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Effect of different growing media and chemical fertilization on growth and chemical composition of ponytail palm (*Beaucarnea recurvata)* plant

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Abstract

A pot experimental trial was carried out to study the effect of 15 treatments which was represented by the combination between five different growing media, i.e. clay + sand, clay + sand + composted leaves, clay + sand + peat moss, clay + sand + vermiculite and composted leaves + peat moss + vermiculite (1:1:1 by volume) and three chemical fertilization rates (a kristalon fertilizer at 0.0, 3 and 6g/pot) on the growth and chemical composition of *Beaucarnea recurvata* plants. Results showed that growing *Beaucarnea recurvata* plants in a mixture medium containing clay + sand + composted leaves (1:1:1 by volume) and supplemented with kristalon fertilizer at 6g/pot produced the tallest plant, the highest leaf P, auxin and gibberellins contents. Besides, the highest values of the number, fresh and dry weights of leaves/plant as well as the highest leaf K content were recorded by Beaucarnea plants grown in a mixture medium involving clay + sand + peat moss and supplied with kristalon fertilizer at 6g/pot in both seasons. In addition, the highest caudex length was registered by using a mixture medium containing clay + sand + vermiculite which received kristalon fertilizer at 6g/pot. Moreover, plants grown in composted leaves+ peat moss+ vermiculite mixture and received kristalon fertilizer at 6 g /pot induced the highest values of caudex diameter, plant width, show value, leaf N, total carbohydrates and cytokinins contents as well as the lowest leaf abscisic content. Conclusively, growing *Beaucarnea recurvata* plants in a medium containing composted leaves + peat moss + vermiculite or a medium composed of clay + sand + peat moss (1:1:1 by volume) and supplemented with kristalon fertilizer at 6g/pot produced the best growth and quality of this plant.

Key words: *Beaucarnea recurvata*, growing media, chemical fertilization, growth and chemical constituents.

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Introduction

Beaucarnea recurvata is native to Mexico. These plants are in the Nolinaceae family, which has recently been split out from the Agavaceae family. Beaucarnea has the potential to become huge-up to six feet in diameter at the base (caudex) and up to 25 feet tall. Flowers occur on mature plants and are spikes of small, creamy-white flowers. *Beaucarnea recurvata* plants have several common names as ponytail palm, bottle palm, elephant's foot and nolina. The common ponytail palm of houseplant fame makes a striking specimen plant for any landscape situation. It is also a very clean plant with no spines and can be useful around a pool. It is a very important and popular plant used in the in-door and out-doors of ornamentation as well as for purifying the air in and out doors. When planting a lot of small plants close together while maturing, their bases start to overlap one another. This leads to a very interesting effect creating a mini-forest of sizeable ponytail palms, some with bases touching or overlapping **(Ismail, 2004).** It is known that potting media as well as nutritional requirements are the most important factors affecting ornamental pot plants well-being. Since, there are many plants which spend their life cycle in pots and they need a medium which provides them with their different needs completely, so it is necessary to find suitable media consisted of a number of necessary components in order to achieve this purpose.

The purpose of a container medium is to physically support the plant and to supply adequate oxygen, water and nutrients for proper root functions. The plant must be held upright in the medium and the medium must be heavy enough to stabilize the container and keep it in an upright position. A balance between available water and aeration in the growth medium is essential for production of quality plants in containers. There must be adequate small pore space to hold water for plant uptake and enough large pores to allow exchange of air in the medium to maintain critical oxygen concentrations. Anaerobic conditions (without oxygen) do not allow the roots to obtain energy from the respiratory process and encourage disease development. Energy is required for root growth, proper hormone balance and nutrient uptake as well as maintenance of cell and organelle membranes. The optimal container medium will minimize the amount of management required for quality plant production.

The production of ornamental pot plants involves a number of cultural inputs, among these, perhaps the most important is the type of growing medium used. The composition of a growing medium should be well drained. Low in soluble salts,

with an adequate exchange capacity. Since, innumerable amendment combinations can produce a growing medium with these characteristics, it is important to consider the economic, cultural optimums, transportation, labor and handling. It can be said that sand, clay, peat moss, perlite, vermiculite and organic matter are the basic components of the special medium of planting (**Hartmann *et al.*, 2002**). Clay has a relatively high cation exchange and water holding capacity. Sand is the least expensive and the heaviest of all inorganic amendments. Peat moss is the most desirable organic matter for the preparation of growing media and is the most widely used substrate for potted plant production in nurseries and it accounts for a significant portion of the material used to grow potted plants **(Ribeiro *et al.*, 2007).** Vermiculite has a very high water holding capacity, excellent ex-change, buffering capacities and aid in aeration and drainage it is less durable than sand and perlite (**El-Khateeb *et al.*, 2006**). When composted leaves are added to the growing media, it leads to decrease soil pH which in turn increases solubility of nutrients for plant uptake. In some cases organic materials may act as low release fertilizers. Also, they improve soil fertility, and stimulate root development, induce active biological conditions and enhance activities of micro-organisms especially those involved in mineralization **(Suresh *et al.*, 2004).** In this respect, **Kakoei and Salehi (2013)** reported that growing *Spathiphyllum wallisii* Regel plants in a mixture medium containing composted leaves, peat moss and sand induced the best growth and chemical constituents of this plant.

