.34e	23.27c	30.29b	18.94b	6.60f	12.50e	20.96c	28.26a	17.08ba	2.60f	4.53e	9.42cb	10.46b	6.75b
Mixture 1	119.23e	150.48d	208.93c	213.5cb	173.04b	11.28e	18.00d	21.50cd	30.17b	20.24b	6.07fg	10.70ef	17.63dc	18.87cd	13.32c	3.03fe	4.38e	7.50d	8.25c	5.79c
Mixture 2	98.93f	130.00ed	137.50de	206.4c	143.21c	10.12fe	16.73ed	20.90dc	30.30b	19.57b	5.67g	9.83fe	19.80c	26.40ba	15.43b	2.43f	4.27e	7.80d	9.43cb	5.98c
Mixture 3	114.00e	225.00cb	252.90b	320.5a	228.10a	12.18e	23.51c	29.10bc	39.33a	26.03a	6.46f	23.3b	22.63cb	29.20a	20.38a	3.73ef	8.68c	9.85bc	12.97a	8.81a
Mean	104.78d	138.14c	192.71b	236.04a		9.98d	15.46c	22.84b	31.70a		5.98d	12.32c	19.68b	23.61a		2.70d	4.81c	8.38b	9.50a	
	Second season: 2007																			
Sandy	50.00h	82.56g	135.70e	186.73d	113.75d	5.17g	7.61gf	17.58d	26.36bc	14.18d	6.41hg	5.10h	16.81d	17.50dc	11.46d	2.10g	2.12g	7.00cd	7.25c	4.62d
Loamy	125.34ef	106.26f	218.00c	250.00b	174.90b	9.26f	11.50e	23.43c	30.40ba	18.63cb	6.68gh	14.33ed	23.00b	29.41a	18.36a	2.65fe	5.04d	9.85b	10.78ba	7.08b
Mixture 1	120.71fe	137.33e	226.91cb	231.63bc	179.15b	11.15e	16.44de	22.81c	32.53ba	20.73b	7.22g	12.48e	17.32dc	19.87c	14.22c	3.40e	5.08d	7.25c	8.74cb	6.12c
Mixture 2	86.67g	128.39ef	201.67cd	229.30bc	161.5cb	8.85f	16.50de	26.76bc	33.24a	21.34b	6.55gh	9.58f	19.70c	26.98ba	15.70b	2.78ef	4.16ed	7.74c	9.35b	5.26cd
Mixture 3	117.10fe	210.40c	248.10b	290.17a	216.44a	12.33e	21.47cd	28.43b	35.46a	24.42a	7.25g	17.35dc	21.00bc	28.57a	18.54a	4.21ed	6.50dc	9.15b	12.50a	8.09a
Mean	99.97d	132.99c	206.08b	237.57a		9.34d	14.71c	23.80b	31.60a		6.82d	11.77c	19.57b	24.47a		3.03d	4.58c	8.20b	9.73a	

* Mixture1: a mixture of sand + loam (1:1, w/w), Mixture2: a mixture of sand + 10% chicken manure compost (CMC) and mixture 3: a mixture of sand + 10% loam + 10% CMC.

* Means having the same letters within a column or row are not significantly different at 5% level according to Duncan's Multiple Range Test.

b- Suckers productivity and water use efficiency:

As shown in Table (4), it is obvious that low and medium amounts of water (75, 100 and 125 ml/pot) caused a slight increase in the suckers produced around century plants in the two seasons, whereas raising the water quantity to 150 ml/pot induced a highly significant increment in such parameter giving 4.83 and 4.54 suckers/plant in the first and second seasons, respectively. A similar trend was observed regarding the effect of media, as all medium types slightly improved this trait, except for the mixture No. 3 that greatly increased it to 3.27 and 3.05 suckers/ plant in the first and second seasons, respectively.

