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QUANTIFYING THE MOST SUITABLE IRRIGATION REGIME FOR *HYMENOCALLIS SPECIOSA* SALISB. PLANT GROWN IN DIFFERENT POTTING MEDIA, UNDER OPEN NURSERY CONDITION

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ABSTRACT: The present experiment was performed on *Hymenocallis speciosa* Salisb. plant throughout two successive seasons (2011/2012 and 2012/2013) at the nursery of Horticulture Research Institute, ARC, Giza, Egypt. The aim was to quantify the water requirements of *Hymenocallis speciosa* Salisb. plants grown in different growing media, i.e. clay, sand/clay, sand/compost (2:1, v/v) and sand/sewage sludge (4:1, v/v) with supplying the plants with different irrigation levels (low, moderate and high) according to field capacity of each growing medium used in every irrigation to asses the most suitable irrigation level for producing the best vigorous plant growth as well as for reducing the amount of water used in agricultural production and determine the best growing media used for producing plants with high yield and quality. Accordingly, bulbs of an average weight of 46 g and 10 cm diameter were selected and planted on March 12th in plastic pots of 30 cm diameter under open field conditions in both seasons. The results emphasized that sand/compost (2:1, v/v) was the best medium used for improving vegetative growth and root parameters as well as most flower traits, bulbs productivity and chemical constituents of plant leaves and bulbs. Besides, it proved its mastery in shortening the time required from planting to flowering. Meanwhile, sand/clay (2:1, v/v) and sand/sewage sludge (4:1, v/v) were less efficient in improving plant traits and occupied the second and third ranks, respectively. In contrast, clay medium gave the least efficiency in this concern comparing with the other media used in the two seasons. Also, great influence was noticed on the above mentioned traits due to supplying plants either moderate or high level in every irrigation. Meanwhile, the lowest irrigation regime gave an intermediate effects on the same traits.

Therefore, and from the interaction it could be recommended to use sand/compost (2:1, v/v) medium in plantation with supplying plants the moderate irrigation level in every irrigation for achieving high plant quality of *Hymenocallis speciosa* Salisb. plant, besides save a good deal of water for other purposes.

Key words: *Hymenocallis speciosa* Salisb., growing media, irrigation levels.

INTRODUCTION

Hymenocallis, Family Amaryllidaceae, spider flower, basket flower, summer daffodil. There are 30-40 species in the genus, all native to the tropical and subtropical Americas, from South United States to the warmer beaches of the Andes (John, 2002).

Hymenocallis speciosa Salisb. bulb globular, 3-4 in diameter, leaves 20 or less, large (often 2 ft long) oblanceolate-oblong and acute, narrowed into a channeled petiole: scape mostly shorter than the foliage, glaucous; flowers 10-15, on very short pedicels, the bracts or spath- values 3-4 in long; tube of perianth greenish, 3-4 in long, the segments often twice longer (entire flower often 9 in. long); cup about 1 inch in long, toothed the free parts of the filaments, little longer than the cup (Photo, 1). The bulb improves with age if care is taken in growing and repotting. The leaves are evergreen and handsome. Flowers very fragrant, and retaining their scent even when dried. Blooms in winter (Bailey, 1933).

Photo 1. *Hymenocallis speciosa* Salisb.

Growing media play a major role in plant growth and development. They also act as plant support, serve as a source of water and essential plant nutrients and permit the diffusion of oxygen to the roots. Growing media also provide a number of functions in addition to support for the above ground part functions that often appear mutually exclusive. Sewage sludge proved highly beneficial effect on sand and calcareous soils and has been described as the most suitable organic conditioner for desert soil (Askar, 1988) and also a slow release fertilizer in potting media to eliminate the need for additional fertilizer (Gouin, 1994). In addition, amending sandy soil by the organic compost proved highly beneficial for both soil properties and plant growth. Decomposition of the compost allows more releasing of inorganic elements in available form to be more easily uptaken by the plant roots (Shanks and Gouin, 1985). Meanwhile, as reported by many authors sandy soil is usually considered the cheapest and most readily available material (Floyed, 1965 and Hall and Richmound, 1968). They also mentioned that it has a low moisture holding capacity. Reed (1986) added that using light soil (a mixture of peat with clay or sand) induced root growth to grow well. Meantime, although clay is full of nutrients, they tend to be bound in soil particles and become unavailable to plant roots.

Few information are available on the effect of growing media on growth and development of *Hymenocallis speciosa* Salisb. plant. So, the literature on other bulbs is indispensable in this concern. Badawy (1998) on *Polianthes tuberosa,* L. claimed that great results were recorded in the different plant traits and their chemical constituents due to using sand/compost leaves medium (1:1, v/v) in cultivation comparing with that gained from other media used (clay and sand). Meanwhile, Arafa *et al*. (2002) stated that using the mixture of composted leaves and clay (1:1, v/v) was the best growing medium for growing tuberose. Nady and Hassanein (2004) on *Dahlia pinnata* concluded that poultry manure at the high rate (80 m^3/fed) surpassed other organic treatments in augmenting different vegetative growth characters, flowering parameters, tuberous roots production and chemical constituents. Abass (2003) on *Polianthes tuberosa*, found that adding sewage sludge at the high level (15% of sand) reduced the time to flowering, increased number of bulbs and the leaf content of N, P and K. Hassanein and El-Sayed (2009) on Gladiolus cv. Eurovision mentioned that vegetative growth parameters (leaf length, number of leaves/plant and leaves dry weight) and flowering aspects (length of spike, flowering part length, number of florets/spike) were gradually increased by increasing the level of the added organic fertilizer (0, 4, 8 and 12 l/fed). Abdel-Sattar (2010) on *Polianthes tuberosa* concluded that a mixture of sand + compost gave the highest means of vegetative and flowering growth parameters, precocity and the longest period of flowering, as well as the highest number and best quality of the produced bulbs and bulblets compared to the other two media (clay and sand + sewage sludge (3:1, v/v) while a mixture of sand + sewage sludge recorded the best content of N, P, K, amino acids and reduced and non-reduced sugars in the new bulbs. Atowa (2012) on *Freesia refracta* cv. Red Lion stated that sandy/sewage sludge (3:1, v/v) medium proved its mastery for producing the tallest vegetative growth, the highest flowering percentage and best flowers quality with giving rise to corms yield, fresh weight of new corms, corms circumference and fresh weight of cormlets, as well as increasing total carbohydrates, N, P and K contents in the leaves. Recently, however, Barsoom (2014) on *Polianthes tuberosa* concluded that using sand/sewage sludge (3:1, v/v) medium proved its superiority for improving flowering traits, bulbs productivity and chemical constituents of the plant.

Quantifying the water requirements of every crop is very necessary to reduce the amount of water used in the agriculture production in Egypt. However, little information are available in this concern especially in the field of ornamental plants. With the forthcoming of the Ethiopian threat on Egypt quota of the water of the River Nile, we are obliged to rationize our methods of irrigation and decrease the waste of water as much as possible.