Fertilizing plants causes them to grow more rapidly and efficiently, just like ensuring a manufacturing plant has all the raw materials it needs for a production line. Fertilizers are essential to produce out the best features of ornamental potted plants. For natural plants to grow and thrive they need a number of chemical elements, but the most important are nitrogen, phosphorus and potassium. Most packaged fertilizers contain these three macronutrients. Nitrogen is especially important, and every amino acid in plants contains nitrogen as an essential component for plants to manufacture new cells (**Marschner, 1997**). Phosphorus which has been called the key to life is essential for cell division and for development of meristematic tissues and it is very important for carbohydrate transformation due to multitude of phosphorylation reaction and to energy rich phosphate bond (**Lambers *et al.*, 2000**). Potassium is important for growth and elongation probably due to its function as an osmoticum and may react synergistically with IAA. Moreover, it promotes CO_2 assimilation and translocation of carbohydrates from the leaves to storage tissues (**Mengel and Kirkby, 1987**). In this concern, **Youssef and Abd El-Aal (2014)** indicated that treating *Hippeastrum vittatum* plants with chemical fertilizer (NPK) at 6 g/plant improved the growth and chemical composition as compared with un-treated plants.

Materials and Methods

A pot experimental study was carried out at the Floriculture Nursery of the Horticulture Department, Faculty of Agriculture at Moshtohor, Benha University, during 2010/2011 and 2011/2012 seasons to evaluate the effect of some different mixture media and chemical fertilization as well as their combination on growth and chemical composition of *Beaucarnea recurvata* plants.

Plant Material: Uniform *Beaucarnea recurvata* plants having 20-25 leaves and 28-32 cm height were selected for achieving this investigation. The plants were obtained from Floriculture Nursery of the Horticulture Department, Faculty of Agriculture at Moshtohor, Benha University. The plants were repotted in plastic pots of 30 cm diameter (one plant / pot) packed with the five chosen growing media, mention later, and placed in a partial shade under lath house condition on 1st October, in both seasons (2010/2011 and 2011/2012).

Procedure and Lay-out of the Experiment:

Two factors were involved in the present study, the first was the growing medium the second was chemical fertilization. The different five growing media chosen; clay + sand (1:1 by volume), clay + sand + composted leaves, clay + sand + peat moss, clay + sand + vermiculite and composted leaves + peat moss + vermiculite (1:1:1 by volume). All media were analyzed for their chemical characteristics (Table, a).

The chemical fertilization rates of 0.0, 3 and 6 g/pot were applied monthly as a dressing application for ten times throughout the growing season. The kristalon chemical fertilizer NPK (19:19:19) was used. The fertilization treatments started from 15 January in both seasons (2010/2011 and 2011/2012) until reaching the end of experiment. Kristalon fertilizer analysis: Nitrogen 19%, P_2O5 19%, K_2O 19%, chelated Zinc 0.0014%, chelated Iron 0.0070%, chelated Manganese 0.0042%, chelated Cupper 0.0016%, chelated Magnesium 0.0120%, Molybdenum 0.0014% and Boron 0.0022%. Common agricultural practices (irrigation, manual weed control, etc.) were carried out as and when needed.

The layout of the experiment was designed to provide a factorial experiment in randomized complete blocks. The study contained 15 treatments (5 growing media x 3 rates of chemical fertilization) with three replicates. Each replicate contained 5 pots. The study was terminated on 30th October during the two seasons.

Table a. The mean chemical characteristics of the five chosen growing media.

Media (1:1:1 by volume)	pH	EC ($dS.m^{-1}$)	Organic matter (%)	Available nitrogen (mg/Kg)	Available phosphorus (mg/Kg)	Available potassium (mg/Kg)
Clay+Sand	7.8	0.72	1.42	3421	532	736
Clay+Sand+composted leaves	6.9	1.21	2.37	4830	634	879
Clay+Sand+peat moss	6.8	0.93	2.14	4621	592	864
Clay+Sand+vermiculite	7.2	0.62	1.12	3142	512	721
Compost.+peat moss+vermiculite	6.7	0.67	2.78	5216	783	983

Recorded data:

1-Growth parameters:

Plant height, number of leaves/plant, fresh and dry weights of leaves/plant, length and diameter of caudex (stem base), plant width, show value; as plant width / plant height ratio according to **Berghage *et al*. (1989)**, fresh and dry weights of roots/plant.

