Journal of Horticultural Science & Ornamental Plants 9 (2): 72-85, 2017
ISSN 2079-2158

DOI: 10.5829/idosi.jhsop.2017.72.85

Response of *Chamaedorea elegans*, Mart. Plants Grown under Different Light Intensity Levels to Chemical and Organic Fertilization Treatments

[1]*Abou Dahab, T.A.M.*, [1]*H.A. Ashour*, [2]*E.E.A. El-deeb and* [1]*Saber M.M. Hend*

[1]Cairo University, Faculty of Agriculture, Ornamental Horticulture Department, Giza, Egypt
[2]Ornamental Plants Res. and Landscape Dep., Hort. Res. Inst., ARC, Giza, Egypt

Abstract: The present study was carried out in the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, during the two successive seasons of 2014 and 2015. The aim of this work was to investigate the response of growth and biochemical constituents of *Chamaedorea elegans*, Mart. plants grown under different light intensity levels to chemical and organic fertilization treatments. The plants were grown under full sunlight, lathe house and green house conditions provided light intensity levels of 100, 30 and 21% respectively. Plants grown under the three levels of light intensity were fertilized every 3 weeks with either chemical NPK (Kirstalon, 19-19-19) at the rate of 2 and 4 g/pot or organic Humic Acid (HA) applied as a soil drenching at the concentration of 3 and 6 ml/L, in addition to the control plants. Results showed that, the lower light intensities levels (30 or 21 %) increased plant height, number of leaves/plant, stem diameter, root length, fresh and dry weights of shoots and roots as well as the contents of total chlorophylls (a + b), carotenoids, K% and indoles, while reduced total carbohydrates, N and P% in shoots compared with full sunlight (100%). Application of either chemical NPK or organic HA treatments increased all the tested vegetative growth parameters and chemical constituents, while organic HA was more effective than chemical NPK treatments. In most cases, supplying the plants grown under the lower light intensities levels (30 or 21 %) with either chemical NPK or organic HA treatments improved vegetative parameters, increased total chlorophylls (a + b), carotenoids, K% and indoles contents compared to plants grown under full sunlight (100%) and received the same fertilizer treatments. organic HA treatments were more effective than chemical NPK treatments and among the two concentrations of HA, the highest concentration (6 ml/L) was more effective one. From the obtained results, it can be concluded that for the best growth and good quality of *Chamaedorea elegans,* the plants should grow under shade conditions at lower light intensity levels (30% to 21%) and supplied with humic acid at rate 6ml/L/ pot every 3 weeks as soil drenching.

Key words: *Chamaedorea elegans* · Light intensity · NPK · Humic acid

INTRODUCTION

Chamaedorea elegans, Mart. is member of Arecaceae family, native to Guatemala and Mexico. It is known as parlor palm, neanthe bella palm and household palm, reaching 2-3 m height (6 -10 feet) and 2 -3 feet spread with upright, slender and usually with one single trunk. The leaves are pinnately compound with 11-20 leaflets, lanceolate, entire margins and mostly stiff, each leaflet is 4 -8 inches long and glossy dark green in color. The flowers are dioeciously, small yellow followed by round black fruits; it blooms periodically through the year in late winter to early spring and it propagated by seeds. This species is one of the best foliage plants used in interiorscapes due to its ability to withstand low irradiance levels with slow rate of growth. The plant grows well with relatively low interior lighting and moist, porous soils. In addition to its uses as an excellent indoor plant, it can be also used for outdoors landscape activates as accent plant in low or indirect light areas of garden [1].

Corresponding Author: Abou Dahab, T.A.M., Department of Ornamental Horticulture, Faculty of Agriculture, Cairo University, Giza, Egypt.