Evapotranspiration of a crop is the sum of transpirations by the crop and evaporation from the soil surface during plant life, (Doorenbos and Pruitt (1984). Various workers on different plants (Eakes *et al*., 1991 a & b on *Salvia splendens* Serp. and Matthews, 1994 on Begonia, El-Ashry *et al*., 1998 on *Strelitizia reginae*, Ali *et al*., 1998 on roses and Moftah and Al-Humaid, 2004 on *Polianthes tuberosa* cv. Double) concluded that water availability was associated with vegetative growth and flowering of the plants, whereas, soil stress caused steady decrease in plant performance. A decline in water potential would decrease all internal plant processes, such as net photosynthesis, cell division and enlargement and reduce epidermal cell turgor (Eakes *et al*., 1991 a&b on *Salvia splendens*, Kiehl *et al*., 1992 on Chrysanthemum, Bastide *et al*., 1993, Serp and Matthews, 1994 on Begonia and Moftah and Al-Humaid, 2004 on tuberose).

In this connection, several authors investigated the effect of different irrigation treatments on plant parameters of various bulb species. Nabih *et al*. (1992a) and Nada *et al*. (1992) on Freesia and Iris, respectively reported that the irrigation periods were not a limiting factor under the condition of loamy clay soil on growth, flowering and corms or bulbs productivity, even when the irrigation period was increased to reach 4 weeks. On *Polianthes tuberosa* Nabih *et al*. (1992b) reported that irrigation treatments of 7 and 12 days intervals increased flower quality; they had almost similar effects on the different morphological traits studied. Meanwhile, prolonging irrigation period to 17 or 22 days showed a decline in flowers quality and flowers and bulbs yield. El-Shakhs *et al*. (2002) on *Dahlia pinnata* reported that increasing both potassium levels and quantities of water improved plant height, number of branches/plant, leaf number/plant, flower diameter, flower stem length, dry weight of cut flower, tuberous roots yield, as well as the percentage of carbohydrates, N, P, K in the leaves, flowers and tuberous roots. Bazaraa *et al*. (2012b) on Gladiolus cv. Novalux concluded that all growth parameters were progressively decreased by prolonging irrigation intervals, such as plant height, spike stem length, rachis length, No. of flowers/spike, number of days to flowering, fresh weight of cut spike and total carbohydrates content in the new corms, while all corms and cormlets parameters, N, P and K content in the new corms were gradually increased by prolonging irrigation intervals.

Therefore, the present experiment was designed to find out the most suitable water regime for *Hymenocallis speciosa* Salisb. plants planted in 30 cm plastic pots filled with different growing media, with giving attention of the scarce of water under Egyptian conditions in the recent years, besides producing plants of high yield and quality of flowers and bulbs.

MATERIALS AND METHODS

A series of pots nursery experimental trial was consummated throughout two successive seasons (2011/2012 and 2012/2013) at the nursery of Horticulture Research Institute, ARC, Giza, Egypt. The aim was to quantify water requirements for plants grown in different growing media, at different irrigation levels in each irrigation. In addition to produce plants of high quality, as well as saving the amount of water used in agriculture production.

Materials:

- Bulbs of *Hymenocallis speciosa* Salisb. plant, having weight of 46 g and 10 cm diameter were selected from the nursery of Horticulture Research Institute in the two seasons to study the effects of different growing media and irrigation levels on the plant parameters.
- Growing media were clay, sandy/clay (2:1, v/v), sandy/compost (2:1, v/v), and sandy/sewage sludge (4:1, v/v).
- Plastic pots (30 cm diameter) were filled with 7-7.50 kg of growing media for each pot. Physical and chemical properties of the growing media used are shown in Tables a, b and c.

Procedure:

On March 12th, in every season bulbs were planted in pots (one bulb each), for every type of growing media used and left to grow under open nursery conditions.

The pots for each type of growing media were divided to three groups for studying the effect of different irrigation levels. Soil moisture retention (field capacity), was determined for each medium using a pressure chamber apparatus (pF-curves) according to Topp *et al*. 1993. They were reached 1430, 1100, 1190 and 1160 cm^3 of water/pot for clay, sand/clay, sand/compost (2:1, v/v) and sand/sewage sludge (4:1, v/v), respectively. The pots of each group were subjected to three irrigation regimes according to the field capacity for every type of growing media, i.e. at 50%, 75% and 100% of field capacity and referred as low, moderate and high, Table (d).

The plants were irrigated using the above mentioned allocations of water for every type of growing medium at three days intervals in winter months (December, January and February), at two days intervals during spring (March, April and May) and autumn (September, October and November), whereas in summer (June, July and August) it was at daily regime. The treatments (12) were carried out in each season (4 growing media × 3 irrigation levels). The plants received the different irrigation levels immediately after planting (March 12th) till the terminate of the experiment (January 25th).

A factorial experiment in randomized complete block design of three replicates was carried out in the two seasons. The main factor was the growing media, whereas, the second one was the irrigation levels. Every experimental unit consisted of 3 pots, and 9 pots giving for every treatment.

Regular agricultural practices, i.e. weeding, and chemical fertilization (Kristalon at 2 g/l at 21 days intervals were applied commencing from June 21st in every season till the terminate of the experiment (January 25th).

The recorded data were:

Vegetative and root parameters:

Plant height (cm), No. of leaves/plant, fresh and dry weights of vegetative parts/plant (g), root length (cm), fresh and dry weights of roots (g).

Flowering characteristics:

Number of days from planting to flowering, flower stem length (cm), flower stem diameter (cm), No. of flowers/plant, flower diameter (cm) and fresh weight of cut flower (g).

Table a. Physical and chemical properties of sand and clay used in plantation.

Soil Medium	Particle size distribution %				S.P	pH	E.C. Dsm^{-1}	Cations (meq/l)				Anions (meq/l)		
	Coarse Sand	Fine Sand	Clay	Silt				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^-
Sand	88.04	3.21	0.72	8.03	21.07	7.75	3.46	13.46	4.98	20.40	0.62	2.40	14.50	22.56
Clay	1.20	22.6	21.7	54.5	42.30	7.40	1.51	2.94	1.29	3.89	2.30	3.53	4.33	2.56

Table b. Chemical properties of the used compost.

Organic additive type	Macro elements %					Micro elements (ppm)				O.C. %	O.M %	C/N Ratio	pH	E.C. dSm^1
	N	P	K	Ca	Mg	Zn	Fe	Mn	Cu					
Compost	1.41	0.47	1.82	0.17	0.74	28.40	10.21	110	46	12.54	21.56	8.90	8.11	4.10

Table c. The main chemical characteristics of the used sewage sludge according to Dewis and Freitas (1970).