2- Leaf chemical composition determinations:

a- Total nitrogen percentage was determined in the dried leaves by using the modified micro-kjeldahl method as described by **Pregl (1945).**

b- Phosphorus was determined colourimetrically in a spectronic (20) spectrophotometer using the method described by **Trouge and Meyer (1939).**

c- Potassium content was determined by a flame photometer according to **Brown and Lilleland (1946).**

d- Total carbohydrates content was determined in dried leaf powder according to **Herbert *et al*. (1971).**

e - Endogenous phytohormones:

Endogenous phytohormones were quantitatively determined in *Beaucarnea recurvata* leaves in the second season using High- Performance Liquid Chromato-graphy (HPLC) according to **Koshioka *et al.* (1983)** for auxin (IAA), gibberellins and abscisic acid (ABA), while cytokinins were determined according to **Nicander *et al.* (1993).**

All recorded data of *Beaucarnea recurvata* were taken at the end of experiment.

Statistical analysis:

All obtained data in both seasons of study were subjected to analysis of variance as factorial experiments in a complete randomized block design. L.S.D. method was used to differentiate between means according to **Snedecor and Cochran (1989).**

Results and Discussion

I- Effect of some growing media and NPK fertilization on some growth parameters of *Beaucarnea recurvata* plants

1-Plant height

Data in Table (1) show that the different growing media have significantly affected plant height, especially using a medium containing 1 part clay: 1 part sand: 1 part composted leaves compared with the other media in both seasons. Data concerning the effect of NPK fertilization on plant height obviously revealed that increasing NPK fertilization levels from 0.0 to 6g/pot caused a gradual increment in this parameter in both seasons. The interaction effect between growing media and NPK fertilization (kristalon fertilizer) had a positive effect on plant height as the tallest plants (72.50 and 74.21 cm) were obtained on plants grown in a mixture medium involving clay + sand + composted leaves at a ratio of 1:1:1 by volume which received NPK fertilization at 6g /pot, in the first and second seasons, respectively. On contrary, the lowest values of plant height (42.35 and 38.64) were scored by using a medium containing clay and sand (1:1 by volume) and receiving no NPK fertilization in the first and second seasons, respectively.

2-Number, fresh and dry weights of leaves /plant.

Data in Tables (1and 2) indicate that using a medium containing clay + sand + peat moss (1:1:1by volume) gave the highest values of the number, fresh and dry weights of leaves /plant, followed by using the growing medium containing clay + sand + composted leaves (1:1:1by volume) in both seasons. Also, all tested applications of NPK fertilization significantly increased the values of these parameters, especially using the highest level (6g/pot) as compared with un-treated plants in both seasons. As for the interaction effect between growing media and NPK fertilization , data in Tables (1 and 2) reveal that all resulted combinations between growing media and NPK fertilization at 3 or 6 g/pot succeeded in increasing the values of these parameters, with superiority for the combination of NPK fertilization at 6g/pot in both seasons. However, the highest number of leaves/plant (76.80 and 71.24), the heaviest fresh weight of leaves/plant (326.8 and 298.2g) and the heaviest dry weights of leaves /plant (55.74 and 50.06 g) were recorded by the plants grown in a medium containing clay + sand + peat moss and received NPK fertilization at 6g /pot, in the first and second seasons, respectively.

Table 1. Effect of growing media and NPK fertilization treatments on plant height and leaves number of *Beaucarnea recurvata* plants during 2010/2011and 2011/2012 seasons.

First season (2010/2011)								
Parameters	Plant height (cm)			Mean	Leaves number/plant			Mean
*Fertilizer media	0.0	3g/pot	6g/pot		0.0	3g/pot	6g/pot	
Clay+sand	42.35	48.07	53.11	47.84	48.36	54.34	61.21	54.64
Clay+sand+compost	58.40	67.13	72.50	66.01	55.27	63.08	72.67	63.67
Clay+sand+peat moss	49.82	52.31	58.24	53.46	61.25	69.71	76.80	69.25
Clay+sand+vermiculite	46.94	51.37	56.28	51.53	53.61	59.20	64.21	59.01
compost+peat+verm.	52.20	59.41	65.09	58.90	57.06	62.41	69.21	62.89
Mean	49.94	55.66	61.04		55.11	61.75	68.82	
L.S.D at 0.05 For media			5.44				5.65	
fertilizer			4.21				4.38	
interaction			9.41				9.79	
Second season (2011/2012)								
Clay+sand	38.64	45.17	56.24	46.68	43.72	49.07	57.39	50.06
Clay+sand+compost	57.92	69.26	74.21	67.13	56.35	61.07	68.41	61.94
Clay+sand+peat moss	47.24	54.63	61.24	54.37	59.31	64.05	71.24	64.87
Clay+sand+vermiculite	49.31	58.12	63.03	56.82	51.24	57.01	62.51	56.92
Compost+peat+verm.	51.90	62.44	65.21	59.85	54.68	62.41	64.30	60.46
Mean	49.00	57.92	63.99		53.06	58.72	64.77	
L.S.D at 0.05 For media			4.96				5.27	
fertilizer			3.84				4.08	
interaction			8.59				9.12	

*Fertilizer: Kristalon compound fertilizer (19:19:19)

Table 2. Effect of growing media and NPK fertilization treatments on fresh and dry weights of leaves of *Beaucarnea recurvata* plants during 2010/2011and 2011/2012 seasons.