Light intensity is one of the most important environmental factors controlling the photosynthesis as it is the source of chemical energy required by plants and thus regulating the process contributing to plant growth and adaptation. As known, light intensity differs spatially, seasonally and diurnally, consequently the plants develop acclimation and plasticity mechanisms to cope with the changes of light regimes [2]. The most of plant species able to adjusting with varying light intensities through morphological, physiological, anatomical and biochemical change to ensure light capture and utilization [3, 4]. The acclimation responses to low light, shade plants tend to have thinner leaves but larger in surface area, lower light compensation point and higher net photosynthetic rates at lower light levels compared with sun plants [5-6]. The chloroplast of the shade plants are generally larger, have greater chlorophyll content and a smaller stromal volume than those of high light plants [7]. In this respect, studies on the effect of light intensity on plant development, photosynthesis and morphology of some foliage plants showed that, highest growth of *Chamaedorea elegans* has been obtained in greenhouses with 70 % shade [8]. Increasing shading level increased plant height, leaf area, leaves and roots dry weights as well as chlorophyll concentration in leaves of *Croton urucurana*, while dry weight of roots and photosynthetic rate decreased [9]. On *Polyscias balfouriana* Gunadasa and Dissanayake [7] found that the highest shade levels of 85 and 90% increased shoot length, leaf expansion and chlorophyll content, whereas highest leaves number was achieved at 85% shade level compared to control (50 % shade). Shade levels of 35% increased growth parameters of *Coleus blumei* including the leaf number, branches, leaf area, leaves dry matter, anthocyanin and chlorophyll pigments compared to unshaded control plants [10]. Also light intensity affect nutrient accumulation, on *Nephrolepis exaltata* plants exposed to the lower light level (75% shade) showed a higher N%, while K and Ca% were higher at50% shade levels compared to full sunlight control plants [11].

Mineral fertilization is considered one of the most important tool affecting ornamental plants. The fertilization with NPK provided by commercial fertilizers improves the vegetative growth of foliage plants particularly with the optimum application rate. Many investigators [12-14] studied the effect of chemical NPK fertilizers on various foliage plants and showed its positive effect on producing vigorous growth. However, the chemical fertilizers recommended for palms include various NPK formulations [15]. In this concern, previous study [8] revealed that fertilization with NPK (28: 9: 19) applied at the rat 2.5 gm / pot/ 3 weeks resulted in the best growth for *Chamaedorea elegans*. On another research Habib [16] on *Caryota mitis*, found that application of NPK (14:7:37) monthly at the rat 4 gm /pot had a remarkable effect on increasing plant height, stem diameter, number of leaves/plant, leaf area, fresh weight of shoots and roots, increasing contents of chlorophyll a, carbohydrate and N, P and K%, while decreased indoles and phenols contents in leaves.

Recently, among the fertilization strategies, using organic substances become the most important practice needed for substitute chemical fertilizers for production of plants because the relatively high cost of synthetic fertilizers along with its harmful effects on the soil and environment. Humic acid (HA) is a natural polymer organic compound which can be used to increase plant growth, nutrient availability in the soil [17]. The beneficial effects of HA on plant growth has been classified into direct and indirect effects. The indirect effects are attributed to improve physical, chemical and biological properties of soil, while its direct effects are various biochemical actions resulted from uptake and penetration of humic substances into the plant tissue and membranes causing increase in chlorophyll content, acceleration of the respiration process, hormonal growth responses or a combination of these processes. In addition, presence of mainly nature hormones likes cytokinins, auxins and gibberellins that play a vital role in enhancing the enzymatic activities of the plants [18-20]. HA enhancing the uptake of nutrient by acting as a chelate in mobilizing nutrients and prevents its leaching which in turn decrease the use of inorganic fertilizers besides increasing the efficiency of the applied fertilizers [19]. The positive effect of humic acid on enhancing nutrient uptake and growth of different ornamental plants has been reported in a number of species [21- 23]. However, only few researches have been carried out to evaluate the effect of humic substances on indoor or foliage plants, such studies showed its role on improving vegetative and root growth parameters of *Spathiphyllum wallisii*, *Cordyline terminalis*, *Dracaena* and *Ruscus* and *Brassaia actinophylla* [24-27]. Increased chlorophylls, carotenoids and total carbohydrates contents enhanced the uptake and accumulation of N, P and K in plant tissues [25, 26, 21, 28].

There is no available data for the comparative effect of inorganic and organic fertilizers on the performance of foliage plants or ornamental palms exposed to varying light regimes. So that, the main objective of this research was to evaluate the response of growth and biochemical constituents of *Chamaedorea elegans* Mart. plants grown under various light intensity to different treatments of chemical and organic fertilization.