On the other hand, the length of resulted suckers was greatly increased in response to either medium type or water amount treatments employed in the two seasons. The tallest suckers, however resulted from plants irrigated with 150 ml of water/pot and cultivated in mixture No. 3, as this combined treatment elongated the length of suckers to 5.28 cm in the first season and to 5.00 cm in the second one.

Table (4): Effect of media, water quantities and their interactions on number and length of suckers developed on *Agave americana* L. cv. Marginata plant during 2006 and 2007 seasons.

Type of medium	Suckers No./plant					Length of sucker (cm)				
	Water quantity (ml)					Water quantity (ml)				
	75	100	125	150	Mean	75	100	125	150	Mean
	First season: 2006									
Sandy	0.00g	0.00g	1.00f	3.00d	1.00b	0.00e	0.00e	2.13dc	2.97c	1.28c
Loamy	0.00g	1.00f	1.67e	5.16b	1.96b	0.00e	1.83d	3.00cb	3.80b	2.16ba
Mixture 1	0.00g	1.00f	1.33fe	4.00c	1.58b	0.00e	1.50ed	2.50c	3.26bc	1.82b
Mixture 2	0.00g	1.00f	1.33fe	4.00c	1.58b	0.00e	1.46ed	2.58c	3.33bc	1.84b
Mixture 3	1.00f	1.67e	2.40de	8.00a	3.27a	1.58de	1.88d	3.20cb	5.28a	2.99a
Mean	0.20b	0.93b	1.55b	4.83a		0.32d	1.33c	2.68b	3.73a	
	Second season: 2007									
Sandy	0.00g	0.00g	1.00fg	3.00d	1.00b	0.00e	0.00e	2.26dc	3.00c	1.32d
Loamy	0.00g	1.00fg	1.78ef	5.33b	2.03b	0.00e	1.96d	2.86cd	3.91b	2.18b
Mixture 1	0.00g	1.00fg	1.33f	3.86c	1.55b	0.00e	1.48ed	2.45dc	3.17c	1.78c
Mixture 2	0.00g	1.00fg	1.38f	3.79c	1.54b	0.00e	1.46ed	2.67cd	3.21c	1.84cb
Mixture 3	1.33f	2.00e	2.17ed	6.71a	3.05a	1.50ed	2.00d	3.10c	5.00a	2.90a
Mean	0.27b	1.00b	1.53b	4.54a		0.30d	1.38c	2.67b	3.66a	

*** Mixture1: a mixture of sand + loam (1:1, w/w), Mixture2: a mixture of sand + 10% chicken manure compost (CMC) and mixture 3: a mixture of sand + 10% loam + 10% CMC.**

*** Means having the same letters within a column or row are not significantly different at 5% level according to Duncan's Multiple Range Test.**

These results indicate the synergistic effects of both high supply of water and high quality of medium ingredients on supplying the growing buds with the required water and nutrients necessary for accelerating growth, and hence forming more and longer suckers. In this concern, Gad (2003) on *Ficus benjamina* pointed out that peat moss alone increased number and quality of branches per plant and shoot: root ratio followed by peat + vermiculite and

vermiculite + straw. Similarly, Benito *et al.* (2006) mentioned that mixing pruning waste compost with sand increased growth and number of tillers on *Lolium perenne* plants.

It appears from data in Table (5) that the amount of water necessary for producing 1g of dry matter in the two seasons was markedly declined in response to either increasing water quantity or improving the components of growing medium. That means that water use efficiency (W.U.E) was increased with increasing supply of water and with improving the quality of medium. In general, the best W.U.E was gained from watering with 150 ml/pot and planting in the mixture No. 3. Such results may indicate the role of increasing water supply combined with improving ingredients of the growing medium (as done in the mixture No. 3) in activating nutrients uptake and absorbing more soil water that leads to activate the vital processes, which finally result in greater growth with higher production of dry matter. On the same line were those results attained by Abdel-Gayed (2001) and Shahin *et al.* (2006) on sisal, Karam *et al.* (2004) on croton and Schuch (2004) on *Ruellia brittoniana*, *Myrtus communis* and *Sophora secundiflora*.