First season (2010/2011)								
Parameters	Fresh weight of leaves(g)			Mean	Dry weight of leaves(g)			Mean
*Fertilizer media	0.0	3g/pot	6g/pot		0.0	3g/pot	6g/pot	
Clay+sand	148.8	189.0	225.7	187.8	23.95	30.81	37.57	30.78
Clay+sand+compost	187.0	239.4	295.2	240.5	30.48	39.67	49.56	39.90
Clay+sand+peat moss	195.6	234.6	326.8	252.3	32.17	39.31	55.74	42.41
Clay+sand+vermiculite	169.6	200.6	236.8	202.3	27.71	33.60	39.88	33.73
Compost+peat+verm.	182.4	217.0	255.3	218.2	29.84	36.23	42.84	36.30
Mean	176.68	216.12	267.96		28.83	35.92	45.12	
L.S.D at 0.05 For media			15.93				3.80	
fertilizer			12.34				2.94	
interaction			27.59				6.57	
Second season (2011/2012)								
Clay+sand	141.9	171.5	210.9	174.8	22.98	28.56	35.28	28.94
Clay+sand+compost	190.4	219.6	265.2	225.1	31.54	36.79	44.78	37.70
Clay+sand+peat moss	200.5	243.2	298.2	247.3	33.20	40.58	50.06	41.28
Clay+sand+vermiculite	163.2	199.5	235.6	199.4	26.73	33.23	39.48	33.15
Compost+peat+verm.	183.6	223.2	243.2	216.7	30.01	37.24	40.82	36.02
Mean	175.9	211.4	250.6		28.89	35.28	42.08	
L.S.D at 0.05 For media			22.02				3.54	
fertilizer			17.06				2.74	
interaction			38.15				6.13	

*Fertilizer: Kristalon compound fertilizer (19:19:19)

3-Length and diameter of caudex:

Data in Table (3) demonstrate that the highest caudex (stem base) length was scored by using a mixture medium of clay + sand + vermiculite, whereas the highest caudex diameter was gained by using a medium containing composted leaves+ peat moss+ vermiculite as compared with the other growing media in both seasons. In addition, both

levels of NPK fertilization significantly increased the length and diameter of caudex, particularly the high level when compared with un-fertilized plants in both seasons. Referring to the interaction effect between growing media and NPK fertilization, data in the same Table, declare that all resulted interactions increased the length and diameter of caudex in both seasons. However, the highest caudex length (15.18 and 14.93 cm) and the highest caudex diameter (15.68 and 16.76 cm) were registered by using the mixture media of clay + sand + vermiculite and composted leaves+ peat moss+ vermiculite and both receiving NPK fertilization at 6g/pot, respectively.

Table 3. Effect of growing media and NPK fertilization treatments on caudex length and caudex diameter of *Beaucarnea recurvata* plants during 2010/2011and 2011/2012 seasons.

Parameters		Caudex length (cm)			Mean	Caudex diameter (cm)			Mean
*Fertilizer / media		0.0	3g/pot	6g/pot		0.0	3g/pot	6g/pot	
First season (2010/2011)									
Clay+sand		11.74	12.60	14.23	12.86	12.94	13.72	14.72	13.79
Clay+sand+compost		10.24	12.19	11.94	11.46	11.78	13.07	13.28	12.71
Clay+sand+peat moss		11.34	13.16	12.84	12.45	13.15	14.92	14.80	14.29
Clay+sand+vermiculite		11.94	13.26	15.18	13.46	11.02	12.41	13.10	12.18
Compost+peat+verm.		10.80	11.86	12.91	11.86	13.87	14.94	15.68	14.83
Mean		11.21	12.61	13.42		12.55	13.81	14.32	
L.S.D at 0.05 For	media		0.49				0.54		
	fertilizer		0.38				0.42		
	interaction		0.85				0.94		
Second season (2011/2012)									
Clay+sand		10.94	11.87	12.64	11.82	11.87	14.21	14.08	13.39
Clay+sand+compost		11.76	12.90	13.81	12.82	10.28	13.48	14.67	12.81
Clay+sand+peat moss		10.22	11.08	12.13	11.14	12.19	14.81	15.21	14.07
Clay+sand+vermiculite		11.79	13.42	14.93	13.38	10.45	12.61	13.41	12.16
Compost+peat+verm.		11.21	12.83	12.70	12.25	14.17	15.90	16.76	15.61
Mean		11.18	12.42	13.24		11.79	14.20	14.83	
L.S.D at 0.05 For	media		0.44				0.61		
	fertilizer		0.34				0.47		
	interaction		0.76				1.05		

*Fertilizer: Kristalon compound fertilizer (19:19:19)

4-Plant width and show value:

Data in Table (4) exhibit that the mixture of composted leaves + peat moss + vermiculite showed to be the most effective one for producing the widest plant and the greatest show value as compared with the other mixtures media in both seasons.