MATERIALS AND METHODS

This experiment was conducted at the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, Egypt during the two successive seasons of 2014 and 2015. The aim of present research was to investigate the response of growth and biochemical constituents of *Chamaedorea elegans*, Mart. plants grown under different light intensity levels to chemical and organic fertilization treatments.

On 1st April, in the two seasons, the seedlings of *Chamaedorea elegans* plants were obtained from a private nursery with average height of 20 cm and planted individually in 20 cm plastic pots filled with the mixture of peat moss+ sand (2:1: v/v), The physical and chemical characteristics of soil mixture used in the study are shown in Table 1.

On 21th April, in both seasons, the plants were divided into groups placed under three locations with 60 plants for each one. The first was placed under full sunlight conditions (with average light intensity was 1819 lux for both seasons, representing 100%), the second one was under lathe house (with average light intensity

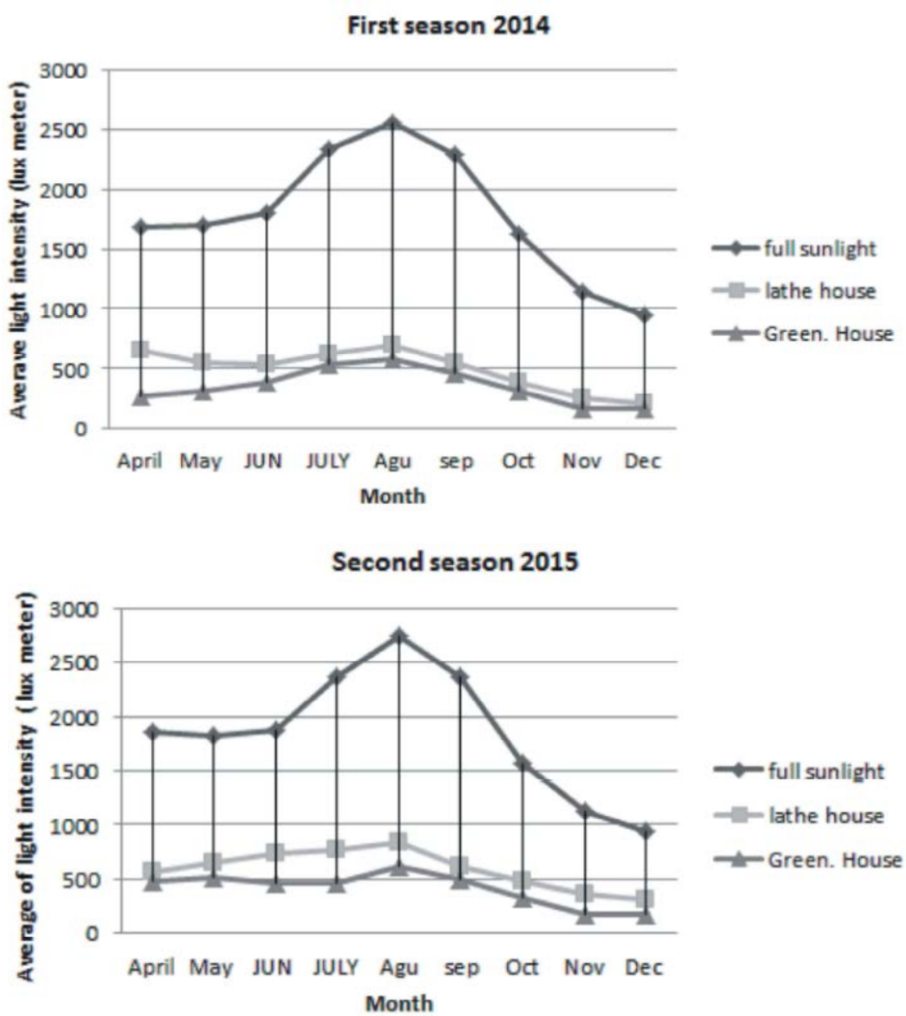

Fig. 1: Average light intensity during the first season 2014 and second season 2015

Table 1: The physical and chemical properties of soil mixture used for growing *Chamaedorea elegans* during 2014 and 2015 seasons

				Macro-nutrients (%)					Micro-nutrients (ppm)			
EC (dS/m)	Organic matter (%)	pH	W H C %	N	P	K	Mg	Ca	Fe	Mn	Zn	Cu
0.78	57.33	6.22	56.44	1.25	0.19	0.65	0. 49	1.76	489.5	121	41.97	8.33

was 546 lux representing 30%), while the third one was under green house (with average light intensity of 383 lux representing 21%). The light intensity of three locations were measured in midday through the experiment (beginning from 21th April, till 21th December in both seasons), using luxmeter (Digital lutron lux-101 lux meter) posited at 20 cm above the plants surface and the monthly mean light intensity was calculated (Fig. 1).