Parameters	Values			
EC (1:20 extraction) dsm^{-1}	2.10			
pH (1:10 suspension)	7.10			
Organic matter (%)	49.30			
Total nitrogen (%)	2.50			
Moisture content (%)	7.00			
Bulk density($g\ cm^{-3}$)	0.51			
	P	**K**	**Mg**	**Ca**
Soluble macronutrients ($mg.kg^{-1}$)	7.40	40	39	360
Total macronutrients ($mg.kg^{-1}$)	3150	2585	8367	44000
	Fe	**Mn**	**Zn**	**Cu**
Extractable micronutrients ($mg.kg^{-1}$ by DPTPA at pH7.3)	455	59	604	38
Total extractable micronutrients ($mg.kg^{-1}$)	23031	413	2159	1035
	Pb	**Ni**	**Cd**	**Co**
Extractable heavy metals ($mg.kg^{-1}$ by DPTPA at pH7.3)	25	30	2.10	1.40
Total heavy metals ($mg.kg^{-1}$)	638.0	119.50	30.40	34.20

Table d. Irrigation treatments according to growing media used of different field capacities (cm^3).

Growing media / Irrigation(cm^3)	Clay	Sand/clay (2:1, v/v)	Sand/compost (2:1, v/v)	Sand/sewage sludge (4:1,v/v)
Field capacity 50 % (low)	715	550	595	580
Field capacity 75 % (moderate)	1070	825	890	870
Field capacity 100 % (high)	1430	1100	1190	1160

Bulbs and bulblets productivity:

Clump circumference (cm), fresh and dry weights of clump (g), circumference of replaced bulb (cm), fresh and dry weights of replaced bulb (g), No. of bulblets/pot (bulblets yield), fresh and dry weights of bulblets/pot (g).

Data were statistically analyzed using SAS Program (1994) Computer Program and means were compared by LSD at 5 % test according to Snedecor and Cochran (1980).

Chemical analysis of leaves:

The following determinations were carried out in the two seasons:

Pigments content: determination of chlorophyll a, b and carotenoids in fresh leaves were carried out according to Wettstein (1957), total carbohydrates in the leaves and bulbs were colorimetricly determined as described by Smith *et al.* (1956), nitrogen was determined by micro-kjeldahle apparatus (Black, 1965). Phosphorus was colorimetricly determined in the acid digested using ascorbic acid method (John, 1970), potassium was determined using flame photometer (Dewis and Freitas, 1970), total protein content was mathematically calculated by multiplying N% by 6.25 (A.O.A.C., 1990).

RESULTS AND DISCUSSION

Vegetative growth parameters:

The data registered in Tables (1 and 2) show that growing the plants in sand/compost (2:1, v/v) resulted in the highest values of vegetative growth parameters in both seasons (expressed by plant height, No. of leaves/plant and fresh and dry weights of vegetative parts). These results were followed with plants grown in either sand/clay (2:1, v/v) or sand/sewage sludge (4:1, v/v), whereas growing the plants in clay medium gave the least values for most of the studied plant characters. These high values by using sand/compost medium may be due to the role of organic matter in providing plants with their needed essential elements for growth and biosynthesis of proteins, DNA and RNA. These results agreed with those obtained by Nabih (1992a) on Freesia, Gommaa (2000) on *Ornithogalum thrysoides*, Abass (2003) and Abdel-Sattar *et al.* (2010) on *Polianthes tuberosa*. Also, the effect of sand/compost medium on increasing No. of leaves/plant was also confirmed by Khalafalla *et al.* (2000) on *Ornithogalum thrysoides* and Soliman (2002) on *Iris tingitana.*

Concerning the effect of irrigation levels, the data in Tables (1 and 2) revealed that supplying the plants with either the moderate or the highest irrigation levels raised insignificantly the vegetative growth parameters in both seasons.

The great influence of high and moderate irrigation levels on plant height and number of leaves/plant was ascertained by a lot of scientists. Abe and Nakai (1999), who explained the increase of plant height by either increasing the number of cell layers in the cell expanding zone and the cambial zone or as a result of water availability that increased cell enlargement over cell division. In this connection, El-Skakhs *et al.* (2002) on *Dahlia pinnata* stated that increasing quantity of water improved plant height and leaf number/plant. Bazarra *et al.* (2012a) on Gladiolus cv. Novalux experimented the effect of different irrigation intervals (1, 2 and 3 weeks) on growth parameters of the plant. They concluded that plant height was progressively decreased by prolonging irrigation interval.

The interaction, revealed the mastery of supplying plants grown in sand/compost (2:1, v/v) medium with either the moderate or the high irrigation levels on No. of leaves/plant as well as fresh and dry weights of vegetative parts. Meanwhile, supplying plants grown in either sand/compost or sand/clay (2:1, v/v) with the moderate or the high irrigation levels were the best treatments used for increasing plant height in both seasons.

Root parameters:

The data in Tables (3 and 4) show that using sand/compost (2:1, v/v) medium in

Table 1. Effect of growing media and irrigation levels on plant height (cm) and No. of leaves/plant of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	Plant height (cm)					No. of leaves/plant				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
2011/2012										
Low	52.33	49.25	55.00	54.83	52.85	22.17	22.00	29.50	27.50	25.29
Moderate	57.17	58.83	57.83	53.92	56.94	23.50	28.50	31.33	20.33	25.92
High	52.50	58.22	59.05	57.33	56.78	21.22	26.55	30.67	25.50	25.99
Mean (A)	54.00	55.44	57.30	55.36		22.30	25.68	30.50	24.44	
L.S.D. (A)			N.S					5.555		
L.S.D. (B)			3.728					N.S		
L.S.D. (AB)			7.455					9.622		
2012/2013										
Low	57.08	54.00	59.67	58.42	57.29	26.17	25.50	30.33	27.50	27.38
Moderate	61.83	64.30	64.92	60.31	62.84	30.17	31.67	36.00	26.83	31.17
High	60.67	64.17	64.08	62.90	62.90	30.33	31.33	33.50	32.00	31.79
Mean (A)	59.86	60.82	62.89	60.46		28.89	29.50	33.28	28.78	
L.S.D. (A)			N.S					4.040		
L.S.D. (B)			3.275					3.499		
L.S.D. (AB)			6.550					6.998		

Table 2. Effect of growing media and irrigation levels on fresh and dry weights of vegetative parts/plant (g) of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	Fresh weight of vegetative parts/plant (g)					Dry weight of vegetative parts /plant (g)				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
2011/2012										
Low	165.60	139.80	205.60	192.90	176.00	11.79	10.70	15.75	13.40	12.91
Moderate	191.80	269.50	302.80	235.80	250.00	12.55	17.61	19.92	14.13	16.05
High	185.23	242.10	278.22	239.80	236.30	12.23	16.46	18.40	14.71	15.45
Mean (A)	180.90	217.20	262.20	222.80		12.19	14.92	18.02	14.08	
L.S.D. (A)			59.690					2.781		
L.S.D. (B)			51.690					N.S		
L.S.D. (AB)			103.400					4.972		
2012/2013										
Low	245.80	191.10	298.90	269.80	251.40	16.48	11.91	18.74	16.10	15.81
Moderate	357.50	375.41	420.10	355.60	377.10	20.92	22.37	23.31	20.80	21.85
High	195.23	358.80	366.51	359.91	320.10	13.64	21.91	22.15	20.01	19.43
Mean (A)	266.20	308.40	361.80	328.40		17.01	18.73	21.40	18.97	
L.S.D. (A)			62.440					2.116		
L.S.D. (B)			54.070					1.833		
L.S.D. (AB)			108.100					3.665		