Table (5): Water use efficiency by *Agave americana* L. cv. Marginata plant under different media, water quantities and their combinations during 2006 and 2007 seasons.

Total amount of water	Type of	Total D.M. (g)/plant/season		W.U.E. (ml/g D.M)	
(ml)/plant/season	medium	2006	2007	2006	2007
	Sandy	7.16	7.27	670.39	660.25
4800	Loamy	13.44	11.85	357.14	405.06
(Treatment of 75 ml)	Mixture 1	14.31	14.55	335.43	329.90
	Mixture 2	12.55	11.63	382.47	412.73
	Mixture 3	15.91	16.54	301.70	290.21
	Sandy	9.85	9.73	649.75	657.76
6400	Loamy	15.90	16.54	402.52	386.94
(Treatment of 100 ml)	Mixture 1	22.38	21.52	285.97	297.40
	Mixture 2	21.00	20.66	304.76	309.78
	Mixture 3	32.19	27.97	198.82	228.82
	Sandy	26.73	24.58	299.29	325.47
8000	Loamy	32.69	33.28	244.72	240.39
(Treatment of 125 ml)	Mixture 1	29.00	30.06	275.86	266.13
	Mixture 2	28.70	34.50	278.75	231.88
	Mixture 3	38.95	37.58	205.39	212.88
	Sandy	34.78	33.61	276.02	285.63
9600	Loamy	40.75	41.18	235.58	233.12
(Treatment of 150 ml)	Mixture 1	38.42	41.27	249.87	232.62
	Mixture 2	39.73	42.59	241.63	225.41
	Mixture 3	52.30	47.96	183.56	200.17
	Sandy	19.63	18.80	473.86	482.28
	Loamy	27.70	25.71	309.99	316.38
Medium mean	Mixture 1	26.03	26.85	286.78	281.51
	Mixture 2	25.50	27.35	301.90	294.95
	Mixture 3	34.84	32.51	222.37	233.02

*** Mixture1: a mixture of sand + loam (1:1, w/w), Mixture2: a mixture of sand + 10% chicken manure compost (CMC) and mixture 3: a mixture of sand + 10% loam + 10% CMC.**

c- Chemical composition:

Data recorded in Tables (6) and (7) proved that leaves content of chlorophyll a, b and carotenoids, as well as the percentages of total carbohydrates, N, P and K in the leaves and roots were greatly increased as a result of elevating the application rate of water, while medium types slightly raised them except for the mixture No.3, which induced a marked increment in such constituents, followed by the loamy soil. The interaction between medium, and water quantity reveal that irrigation level at 150ml/pot combined with planting in the mixture No.3 gave the highest contents for the previously stated constituents. This result could be interpreted by the synergistic effect of both enough water and favourable composed medium on supplying century plants with their required water and nutrients necessary for good and healthy growth.

Table (6): Effect of media, water quantities and their interactions on pigments content (mg/g F.W.) in the leaves of *Agave americana* L. cv. Marginata plant during 2007 season.

Type of medium	Water quantity (ml)				
	75	100	125	150	Mean
	Chlorophyll a				
Sandy	0.220	0.243	0.286	0.350	0.275
Loamy	0.228	0.251	0.310	0.386	0.294
Mixture 1	0.226	0.246	0.298	0.370	0.285
Mixture 2	0.223	0.245	0.286	0.346	0.276
Mixture 3	0.265	0.293	0.356	0.476	0.348
Mean	0.233	0.256	0.308	0.386	
	Chlorophyll b				
Sandy	0.161	0.179	0.202	0.243	0.196
Loamy	0.170	0.191	0.233	0.281	0.219
Mixture 1	0.166	0.187	0.214	0.268	0.209
Mixture 2	0.164	0.181	0.217	0.256	0.205
Mixture 3	0.197	0.225	0.256	0.331	0.252
Mean	0.172	0.193	0.225	0.276	
	Carotenoids				
Sandy	0.109	0.132	0.150	0.178	0.142
Loamy	0.146	0.180	0.203	0.245	0.194
Mixture 1	0.135	0.167	0.197	0.248	0.187
Mixture 2	0.125	0.153	0.173	0.217	0.167
Mixture 3	0.173	0.211	0.255	0.310	0.237
Mean	0.138	0.169	0.196	0.240	