In both seasons, plants grown under the three levels of light intensity were received the different fertilization treatments applied every 3 weeks (from 30th April till 1st December) including, either chemical NPK in forms of Kirstalon (NPK, 19-19-19) at the rate of 2 and 4 g/pot or organic Humic Acid (HA) in forms of DICA (commercial name of humic acid, consists of humic acid 15% + Fulvic acid 10% + Amino acids 10% + Potassium 6% + Phosphor 4% + Nitrogen 1%) applied as a soil drenching at the concentration of 3 and 6 ml/L (27 cm^3 of solution/ plant). In addition to the control plants which received no fertilization treatment. The common cultural practices, such as hand picking of weeds and regular irrigation were also performed.

The experiment layout was a split-plot design with 15 treatments [3 light intensity levels x 5 fertilization treatments (including the control)] with 3 replicates, each consisting of 60 plants (4 plants / replicate). The light intensity treatments were assigned to the main plots, while fertilization treatments were assigned to the sub-plots and were assigned randomly under each light intensity levels.

At the end of experiment, on 21th December in both seasons, the data on vegetative growth parameters were recorded, including plant height (cm), number of leaves/plant, stem diameter (mm, at one cm above soil surface), root length (cm), fresh and dry weights of shoots and roots/plant. Chemical determinations including; total chlorophylls (a + b) and carotenoids contents (mg/g FW) in fresh leaf samples were determined according to the method of Lichtenthaler [29], total carbohydrates (%) in dried shoots samples were determined using the method recommended by Dubois *et al*. [30]. N, P and K % were estimated in digested extract of dried shoots samples according to the methods outlined by Westerman [31]. Phenol and indole contents in fresh leave samples determined as described by Selim *et al*. [32].

The data recoded on vegetative growth characteristics were subjected to an analysis of variance as a factorial experiment in split plot design and the means of the obtained data were compared using the "Least Significant Difference (LSD)" test at the 0.05 level [33].

RESULTS AND DISCUSSION

Vegetative Growth Parameters

Effect of Light Intensity: The obtained results in the two seasons (Tables 2 and 3) revealed that the different levels of light intensity had a clear effect on vegetative growth parameters of *Chamaedorea elegans* Mart plants. In both seasons, in most cases, plants grown under green house (21% light intensity) had significantly higher values of plant height, number of leaves/plant, stem diameter, root length as well as fresh and dry weights of shoots and roots closely followed by plants grown under lathe house (30 % light intensity) as compared to those grown under full sunlight condition which resulted in the lowest values of studied parameters. The only one exception to this general trend was recorded in the second season with plants grown under lathe house which gave insignificantly higher plant height than those grown under full sunlight. On the other words, the vegetative growth parameters were increased steadily as a result of decreasing light intensity level from 100% or 30 to 21%. These results are in agreement with several studies on other foliage plants which reported increases in growth parameters of plants grown under low light intensity (shaded plants) as compared to those exposed to full sunlight [7, 9-11, 34-37].

Increases the vegetative growth parameters of *Chamaedorea elegans* Mart plants with lower light intensity levels to reach the highest values with 21% (i.e., 79% shade level) may be due to the plants received the optimum light level for maximum photosynthesis and consequently better growth. Although light is important for photosynthetic energy conversion, high irradiation levels can cause damage to sensitive plants by destruction of pigments which is accompanied by photosynthesis reduction and consequently decrease in the biomass [38]. In these regard it was also mentioned by previous authors that, high light intensity may be effect on the enzymes responsible for amino acids activity and

Table 2: Effect of light intensity, fertilization treatments and their interactions on plant height, number of leaves /plant, stem diameter, root length and fresh weight of shoots of *Chamadoria elegans* during the 2014 and 2015 seasons