Table 3. Effect of growing media and irrigation levels on root length (cm) of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	Root length (cm.)									
	2011/2012					2012/2013				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
Low	36.33	34.50	41.17	40.33	38.08	39.92	35.00	47.67	46.08	42.17
Moderate	40.67	47.17	47.78	40.00	43.90	44.00	49.00	49.50	43.17	46.42
High	35.55	47.22	43.83	46.50	43.28	37.52	47.00	47.33	45.00	45.90
Mean (A)	37.52	42.96	44.26	42.28		42.72	43.67	48.17	44.75	
L.S.D. (A)			4.020					3.568		
L.S.D. (B)			3.482					3.030		
L.S.D. (AB)			6.963					6.180		

Table 4. Effect of growing media and irrigation levels on fresh and dry weights of roots (g) of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	Fresh weight of roots (g)					Dry weight of roots (g)				
	2011/2012									
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
Low	106.60	100.40	164.40	156.10	131.90	12.75	11.74	21.25	19.36	16.27
Moderate	147.30	180.10	202.60	137.90	167.00	20.61	23.42	27.01	17.93	22.24
High	127.70	168.00	154.10	160.90	152.70	15.75	23.18	21.57	23.06	20.89
Mean (A)	127.20	149.50	173.70	151.70		16.37	19.45	23.28	20.12	
L.S.D. (A)			27.450					2.801		
L.S.D. (B)			N.S					2.420		
L.S.D. (AB)			47.550					4.852		
	2012/2013									
Low	123.60	108.80	176.70	165.50	143.60	19.02	17.15	24.05	22.53	20.69
Moderate	158.10	215.90	292.80	145.50	203.10	21.46	28.17	32.36	18.70	25.17
High	160.00	193.70	167.70	174.80	173.80	21.34	25.31	23.11	24.62	23.60
Mean (A)	147.20	172.80	212.40	161.70		20.61	23.54	26.51	21.95	
L.S.D. (A)			26.020					3.492		
L.S.D. (B)			22.530					N.S		
L.S.D. (AB)			45.060					6.048		

plantation surpassed the other media used in improving all roots parameters, as it raised root length as well as fresh and dry weights of roots, followed by plants grown in either sand/clay (2:1, v/v) or sand/sewage sludge (4:1, v/v) in both seasons. On the contrary, using clay medium recorded the least scores in most cases.

These results agreed with Bazarra *et al*. (2014) and Saeed *et al*. (2014) on Gladiolus cv. Novalux reported that sand/compost (1:1, v/v) medium proved its mastery in raising root length of corm. They attributed to the beneficial effect of mixing the organic compost with sand, which improves both soil properties and plant growth. Also, decomposition of compost allows more releasing of inorganic elements in available form to the plant roots. In addition, organic acids released during decomposition help more releasing of the nutrients from the mineral portion of the soil (Shanks and Gouin, 1985).

Referring to the effect of irrigation levels, data in Tables (3 and 4) show the prevalence of supplying plants with either the moderate or the high irrigation levels in producing the longest roots and producing the heaviest fresh and dry weights of roots in both seasons. The lowest irrigation level, on the other side, recorded the least scores in all cases.

The results revealed that applying irrigation at moderate or the highest levels improved root parameters in most cases. In this connection, Mortimer *et al*. (2003) exposed *Protea hybrida* "Syliva" plants in the glasshouse to watering regimes maintaining water at 20, 40 and 60% of field capacity. They concluded that higher water supply reached its maximum value at 40% of field capacity. Moreover, Garas (2011) on *Hibiscus rosa-sinensis* concluded that the moderate level of irrigation (0.75 l/pot) increased root length and fresh and dry weights of roots in the two seasons.

The interaction showed that moderate level of irrigation for plants grown in sand/compost (2:1, v/v) medium increased root length as well as fresh and dry weights of roots, followed by that grown in sand/clay (2:1, v/v) medium and treated with the moderate or the high irrigation level. In contrast, the lowest values were obtained on plants grown in clay medium at the lowest irrigation level.

Flowering parameters:

Data in Tables (5, 6, 7 and 8) indicate that growing plants in sand/compost (2:1, v/v) medium improved flower stem length, flower stem diameter, No. of flowers/plant, flower diameter as well as fresh weight of cut flower in both seasons. This was followed by sand/clay (2:1, v/v) resulting in the earliest flowering in both seasons. In contrast, using clay medium in plantation gave less efficiency in improving such traits.

These results are in agreement with Badawy (1998), Nasr (2001), El-Fawakhry (2001) and Abdel-Sattar *et al*. (2010) on *Polianthes tuberosa*, Soliman (2002) on *Iris tingitana* and Khalafalla *et al*. (2000) on *Ornithogalum thrysoides*. In this respect, the promotive effect might be due to interprets the efficiency of pre-planting compost incorporation in the sand, which plays a vital role in providing the plants with their needs from, macro and micro elements, when is decomposed. As the organic matter decomposes and become chemically altered, this change gives a negative charge that attracts and holds inorganic elements such as K, Ca and Mg in available forms to be absorbed by the plant roots (Wallace and Wallace, 1986). Process of feeding plant with nutrients is reflected in more accumulation of biosynthates in the plant tissues that encourage more carbohydrates accumulation. The active role of organic soil conditioners in improving hydrophysical properties at the desert soil and increasing water holding capacity of the soil (Askar, 1988). Decomposition of the organic compost may be necessary for forming precursors of a class of compounds with ultimately forms amino acids and hormones needed for better biosynthesis of the flower

Table 5. Effect of growing media and irrigation levels on number of days from planting to flowering of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	Number of days from planting to flowering (days)									
	2011/2012					2012/2013				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
Low	211.80	191.30	180.00	201.30	196.10	207.00	200.30	180.70	193.30	195.30
Moderate	207.80	184.50	178.80	184.70	189.00	191.70	178.20	171.00	193.30	183.50
High	211.30	192.20	192.30	205.00	200.20	195.30	184.20	186.50	202.30	192.10
Mean (A)	210.30	189.30	183.70	197.00		198.00	187.60	179.40	196.30	
L.S.D. (A)			6.549					6.649		
L.S.D. (B)			5.672					5.758		
L.S.D. (AB)			11.340					11.520		