*** Mixture1: a mixture of sand + loam (1:1, w/w), Mixture2: a mixture of sand + 10% chicken manure compost (CMC) and mixture 3: a mixture of sand + 10% loam + 10% CMC.**

Such gains are in accordance with those of Graham and Nobel (1999) on *Agave desertii*, Abdel-Gayed (2001) and Shahin *et al.* (2006) on *Agave sisalana*, Gad (2003) on *Ficus benjamina*, Karam *et al.* (2004) on croton and Chen and Li (2006) who reported that coal fly ash, as an alternative to lime amendment, provides nutrients for Spathiphyllum plants, which was confirmed by high nutrients content in plant shoots.

Table (7): Effect of media, water quantities and their interactions on some chemical constituents of *Agave americana* L. cv. Marginata leaves and roots during 2007 season.

	Total carbohydrates (%)					N (%)					P (%)					K (%)				
Type of	Water quantity (ml)					Water quantity (ml)					Water quantity (ml)					Water quantity (ml)				
medium	75	100	125	150	Mean	75	100	125	150	Mean	75	100	125	150	Mean	75	100	125	150	Mean
	In the leaves																			
Sandy	25.00	28.46	31.52	36.60	30.40	0.96	0.99	1.12	1.13	1.05	0.18	0.15	0.21	0.17	0.18	1.57	1.82	2.16	2.10	1.91
Loamy	27.68	30.87	35.33	42.53	34.10	1.36	1.28	1.80	1.42	1.47	0.22	0.25	0.30	0.26	0.26	1.90	2.26	2.58	2.50	2.31
Mixture 1	26.40	28.79	34.52	38.49	32.05	1.07	1.14	1.56	1.51	1.32	0.24	0.21	0.26	0.23	0.24	1.84	2.21	2.36	2.34	2.19
Mixture 2	27.10	29.00	32.86	37.80	31.69	1.12	1.05	1.50	1.30	1.24	0.21	0.17	0.24	0.21	0.21	1.70	2.00	2.24	2.15	2.02
Mixture 3	30.45	32.68	35.78	43.55	35.62	1.40	1.48	1.89	2.00	1.69	0.29	0.30	0.35	0.11	0.34	2.10	2.33	2.60	2.67	2.43
Mean	27.33	29.96	34.00	39.80		1.18	1.19	1.58	1.47		0.23	0.22	0.27	0.26		1.82	2.13	2.39	2.35	
	In the roots																			
Sandy	16.48	19.04	20.38	20.16	19.02	0.89	0.98	1.00	1.07	0.99	0.14	0.16	0.17	0.15	0.16	0.50	0.68	0.70	0.63	0.63
Loamy	18.35	20.73	23.15	24.59	21.71	0.93	1.21	1.43	1.52	1.27	0.17	0.21	0.29	0.24	0.23	0.63	0.74	0.87	0.76	0.75
Mixture 1	17.41	19.36	22.61	23.80	20.80	0.93	1.17	1.31	1.46	1.22	0.15	0.23	0.26	0.23	0.22	0.56	0.66	0.69	0.68	0.65
Mixture 2	17.13	19.50	21.78	22.71	20.28	0.91	1.12	1.30	1.27	1.15	0.15	0.18	0.21	0.21	0.19	0.53	0.63	0.71	0.64	0.63
Mixture 3	21.76	22.00	26.00	25.30	23.77	1.15	1.29	1.20	1.79	1.36	0.20	0.24	0.26	0.25	0.24	0.76	0.81	0.93	0.79	0.82
Mean	18.23	20.13	22.79	23.31		0.96	1.16	1.25	1.42		0.16	0.21	0.24	0.22		0.60	0.71	0.78	0.70	

* Mixture1: a mixture of sand + loam (1:1, w/w), Mixture2: a mixture of sand + 10% chicken manure compost (CMC) and mixture 3: a mixture of sand + 10% loam + 10% CMC.