Additionally, all tested NPK applications significantly increased the plant width as compared with untreated plants, but it failed to induce significant differences in case of the show value parameter in both seasons. Moreover, the interaction effect between growing media and NPK fertilization reveal that plants grown in composted leaves+ peat moss+ vermiculite mixture and receiving chemical fertilizer at 6 g /pot induced the highest values of plant width (49.34 and 53.24 cm) and show value (0.758 and 0.816) in the first and second seasons, respectively.

5-Fresh and dry weights of roots/plant:

It is obvious from Table (5) that using a mixture medium containing clay + sand + peat moss was more effective in increasing the fresh and dry weights of roots/plant as compared with the other growing media in both seasons. Besides, fresh and dry weights of roots/plant were greatly increased by both levels of NPK fertilization, especially the high level in both seasons. As for the interaction effect between growing media and NPK fertilization, data in Table (5) clear that grown ponytail palm plants in medium containing clay + sand + peat moss and fertilized with NPK fertilization at 6 g /pot is being the most effective one in inducing the heaviest fresh and dry weights of roots/pot in both seasons. The positive action of growing media on supplying the plants with their requirements from aeration, water and nutrients could explain the present results.

The aforementioned results of growing media are in conformity with those reported by **Muhabat Shah *et al.* (2006)** on *Ficus binnendijkii* 'Amstel Queen', **Khayyat *et al.* (2007)** on *Epipremnum aureum*, **Kiran *et al.* (2007)** on *Dahlia pinnata*, **Chavez *et al.* (2008)** on *Petunia hybrida*, **Riaz *et al.* (2008)** on *Zinnia elegans*, **Younis *et al.* (2010)** on *Codiaeum variegatum*, **Ikram *et al.* (2012)** on tuberose plant, **Khalaj *et al.* (2011)** on *Gerbera jamesonii* L., **Aklibasinda *et al.* (2011)** on *Pinus sylvestris*, **Abouzar (2012)** on *Ficus benjamina*,

Table 4. Effect of growing media and NPK fertilization treatments on plant width and show value of *Beaucarnea recurvata* plants during 2010/2011and 2011/2012 seasons.

First season (2010/2011)									
Parameters		Plant width (cm)			Mean	Show value (plant width/height ratio)			Mean
*Fertilizer / media		0.0	3g/pot	6g/pot		0.0	3g/pot	6g/pot	
Clay+sand		29.49	32.17	31.80	31.15	0.696	0.669	0.599	0.655
Clay+sand+compost		28.31	34.63	33.21	32.05	0.485	0.516	0.458	0.486
Clay+sand+peat moss		32.42	39.60	42.41	38.14	0.651	0.757	0.728	0.712
Clay+sand+vermiculite		29.43	32.81	31.84	31.36	0.627	0.639	0.566	0.611
Compost+peat+verm.		36.24	42.91	49.34	42.83	0.694	0.722	0.758	0.725
Mean		31.18	36.42	37.72		0.631	0.661	0.622	
L.S.D at 0.05 For	media	4.12				0.14			
	fertilizer	3.19				N.S			
	interaction	7.13				0.25			
Second season (2011/2012)									
Clay+sand		27.43	34.22	36.20	32.62	0.710	0.758	0.644	0.704
Clay+sand+compost		26.24	35.08	36.17	32.50	0.453	0.506	0.487	0.482
Clay+sand+peat moss		31.06	41.93	47.21	40.07	0.657	0.768	0.771	0.732
Clay+sand+vermiculite		28.41	36.01	39.25	34.56	0.576	0.620	0.623	0.606
Compost+peat+verm.		34.07	45.30	53.24	44.20	0.656	0.687	0.816	0.720
Mean		29.44	38.51	42.41		0.610	0.668	0.668	
L.S.D at 0.05 For	media	4.65				0.12			
	fertilizer	3.60				N.S			
	interaction	8.05				0.20			

*Fertilizer: Kristalon compound fertilizer (19:19:19)

Table 5. Effect of growing media and NPK fertilization treatments on fresh and dry weights of roots of *Beaucarnea recurvata* plants during 2010/2011and 2011/2012 seasons.

First season (2010/2011)									
Parameters		Fresh weight of roots/plant(g)			Mean	Dry weight of roots/plant (g)			Mean
*Fertilizer / media		0.0	3g/pot	6g/pot		0.0	3g/pot	6g/pot	
Clay+sand		36.25	41.37	43.09	40.24	5.40	6.15	6.45	6.00
Clay+sand+compost		41.27	52.40	51.37	48.35	6.15	7.80	7.65	7.20
Clay+sand+peat moss		48.19	62.83	68.42	59.81	7.20	9.30	9.98	8.83
Clay+sand+vermiculite		39.28	56.41	59.36	51.68	5.85	8.40	8.85	7.70
Compost+peat+verm.		45.22	61.50	64.27	57.00	6.75	9.15	9.60	8.50
Mean		42.04	54.90	57.30		6.27	8.16	8.51	
L.S.D at 0.05 For	media	6.11				1.65			
	fertilizer	4.73				1.28			
	interaction	10.58				2.86			
Second season (2011/2012)									
Clay+sand		32.11	49.21	47.16	42.83	5.12	7.84	7.52	6.83
Clay+sand+compost		34.23	57.04	56.37	49.21	5.44	9.12	8.96	7.84
Clay+sand+peat moss		43.78	59.44	72.30	58.51	6.88	9.44	11.52	9.28
Clay+sand+vermiculite		41.33	62.60	61.74	55.22	6.56	9.92	10.06	8.85
Compost+peat+verm.		42.56	63.75	67.92	58.08	6.72	10.08	10.72	9.17
Mean		38.80	58.41	61.10		6.14	9.28	9.76	
L.S.D at 0.05 For	media	5.38				1.90			
	fertilizer	4.17				1.47			
	interaction	9.32				3.29			