Table 6. Effect of growing media and irrigation levels on flower stem length (cm) and flower stem diameter (mm) of *Hymenocallis speciosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	Flower stem length (cm.)					Flower stem diameter (mm)				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
					2011/2012					
Low	17.05	20.33	28.83	19.13	21.34	1.52	1.47	1.24	1.53	1.44
Moderate	22.50	37.08	35.17	26.33	30.27	1.79	1.84	2.93	2.61	2.29
High	17.42	27.42	32.67	21.50	24.75	1.33	1.47	1.90	1.85	1.64
Mean (A)	18.99	28.28	32.22	22.32		1.55	1.59	2.02	2.00	
L.S.D. (A)			1.355					0.144		
L.S.D. (B)			1.173					0.125		
L.S.D. (AB)			2.347					0.250		
					2012/2013					
Low	33.30	25.18	41.17	29.75	32.35	1.68	1.51	1.83	1.68	1.68
Moderate	38.05	44.08	50.58	41.72	43.61	1.89	1.90	2.94	2.62	2.34
High	35.92	44.67	46.42	38.50	41.38	1.56	1.63	1.95	2.05	1.80
Mean (A)	35.76	37.98	46.06	36.66		1.71	1.68	2.24	2.12	
L.S.D. (A)			2.394					0.202		
L.S.D. (B)			2.073					0.175		
L.S.D. (AB)			4.146					0.349		

Table 7. Effect of growing media and irrigation levels on No. of flowers/plant and floret diameter (cm) of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	No. of flowers/plant					Flower diameter (cm)				
	2011/2012									
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
Low	7.67	5.83	9.67	6.00	7.29	19.60	18.17	23.37	18.05	19.80
Moderate	6.58	8.83	9.83	8.50	8.44	20.58	24.13	25.00	21.08	22.70
High	4.83	6.67	9.67	5.67	6.71	21.67	21.60	23.25	21.00	21.88
Mean (A)	6.36	7.11	9.72	6.72		20.62	21.30	23.87	20.04	
L.S.D. (A)			0.629					0.802		
L.S.D. (B)			0.545					0.695		
L.S.D. (AB)			1.090					1.390		
	2012/2013									
Low	7.83	5.50	10.83	7.67	7.96	23.07	21.75	25.10	22.33	23.06
Moderate	8.83	12.67	15.17	10.00	11.67	23.45	25.13	25.58	24.68	24.71
High	7.50	10.25	13.67	7.50	9.73	22.53	25.05	25.22	22.67	23.87
Mean (A)	8.06	9.47	13.22	8.39		23.02	23.98	25.30	23.23	
L.S.D. (A)			1.188					0.661		
L.S.D. (B)			1.029					0.573		
L.S.D. (AB)			2.058					1.145		

Table 8. Effect of growing media and irrigation levels on fresh weight of cut flower (g) of *Hymenocallis spesiosa* Salisb. throughout 2011/2012 and 2012/2023.

Medium (A) / Irrigation (B)	Fresh weight of cut flower (g)									
	2011/ 2012					2012/ 2013				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
Low	28.41	41.12	35.52	19.06	24.28	39.83	25.28	44.69	35.14	36.24
Moderate	30.34	35.44	44.46	36.89	36.78	41.85	52.89	59.04	48.88	50.66
High	23.44	33.83	35.47	30.91	30.91	37.70	47.23	57.17	42.62	46.18
Mean (A)	27.40	27.80	38.95	28.95		39.79	41.80	53.63	42.21	
L.S.D. (A) 5%			2.379					4.395		
L.S.D. (B) 5%			2.060					3.806		
L.S.D. (AB) 5%			4.120					7.612		

primordia initiation and more cell division consequently early flowering time.

Concerning irrigation levels, the data show that supplying plants with moderate irrigation level produced the earliest flowering in both seasons, this was followed by low irrigation level in the first season, and moderate one in the second season. Application of the moderate irrigation level surpassed all other irrigation levels used for improving flower stem length, flower stem diameter, No. of flowers/plant (in the second season), flower diameter as well as fresh weight of cut flower.

Concerning the interaction, the data in Table (8) show that supplying the plants grown in sand/compost (2:1, v/v) medium with the moderate irrigation level produced the earliest flowering in both seasons, as well as its positive effect on other flowering traits (Tables 5, 6, 7 and 8).

Bulbs and bulblets productivity:

Data in Tables (9-14) clear that growing the plants in sand/compost (2:1, v/v) medium resulted in raising all bulb and bulblet parameters in both seasons (clump circumference, fresh and dry weights of clump, circumference of replaced bulb, fresh and dry weights of replaced bulb, No. of bulblets/pot (bulblets yield) as well as fresh and dry weights of bulblets). Thereafter, came the effect of either sand/clay (2:1, v/v) or sand/sewage sludge (4:1, v/v) on improving the previous traits, whereas, the least values were obtained from using clay medium in plantation.

The obtained results are confirmed with that reported by Arafa *et al*. (1996) on *Freesia refracta* who found that composted leaves and sand/composted leaves (1:1, v/v) resulted in favourable effect on corms productivity. Khalafalla *et al*. (2000) on *Ornithogalum thrysoids,* pointed out that using sand/composted leaves medium increased significantly fresh and dry weights of the produced bulbs. Nasr (2001) on *Polianthes tuberosa* stated that sand/composted leaves medium resulted in significant increase in bulbs yield followed by sand/clay medium, while clay medium gave the lowest values. Abdel-Sattar *et al*. (2010) found that sand/compost medium was the best for raising No. of bulbs/plot (bulbs yield) followed by sand/sewage sludge, whereas, the lowest values resulted from growing plants in clayey medium. Clayey and sand/compost media proved their mastery for raising bulb fresh weight. Bazaraa *et al*. (2012b) on Gladiolus cv. Novalux concluded that growing plants in sand/clay (1:1, v/v) improved corms production. Saeed *et al*. (2014) on the above mentioned Gladiolus cultivar concluded that sand/compost (2:1, v/v) medium proved its mastery for increasing corms yield, corm fresh and dry weights and corm circumference.

Concerning the effect of irrigation levels, it is clear from data that irrigation at moderate or high levels were the best treatments used in improving all bulbs or bulblets traits in the two seasons.

The prevalence of the moderate or the high irrigation levels in improving the different bulbs and bulblets traits was confirmed by other researchers on various bulb species. El-Shakhs *et al*. (2002) on *Dahlia pinnata,* reported that increasing quantaties of water improved tuberous roots yield. On the other side, Bazaraa *et al*. (2012a) on Gladiolus cv. Novalux experimented the effect of different irrigation intervals (1, 2 and 3 weeks) on corms and cormlets productivity. They reported that corms and cormlets parameters gradually increased by prolonging irrigation intervals.

The interaction showed that using sand/compost (2:1, v/v) followed by sand/clay (2:1, v/v) with applying either the moderate or the high irrigation level in improving bulbs and bulblets quantity and quality in both seasons as indicated in the aforementioned Tables.