According to the aforementioned results, it may be concluded that one-year-old suckers of *Agave americana* L. cv. Marginata grown in 15 cm diameter clay pot filled with a mixture of sand + 10% loam + 10% chicken manure compost should be twice irrigated weekly during summer months with 150 ml of fresh water/pot to get the best and healthy growth.

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إستجابة نبات الأجاف (صنف مارجيناتا) للبيئات وكميات مياه الرى المختلفة

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أجريت هذه الدراسة بحديقة الأورمان النباتية – الجيزة – مصر خلال الموسمين المتتابعين ٢٠٠٥ ،٢٠٠٦ وذلك لدراسة تأثير الرى مرتين اسبوعيا خلال موسم النمو بكميات مختلفة من المياه هى: ٧٥، ١٠٠ ،١٢٥و ١٥٠ مل/إصيص، والزراعة فى خمس بيئات مختلفة هى: الرمل، الطمى، مخلوط متساوى من الرمل والطمى (بنسبة ١:١ وزنا)، مخلوط من الرمل + ١٠%كومبوست زرق الدواجن ومخلوط من الرمل + ١٠% طمى + ١٠% كومبوست زرق الدواجن ، وكذلك التفاعل بينهما على النمو الخضرى والجذرى، عدد وطول الخلفات الناتجة/نبات، كفاءة إستخدام مياه الرى والتركيب الكيميائى لنبات الأجاف (نبات القرن) صنف مارجيناتا (*Agave americana* L. cv. Marginata) عمر سنه عند زراعتها فى أصص من الفخار قطرها ١٥سم تحت ظروف الشمس الساطعة.

ولقد أوضحت النتائج حدوث زيادة معنوية فى ارتفاع النبات، عدد الأوراق /نبات، طول وعرض الورقه، طول أطول جذر، عدد الجذور /نبات، وكذلك فى الوزن الطازج والجاف للنموات الخضرية والجذرية بزيادة كمية المياه المستخدمة فى الرى أو بتحسين جودة مخلوط الزراعة، وذلك فى معظم الحالات لكلا الموسمين. ولقد تم الحصول على نفس الإتجاه فيما يتعلق بعدد وطول الخلفات المتكونة على كل نبات، كفاءة إستخدام مياه الرى، محتوى الأوراق من كلوروفيللى أ ، ب والكاروتينويدات، وكذلك النسبة المئوية للكربوهيدرات الكلية والنيتروجين والفوسفور والبوتاسيوم فى الأوراق والجذور. وبصفة عامة، حققت النباتات أفضل النتائج فى جميع الصفات المذكورة سابقا عندما رويت بمعدل ١٥٠ مل/اصيص وزرعت فى مخلوط التربة الثالث (المكون من الرمل + ١٠% طمى+ ١٠% كومبوست زرق الدواجن).

وعليه، فإنه للحصول على أفضل معدل للنمو الخضرى والجذرى، وأكبر عدد وطول للخلفات الناتجة، زيادة كفاءة مياه الرى المستخدمة مع تحسين محتوى النباتات من المكونات الداخلية ،فإننا نوصى برى نباتات الأجاف (نبات القرن) صنف مارجيناتا عند زراعتها تحت الشمس فى أصص فخار قطرها ١٥سم مرتين أسبوعيا خلال الصيف بمعدل ١٥٠مل/أصيص، على أن تكون الزراعة فى مخلوط يتكون من الرمل + ١٠% طمى + ١٠% كومبوست زرق الدواجن.