Yousif and Kako (2012) on *Hyacinthus orientalis* L., **Kakoei and Salehi (2013)** on *Spathiphyllum wallisii* Regel, **Herath *et al.* (2013)** on *Ophiopogon sp*. and **Tahir *et al.* (2013)** on *Antirrhinum majus* L.

The abovementioned results of chemical fertilization are in harmony with those attained by **Singh *et al.* (2002)** on *Gladiolus grandiflorum*, **Pal and Biswas (2005)** on *Polianthes tuberosa* L., **El-**

Malt *et al.* (2006) on *Hippeastrum vittatum*, **Youssef and Gomaa (2007)** on *Iris tingitana*, **Abou El-Ella (2007)** on *Acanthus mollis*, **El-Naggar and El-Nasharty (2009)** on *Hippeastrum vittatum*, **Hussein (2009)** on *Cryptostegia grandiflora*, **Abd El-All (2011)** on *Aspidistra elatior*, **Habib (2012)** on *Caryota mitis* Lour**, Wanderley *et al.* (2012)** on areca bamboo palm (*Dypsis lutescens*) and **Youssef and Abd El-Aal (2014)** again on *Hippeastrum vittatum.*

II- Effect of some growing media and NPK fertilization on some chemical constituents of *Beaucarnea recurvata* plants

1- Leaf N, P, K and total carbohydrates contents:

Data in Tables (6&7) indicate that all used growing media and NPK fertilization as well as their interactions had a pronounced effect on increasing leaf N, P, K and total carbohydrates contents of *Beaucarnea recurvata* plants in both seasons. However, the highest values of both leaf N and total carbohydrates content were scored by using the mixture medium of composted leaves+ peat moss+ vermiculite, whereas the highest values of both leaf P and K contents were registered by growing the plants in the mixture media of clay + sand + composted leaves and clay + sand + peat moss which received chemical fertilizer at 6 g /pot, respectively as compared with the other treatments in both seasons.

2-Endogenous phytohormones content.

Endogenous phytohormones results of *Beaucarnea recurvata* leaves during 2011/2012 season as affected by different growing media and chemical fertilization treatments are shown in Table (8). According to these results, all promoters (auxins, gibberellins and cytokinins) were increased by using different growing media and chemical fertilization as well as their combination, yet abscisic acid was decreased. However, the highest value of leaf cytokinins content (16.80 µg/g F.W) as well as the lowest leaf abscisic acid content (0.32 µg/g F.W) were recorded by growing *Beaucarnea recurvata* plants in medium containing composted leaves+ peat moss+ vermiculite that received chemical fertilization at 6g/pot, whereas the highest leaf auxins (31.62 µg/g F.W) and gibberellins (68.18 µg/g F.W) contents were scored by using the medium containing clay + sand + composted leaves and fertilized with NPK fertilization at the high rate (6g/pot). These data could also be of great influence upon different vegetative growth and nutritional status of the plants. The stimulated effect of kristalon fertilizer may be due to the role of kristalon fertilizer on supplying the plants with their nutrients i.e. with more carbohydrates and proteins production which are necessary for vegetative, roots growth and chemical composition of Beaucarnea plants (**Marschner, 1997**).

Table 6. Effect of growing media and NPK fertilization treatments on leaf N and P contents of *Beaucarnea recurvata* plants during 2010/2011and 2011/2012 seasons.