Table 9. Effect of growing media and irrigation levels on clump circumference (cm) of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	Clump circumference (cm)									
	2011/2012					2012/2013				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
Low	23.67	22.83	27.92	26.42	25.60	27.33	25.33	32.33	30.58	28.31
Moderate	24.00	26.25	27.33	24.83	25.60	27.89	29.75	32.25	28.33	29.56
High	23.95	27.06	27.33	25.00	25.83	25.67	30.00	31.33	28.06	28.76
Mean (A)	23.87	25.38	31.33	25.42		26.96	28.36	31.97	28.99	
L.S.D. (A)			2.260					2.661		
L.S.D. (B)			N.S					N.S		
L.S.D. (AB)			3.915					4.614		

Table 10. Effect of growing media and irrigation levels on fresh and dry weights of clump (g) of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	Fresh weight of clump (g)					Dry weight of clump (g)				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
	2011/2012									
Low	149.20	128.30	221.20	188.70	171.90	36.65	32.25	42.01	48.29	42.12
Moderate	175.40	245.70	262.60	171.00	213.70	41.53	54.50	56.42	41.26	48.13
High	170.70	208.90	274.14	236.45	222.50	40.34	50.20	53.18	50.74	43.34
Mean (A)	165.10	194.30	252.27	198.70		38.04	42.78	50.54	46.76	
L.S.D. (A)			51.450					7.025		
L.S.D. (B)			44.560					N.S		
L.S.D. (AB)			89.120					12.170		
	2012/2013									
Low	206.90	254.70	291.50	274.90	257.00	48.50	56.49	59.98	58.87	55.96
Moderate	333.20	390.00	395.90	272.00	347.80	70.63	78.38	79.48	57.53	71.51
High	325.53	339.00	339.30	334.90	334.70	64.69	72.53	74.38	68.21	69.95
Mean (A)	288.50	327.90	342.20	293.90		61.27	69.13	71.28	61.54	
L.S.D. (A)			N.S					N.S		
L.S.D. (B)			54.800					11.690		
L.S.D. (AB)			109.600					23.390		

Table 11. Effect of growing media and irrigation levels on circumference of replaced bulb (cm) of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	Circumference of replaced bulb (cm)									
	2011/2012					2012/2013				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
Low	19.25	17.92	20.42	19.83	19.35	22.42	21.67	25.33	24.42	23.46
Moderate	20.50	22.00	21.58	19.67	20.94	24.00	25.25	24.83	21.75	23.96
High	18.43	21.50	22.39	19.67	20.50	22.67	25.50	25.67	24.17	24.50
Mean (A)	19.39	20.47	21.46	19.72		23.03	24.14	25.28	23.44	
L.S.D. (A)			1.720					1.602		
L.S.D. (B)			N.S					N.S		
L.S.D. (AB)			2.079					2.775		

Table 12. Effect of growing media and irrigation levels on fresh and dry weights of replaced bulb (g) of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	Fresh weight of replaced bulb (g)					Dry weight of replaced bulb (g)				
	2011/2012									
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
Low	92.46	76.55	117.30	105.90	98.04	22.35	17.53	30.29	24.04	23.55
Moderate	107.90	140.30	133.80	101.90	120.90	24.58	29.50	27.47	22.83	26.10
High	127.70	141.90	179.10	140.70	147.40	26.57	30.00	33.02	29.77	29.84
Mean (A)	109.30	119.60	143.40	116.10		24.50	25.68	30.26	25.55	
L.S.D. (A)			30.550					5.133		
L.S.D. (B)			26.460					4.445		
L.S.D. (AB)			52.920					8.890		
	2012/2013									
Low	160.80	162.94	185.50	182.40	172.90	36.86	35.30	40.66	39.72	38.13
Moderate	212.10	233.10	226.90	144.20	204.10	44.60	52.83	45.51	34.70	44.41
High	158.00	232.40	234.70	212.10	209.30	35.17	49.92	51.75	44.83	45.42
Mean (A)	177.00	209.48	215.70	179.57		38.88	46.02	45.97	39.75	
L.S.D. (A)			35.050					N.S		
L.S.D. (B)			30.350					7.142		
L.S.D. (AB)			60.710					14.280		

Table 13. Effect of growing media and irrigation levels on No. of bulblets/pot of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	No. of bulblets/pot									
	2011/2012					2012/2013				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
Low	2.50	2.00	3.50	3.00	2.75	3.00	2.67	4.00	3.33	3.25
Moderate	1.67	3.33	4.83	3.00	3.21	3.11	3.67	4.00	3.17	3.49
High	2.00	3.11	3.22	2.83	2.79	2.67	3.50	4.00	3.17	3.33
Mean (A)	2.06	2.81	3.85	2.94		2.93	3.28	4.00	3.22	
L.S.D. (A)			0.868					N.S		
L.S.D. (B)			N.S					N.S		
L.S.D. (AB)			1.503					N.S		

Table 14. Effect of growing media and irrigation levels on fresh and dry weights of bulblets/ pot (g) of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	Fresh weight of bulblets/pot (g)					Dry weight of bulblets/pot (g)				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
					2011/2012					
Low	56.73	51.75	104.00	82.84	73.82	11.85	9.47	20.60	16.33	14.56
Moderate	73.53	100.50	144.20	95.49	103.40	13.97	21.66	22.19	19.15	19.24
High	72.91	74.98	116.10	73.03	84.25	12.06	17.09	17.43	13.36	14.99
Mean (A)	67.72	75.74	121.40	83.78		12.63	16.07	20.07	16.38	
L.S.D. (A)			23.830					6.028		
L.S.D. (B)			27.520					N.S		
L.S.D. (AB)			47.660					10.440		
					2012/2013					
Low	57.42	91.74	106.00	120.00	93.80	14.95	20.97	23.56	26.04	21.38
Moderate	121.10	163.20	161.30	111.35	139.20	26.47	33.88	29.36	25.84	28.89
High	82.28	122.00	122.10	96.23	105.70	17.14	26.76	27.91	23.40	23.80
Mean (A)	86.94	125.60	129.80	109.20		19.52	27.20	26.94	25.09	
L.S.D. (A)			40.820					N.S		
L.S.D. (B)			35.360					N.S		
L.S.D. (AB)			70.710					15.190		

Chemical constituents of the leaves:

Pigments content:

The data in Table (15) revealed that sand/compost followed by sand/clay (2:1, v/v) were the best growing media for raising pigments content in the leaves (chlorophyll (a, b) and caroteniods) in both seasons. Meanwhile, using sand/sewage sludge (4:1, v/v) medium recorded the lowest records in this regard.

In this connection, Atowa (2012) on *Freesia refracta* cv. Red Lion concluded that chlorophyll (b) followed by carotenoids accumulation in leaves was augmented due to using sand/clay medium in plantation.

Supplying plants with moderate or high irrigation levels increased pigments content in the leaves more than that obtained from the lowest one in most cases.

In this respect, Garas (2011) on *Hibiscus rosa-sinensis* concluded that chlorophyll a, b and caroteniods accumulation in the leaves was augmentatively increased by decreasing irrigation level.

The interactions increased pigments content to some extent as a result of the moderate irrigation level using in plants grown in sand/compost (2:1, v/v) medium.

Total carbohydrates % in the leaves:

Sand/compost (2:1, v/v) medium resulted in an increase of total carbohydrates% in the leaves for both seasons, while, the least scores, were registered due to using clay medium in plantation.

This result was in harmony with those of El-Shakhs *et al*. (2002) on *Dahlia pinnata* who concluded that increasing quantity of water improved the percentage of carbohydrates in the leaves.

The interaction, indicated the superiority of growing plants in sand/compost (2:1, v/v) medium from using moderate or high irrigation levels for increasing the accumulation rate of total carbohydrates in the same organ.

Minerals % in the leaves:

Obviously data outlined in Table (16) reveal the superiority of growing plants in sand/compost (2:1, v/v) medium in cultivation for raising minerals % in the leaves (N, P and K) more than that gained from the other growing media used in the two seasons. The least scores, on the other side, were obtained due using clayey medium in plantation.

Highest results were recorded for the same constituents due to supplying plants either the moderate or the high irrigation levels, with the superiority in some instances for the moderate one in the two seasons.

With respect to the interaction, it is evident from data registered in Table (17) the prevalence of growing plants in sand/compost (2:1, v/v) medium and supplying them with the moderate irrigation level for raising the same constituents in leaves in the two seasons. However, receiving sand/clay (2:1, v/v) medium the same irrigation level showed also a favourable effect on minerals % in the leaves in both seasons.

Chemical constituents of the new formed bulbs:

Total carbohydrates %:

Data presented in Table (18) showed that sand/compost (2:1, v/v) medium surpassed the other growing media used in raising total carbohydrates accumulation in the new formed bulbs, giving the utmost high values in this regard. Meanwhile, sand/clay (2:1, v/v) medium achieved the second position in raising the same constituents in the same organ. In contrast, the lowest records were attained resulting from using clay medium in plantation.

Similar findings were also reported by various authors on different bulb species as Manoly (1996) on Iris, Badawy (1998) on *Polianthes tuberosa* and Saeed *et al*. (2014) on Gladiolus cv. Novalux.

Great influence, was also noticed in total carbohydrates accumulation in the new

Table 15. Effect of growing media and irrigation periods on pigments content in the leaves [chlorophyll (a, b) and carotenoids (mg/g f.w.)] of *Hymenocallis speciosa* Salisb. plant throughout 2011/ 2012 and 2012/2013.

Medium (A) / Irrigation (B)	Chlorophyll (a)					Chlorophyll (b)					Carotenoids				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
2011/2012															
Low	0.67	0.64	1.13	0.71	0.79	0.29	0.27	0.69	0.35	0.40	0.16	0.12	0.47	0.18	0.23
Moderate	0.65	0.94	1.03	0.58	0.80	0.37	0.76	0.79	0.26	0.55	0.28	0.29	0.37	0.11	0.26
High	0.52	0.65	0.68	0.58	0.61	0.32	0.37	0.40	0.34	0.36	0.16	0.24	0.21	0.17	0.20
Mean (A)	0.61	0.74	1.09	0.62		0.33	0.47	0.63	0.32		0.20	0.22	0.35	0.15	
2012/2013															
Low	0.89	0.74	1.01	0.89	0.88	0.56	0.47	0.64	0.61	0.57	0.25	0.15	0.36	0.32	0.27
Moderate	1.00	1.06	1.13	0.60	0.95	0.71	0.84	0.82	0.32	0.67	0.35	0.41	0.45	0.12	0.33
High	0.91	1.07	1.09	1.05	1.03	0.41	0.79	0.86	0.65	0.68	0.36	0.43	0.44	0.39	0.41
Mean (A)	0.93	0.96	1.08	0.85		0.56	0.70	0.77	0.53		0.32	0.33	0.42	0.28	

Table 16. Effect of growing media and irrigation periods on total carbohydrates (%) in the leaves of *Hymenocallis speciosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	Total carbohydrates (%) in the leaves									
	2011/2012					2012/2013				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
Low	24.58	19.79	30.25	29.13	25.94	27.99	26.01	32.36	29.34	28.93
Moderate	28.03	32.33	33.53	26.15	30.01	30.25	33.59	35.69	28.68	32.05
High	26.66	29.47	32.01	30.77	29.73	29.74	32.19	34.26	31.66	31.96
Mean (A)	26.42	27.20	31.93	28.68		29.33	30.60	34.10	29.89	

Table 17. Effect of growing medium and irrigation periods on N, P and K (%) in the leaves of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	N (%) in leaves					P (%) in leaves					K (%) in leaves				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + Compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
2011/2012															
Low	1.92	1.82	2.16	2.10	2.00	0.24	0.23	0.32	0.25	0.26	1.49	1.41	1.67	1.55	1.53
Moderate	2.13	2.40	2.59	2.21	2.33	0.49	0.58	0.61	0.44	0.53	1.58	1.61	1.70	1.64	1.63
High	2.10	1.96	2.38	2.10	2.14	0.20	0.23	0.32	0.24	0.25	1.38	1.55	1.67	1.41	1.50
Mean (A)	2.05	2.06	2.38	2.14		0.31	0.35	0.42	0.31		1.48	1.52	1.68	1.53	
2012/2013															
Low	1.96	1.92	2.19	2.10	2.04	0.36	0.33	0.51	0.43	0.41	1.58	1.55	1.70	1.65	1.62
Moderate	2.58	2.66	2.80	2.38	2.61	0.58	0.66	0.69	0.51	0.61	1.63	1.70	1.75	1.67	1.69
High	2.10	2.13	2.52	2.50	2.31	0.41	0.38	0.49	0.43	0.43	1.35	1.47	1.69	1.48	1.50
Mean (A)	2.21	2.24	2.50	2.33		0.45	0.46	0.56	0.46		1.52	1.57	1.71	1.60	

Table 18. Effect of growing medium and irrigation periods on total carbohydrates (%) in bulbs of *Hymenocallis speciosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	Total carbohydrates (%) in bulbs									
	2011/ 2012					2012/ 2013				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean
Low	35.59	37.27	43.64	40.44	39.24	44.04	42.71	47.09	45.32	44.79
Moderate	45.44	48.83	50.63	43.39	47.07	48.26	51.23	53.03	46.49	49.75
High	40.04	43.83	49.10	42.44	43.85	45.47	47.35	50.35	46.38	47.39
Mean (A)	40.36	43.31	47.79	42.09		45.92	47.10	50.16	46.06	

formed bulbs resulting from supplying plants with the moderate irrigation level in both seasons. Thereafter, came the effect of using the highest one followed by the lowest irrigation levels which occupied the second and third categories, respectively.