First season (2010/2011)								
Parameters	N%				P%			
*Fertilizer media	0.0	3g/pot	6g/pot	Mean	0.0	3g/pot	6g/pot	Mean
Clay+sand	2.24	2.37	2.42	2.34	0.182	0.194	0.192	0.189
Clay+sand+compost	2.32	2.64	2.79	2.58	0.193	0.247	0.254	0.231
Clay+sand+peat moss	2.36	2.59	2.60	2.52	0.189	0.219	0.217	0.208
Clay+sand+vermiculite	2.29	2.56	2.52	2.46	0.196	0.194	0.212	0.201
Compost+peat+verm.	2.39	2.80	2.94	2.71	0.191	0.241	0.249	0.227
Mean	2.32	2.59	2.65		0.190	0.219	0.225	
L.S.D at 0.05 For media		0.15				0.018		
fertilizer		0.12				0.014		
interaction		0.27				0.031		
Second season (2011/2012)								
Clay+sand	2.16	2.46	2.43	2.35	0.191	0.212	0.219	0.207
Clay+sand+compost	2.26	2.39	2.40	2.35	0.203	0.256	0.262	0.240
Clay+sand+peat moss	2.28	2.38	2.35	2.34	0.192	0.191	0.214	0.199
Clay+sand+vermiculite	2.21	2.31	2.35	2.29	0.194	0.233	0.229	0.219
Compost+peat+verm.	2.29	2.68	2.84	2.60	0.198	0.241	0.253	0.231
Mean	2.24	2.44	2.47		0.196	0.227	0.235	
L.S.D at 0.05 For media		0.14				0.015		
fertilizer		0.11				0.012		
interaction		0.25				0.027		

*Fertilizer: Kristalon compound fertilizer (19:19:19)

Table 7. Effect of growing media and NPK fertilization treatments on leaf K and total carbohydrates contents of *Beaucarnea recurvata* plants during 2010/2011and 2011/2012 seasons.

Parameters		K%				Total carbohydrates %			
*Fertilizer / media		0.0	3g/pot	6g/pot	Mean	0.0	3g/pot	6g/pot	Mean
First season (2010/2011)									
Clay+sand		1.53	1.84	1.93	1.77	12.11	13.94	14.83	13.63
Clay+sand+compost		1.81	2.43	2.41	2.22	12.36	16.21	15.96	14.84
Clay+sand+peat moss		1.83	2.46	2.52	2.27	12.40	15.30	17.21	14.97
Clay+sand+vermiculite		2.14	2.11	2.20	2.15	12.65	15.14	15.74	14.51
Compost+peat+verm.		1.89	2.37	2.45	2.24	14.15	16.93	18.26	16.45
Mean		1.84	2.24	2.30		12.73	15.50	16.40	
L.S.D at 0.05 For	media		0.35				1.59		
	fertilizer		0.27				1.23		
	interaction		0.60				2.75		
Second season (2011/2012)									
Clay+sand		1.62	1.98	1.19	1.60	10.39	14.12	14.92	13.14
Clay+sand+compost		1.96	1.94	2.14	2.01	11.08	14.82	14.96	13.62
Clay+sand+peat moss		1.93	2.54	2.61	2.36	12.14	15.94	17.16	15.08
Clay+sand+vermiculite		1.87	2.34	2.28	2.16	11.18	15.37	15.29	13.95
Compost+peat+verm.		1.90	2.43	2.50	2.28	13.64	17.82	18.93	16.80
Mean		1.86	2.25	2.14		11.69	15.61	16.25	
L.S.D at 0.05 For	media		0.27				1.51		
	fertilizer		0.21				1.17		
	interaction		0.47				2.62		

*Fertilizer: Kristalon compound fertilizer (19:19:19)

Table 8. Effect of growing media and NPK fertilization treatments on leaf endogenous phytohormones contents of *Beaucarnea recurvata* during 2011/2012 season.

Plant hormones	Promoters									Inhibitors		
	Cytokinins µg/g F.W			Auxins (IAA) µg/g F.W			Gibberellins (GA_3) µg/g F.W			Abscisic acid (ABA) µg/g F.wt.		
*Fertilizer / media	0g/pot	3g/pot	6g/pot	0g/pot	3g/pot	6g/pot	0g/pot	3g/pot	6g/pot	0g/pot	3g/pot	6g/pot
Clay+sand	10.18	9.20	11.33	23.71	25.01	29.23	37.36	48.91	51.27	0.68	0.60	0.52
Clay+sand+compost	11.71	10.35	9.24	24.16	28.40	31.62	53.28	62.64	68.18	0.49	0.36	0.46
Clay+sand+peat moss	11.20	11.78	13.51	18.22	27.31	24.20	36.31	48.20	39.32	0.61	0.42	0.57
Clay+sand+vermiculite	12.14	12.92	15.06	23.54	21.74	25.93	34.30	54.16	51.02	0.58	0.54	0.59
Compost+peat+verm.	13.16	14.93	16.80	19.42	24.09	21.67	39.04	46.15	42.51	0.62	0.39	0.32

*Fertilizer: Kristalon compound fertilizer (19:19:19)

Generally, increments of cytokinins, auxins and gibberellins obtained in the present study could interpret the obtained results of vegetative growth (Tables, 1-5), as well as chemical constituents (Tables, 6&7). For example, increasing cytokinins could favor increasing caudex diameter, number of formed leaves and roots as well as their fresh and dry weights. Whereas, increasing gibberellins and auxins could favor increasing plant height.

The obtained results are of great interest, since the increment of endogenous cytokinins clearly could explain the improvement of all growth characteristics obtained in the present study. Cytokinins are known as shooting hormones (**Salisbury and Ross, 1974**). This promotive effect of cytokinin could be illustrated herewith in this study by the improvement for example in caudex diameter, number of leaves and roots as well as in leaves fresh and dry weights. Also, of interest is to note that these treatments were accompanied with a significant increase in plant height that is being expected when related with the obtained increases in endogenous auxin and gibberellins levels. Finally, such results are of economic value ornamentally. Since more marketable characteristics were achieved for making this plant as an attractive pot plant.