The interaction, indicated the prevalence of receiving plants grown in sand/compost (2:1, v/v) medium the moderate irrigation level in elevating the accumulation rate of total carbohydrates in the new formed bulbs.

Minerals % in the new formed bulbs:

Data in Table (19) revealed that sand/compost (2:1, v/v) medium proved its superiority in elevating minerals % in the new formed bulbs, registering the utmost high values in this concern in both seasons. Meanwhile, the second rank was belonged to plants grown in sand/clay (2:1, v/v) medium. Meantime, plants grown in either clay or sand/sewage sludge (4:1, v/v) gave an intermediate effect in this regard.

The previous results indicate the prevalence of sand/compost medium in increasing minerals (N, P and K) percentages in either the leaves or bulbs. However, many authors recorded a similar effect on other bulbs due to using the same medium (sand/compost) in plantation as Bazaraa *et al*. (2014) and Saeed *et al*. (2014) on Gladiolus cv. Novalux who stated that growing cormlets in sand/compost medium showed its superiority in raising N, P and K in the new corms.

Highest results, were also recorded in minerals % in the new formed bulbs due to supplying plants with the moderate irrigation level in both seasons. Meanwhile, the other two irrigation levels (high and low) gave an intermediate effect, with the superiority of the highest one in case of N and P accumulation in the new formed bulbs.

Table 19. Effect of growing medium and irrigation periods on N, P and K (%) in bulbs of *Hymenocallis spesiosa* Salisb. plant throughout 2011/2012 and 2012/2013.

Medium (A) / Irrigation (B)	N (%) in bulbs					P (%) in bulbs					K (%) in bulbs				
	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + Compost	Sand + sewage sludge	Mean (B)	Clay	Sand + clay	Sand + compost	Sand + sewage sludge	Mean (B)
2011/2012															
Low	0.83	0.76	0.98	0.85	0.86	0.27	0.29	0.40	0.38	0.34	0.56	0.52	0.69	0.57	0.59
Moderate	0.89	1.06	1.21	0.87	1.01	0.43	0.48	0.62	0.38	0.48	0.67	0.69	0.79	0.58	0.71
High	0.63	0.86	1.01	0.84	0.84	0.36	0.40	0.45	0.38	0.40	0.53	0.63	0.70	0.57	0.61
Mean (A)	0.78	0.89	1.07	0.85		0.35	0.39	0.49	0.38		0.59	0.61	0.73	0.57	
2012/2013															
Low	0.92	0.86	1.15	0.96	0.97	0.39	0.33	0.46	0.41	0.40	0.68	0.63	0.81	0.66	0.70
Moderate	0.99	1.30	1.35	0.93	1.14	0.49	0.51	0.72	0.43	0.54	0.72	0.89	0.91	0.69	0.80
High	0.76	0.96	1.19	0.94	0.96	0.44	0.49	0.50	0.46	0.47	0.61	0.72	0.78	0.69	0.70
Mean (A)	0.89	1.04	1.23	0.94		0.44	0.44	0.56	0.43		0.67	0.75	0.83	0.68	

The aforementioned results, on the other hand, also showed the superiority of supplying plants with the moderate irrigation level for raising either total carbohydrates or minerals concentration in either the leaves or the bulbs. In this connection, Nabih *et al.* (1992 b) on *Polianthes tuberosa* studied the effect of different irrigation periods (7, 12, 17 and 22 days) on chemical constituents of the new formed bulbs. They indicated that the great influence was due to the shortest irrigation period (7 days) on increasing soluble, non-soluble and total sugars as well as nitrogen, phosphorus and potassium concentrations in the new bulbs. However, Bazaraa *et al.* (2012a) on Gladiolus cv. Novalux reported that total carbohydrates content in new corms was progressively decreased by prolonging the irrigation interval.

The interaction, indicated the mastery of receiving plants grown in sand/compost (2:1, v/v) medium the moderate irrigation level in raising the different minerals % (N, P and K) in the new formed bulbs.

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تحديد أنسب كمية مياه ري لنمو نبات الـ *Hymenocallis speciosa* Salisb. في بيئات أصص مختلفة تحت ظروف الزراعة في الجو المكشوف بالمشتل

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تم إجراء هذه التجربة على نبات الـ *Hymenocallis speciosa* Salisb. خلال موسمي (٢٠١٢/٢٠١١، ٢٠١٣/٢٠١٢) بمشتل معهد بحوث البساتين، مركز البحوث الزراعية، جيزة، مصر، بهدف تحديد الاحتياجات المائية لنمو نبات الـ *Hymenocallis speciosa* Salisb. في بيئات نمو مختلفة (طين، رمل + طين ورمل + كمبوست (١:٢ حجما) ورمل + حمأة (١:٤ حجما)) حيث تم ري النباتات بمستويات مختلفة من الماء (منخفض ، متوسط ، عالي تبعا للسعة الحقلية لكل بيئة) وذلك لتحديد أنسب مستوى مياه لإنتاج أفضل نمو بالإضافة إلى خفض كمية المياه المستخدمة في الإنتاج الزراعي، كذلك تحديد أنسب البيئات لإنتاج نباتات عالية المحصول والجودة. تم اختيار الأبصال بمتوسط وزن ٤٦ جرام وقطر ١٠ سم وتمت الزراعة في ١٢ مارس في أصص بلاستيكية ذات قطر ٣٠ سم بمشتل معهد بحوث البساتين في كلا الموسمين. وقد أوضحت النتائج أن مخلوط الرمل + الكمبوست (١:٢ حجما) كان أفضل بيئة أدت إلى تحسين خصائص النمو الخضري والجذري ومعظم الخصائص الزهرية وإنتاجية الأبصال والمحتوى الكيماوي للأوراق والأبصال. وقد أظهرت تلك البيئة تفوقا ملحوظا في تقصير الوقت اللازم من الزراعة حتى الإزهار. وقد نتج عن استخدام بيئتي الرمل + الطين (١:٢ حجما) والرمل + الحمأة (١:٤ حجما) أنها أقل تأثيرا في تحسين خصائص النبات. وكان استخدام الطين هو أقل التأثيرات بالمقارنة بالبيئات الأخرى في كلا الموسمين. وقد نتج عن الري بالمستويين المتوسط والعالي تأثير ممتاز على الصفات سالفة الذكر. أما المستوى المنخفض من الري فقد أعطى تأثيرا متوسطا على نفس الصفات.

من النتائج السابقة ومن التفاعلات يمكن التوصية بإستخدام مخلوط الرمل + الكمبوست (١:٢ حجما) فى الزراعة مع إمداد النباتات بالمستوى المتوسط من الري فى كل رية وذلك للحصول على نباتات جيدة الصفات لنبات الـ *Hymenocallis speciosa* Salisb. بالإضافة إلى توفير كميات من المياه لأغراض أخرى.