The aforementioned results of growing media concerning chemical constituents are in conformity with those reported by **Bashir *et al.* (2007)** on jojoba (*Simmondsia chinensis*), **Khelikuzzaman (2007)** on *Tradescantia sp.*, **Turhan *et al.* (2007)** on *Crocus sativus* L., **Ostos *et al.* (2008)** on *Pistacia lentiscus*, **Khalaj *et al.* (2011)** on *Gerbera jamesonii* L., **Khattak *et al.* (2011)** on *Vinca rosea*, **Habib (2012)** on *Caryota mitis* Lour, **Aklibasinda *et al.* (2011)** on *Pinus sylvestris*, **Abouzar (2012)** on *Ficus benjamina*, **Alidoust *et al.* (2012)** on Dracaena and **Waseem *et al.* (2013)** on *Matthiola incana*.

The abovementioned results of fertilization are in harmony with those attained by **Singh *et al*. (2002)** on *Gladiolus grandiflorum*, **Pal and Biswas (2005)** on *Polianthes tuberosa* L., **El-Malt *et al.* (2006)** on *Hippeastrum vittatum*, **Youssef and Goma (2007)** on *Iris tingitana*, **El-Naggar and El-Nasharty (2009)** on *Hippeastrum vittatum*, **Abd El-All (2011)** on *Aspidistra elatior*, **Rodrigo *et al.* (2011)** on *Pinus nigra and Betula papyrifera*, **Habib (2012)** on *Caryota mitis* Lour, **Wanderley *et al.* (2012)** on areca bamboo palm (*Dypsis lutescens*) and **Youssef and Abd El-Aal (2014)** again on *Hippeastrum vittatum.*

In conclusion, growing *Beaucarnea recurvata* plants in medium containing composted leaves+ peat moss+ vermiculite or medium containing clay+ sand + peat moss (1:1:1 by volume) and fertilized with kristalon fertilizer at 6 g /pot is necessary for improving the growth, quality and nutritional status of the plants.

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الملخص العربي

تأثير بيئات النمو المختلفه والتسميد الكيماوي علي النمو والمحتوي الكيماوي لنبات البوكارنيا

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أجريت تجربه أصص لدراسه تأثير 15 معامله ممثله للتفاعل بين خمسه بيئات نمو مختلفه وهي الطمي + الرمل (1:1 حجما) ، الطمي + الرمل + كمبوست الأوراق ، الطمي + الرمل + البيت موس، الطمي + الرمل + الفيرميكيوليت و كمبوست الأوراق + البيت موس+ الفيرميكيوليت (1:1:1 جحما) وثلاثه معدلات من التسميد الكيماوي (سماد الكريستالون بتركيز 0، 4، 6 جرام/ أصيص) علي النمو والمحتوي الكيماوي لنبات البوكارنيا. أوضحت النتائج أن زراعه نبات البوكارنيا في مخلوط بيئه يتكون من الطمي والرمل وكمبوست الأوراق وتسميدها بالكريستالون بمعدل 6 جرام/ أصيص قد أعطي أطول النباتات، وأكبر محتوي للأوراق من الفوسفور والأكسين والجبريللين. بالأضافه، وجد أن أكبر عدد ووزن طازج وجاف للأوراق / نبات وأكبر محتوي للأوراق من البوتاسيوم قد تم الحصول عليه عند استخدام مخلوط بيئه يتكون من الطمي والرمل والبيت موس وتسميد النباتات بسماد الكريستالون بمعدل 6 جرام/ أصيص في كلا الموسمين. تم الحصول علي أكبر طول للزلوعه (قاعده الساق Caudex) عند زراعه النباتات في مخلوط بيئه يتكون من الطمي والرمل والفيرميكيوليت والتسميد بمعدل 6 جرام كريستالون / أصيص . وجد أن زراعه نباتات البوكارنيا في مخلوط بيئه تحتوي علي كمبوست الأوراق والبيت موس والفيرميكيوليت واضافه 6 جرام سماد كريستالون / أصيص قد أعطي أكبر قطر للزلوعه وأكبر عرض (قطر) للنبات وأعلي قيمه جماليه (Show value) وأكبر محتوي للأوراق من النيتروجين والكربوهيدرات والسيتوكينين بالأضافه الي أقل محتوي للأوراق من حمض الأبسيسيك.

وبناءا علي النتائج المتحصل عليها وجد أن زراعه نباتات البوكارنيا في بيئه تحتوي علي كمبوست الأوراق والبيت موس والفيرميكيوليت أو مخلوط بيئه يحتوي علي الطمي والرمل والبيت موس واضافه 6 جرام سماد كريستالون / أصيص قد أعطي أفضل نمو وجوده للنباتات.