	First season (2014)				Second season (2015)			
	Light intensity(A)				Light intensity (A)			
*Fertilization treatments (B)	Full sun (100%)	Lathe house (30%)	Green house (21%)	Mean (B)	Full sun (100%)	Lathe house (30%)	Green house (21%)	Mean (B)
				Plant height (cm)				
Control	39.88	39.80	44.43	41.37	42.42	43.71	51.02	45.72
NPK at 2 g/ pot	42.92	46.70	48.68	46.10	50.52	48.68	55.47	51.56
NPK at 4g/ pot	40.32	40.43	46.66	42.47	45.63	47.57	54.00	49.07
HA at 3 ml/L	44.23	46.38	49.45	46.69	51.88	52.10	60.40	54.79
HA at 6 ml/L	44.73	49.98	50.30	48.34	53.43	54.70	62.90	57.01
Mean (A)	42.42	44.66	47.90	----	48.78	49.35	56.76	----
L.S.D. (0.05)								
A	2.18				0.58			
B	0.71				0.73			
AX B	1.23				1.29			
				Number of leaves/plant				
Control	3.83	4.33	4.67	4.28	2.17	3.83	5.83	3.94
NPK at 2 g/ pot	4.83	5.67	6.33	5.61	5.50	7.00	6.83	6.44
NPK at 4g/ pot	4.17	5.17	5.33	4.89	4.83	6.00	6.33	5.72
HA at 3 ml/L	5.50	6.17	6.67	6.11	6.00	7.00	7.33	6.78
HA at 6 ml/L	6.33	7.33	8.17	7.28	7.33	8.50	9.00	8.28
Mean (A)	4.93	5.73	6.23	----	5.17	6.47	7.06	----
L.S.D. (0.05)								
A	0.27				0.29			
B	0.35				0.37			
AX B	0.60				0.65			
				Stem diameter (mm)				
Control	4.63	9.23	7.92	7.26	4.50	6.08	8.70	6.43
NPK at 2 g/ pot	7.91	11.24	12.13	10.43	11.33	15.02	15.67	14.01
NPK at 4g/ pot	7.10	8.70	11.43	9.08	10.63	16.77	15.00	14.13
HA at 3 ml/L	9.24	12.36	14.01	11.87	15.83	16.80	19.83	17.49
HA at 6 ml/L	13.26	15.26	16.12	14.88	17.33	17.65	21.67	18.88
Mean (A)	8.43	11.36	12.32	----	11.92	14.46	16.17	----
L.S.D. (0.05)								
A	1.06				1.07			
B	1.42				1.39			
AX B	2.37				2.40			
				Root length (cm)				
Control	14.81	16.74	20.55	17.37	19.02	23.18	30.17	24.12
NPK at 2 g/ pot	26.89	32.33	28.76	29.33	33.27	28.03	39.17	33.49
NPK at 4g/ pot	18.97	19.48	24.45	20.97	27.74	31.78	34.30	31.27
HA at 3 ml/L	29.54	32.94	34.03	32.17	34.81	36.36	41.58	37.58
HA at 6 ml/L	36.99	41.64	45.37	41.33	37.60	41.24	44.60	41.15
Mean (A)	25.44	28.63	30.63	----	30.49	32.12	37.96	----
L.S.D. (0.05)								
A	0.61				0.78			
B	0.80				1.00			
AX B	1.38				1.74			
				Fresh weight of shoots (g/plant)				
Control	9.78	16.04	17.24	14.35	18.44	24.15	30.59	24.39
NPK at 2 g/ pot	15.32	19.44	28.73	21.16	36.24	39.08	44.39	39.90
NPK at 4g/ pot	8.58	14.67	24.85	16.03	32.83	37.55	31.82	34.07
HA at 3 ml/L	19.82	21.85	30.46	24.04	38.74	43.26	50.88	44.29
HA at 6 ml/L	22.19	28.75	35.20	28.71	47.69	48.37	55.53	50.53
Mean (A)	15.14	20.15	27.30	----	34.79	38.48	42.64	----
L.S.D. (0.05)								
A	1.02				1.70			
B	1.31				1.37			
AX B	2.27				3.79			

* NPK= Kirstalon, 19-19-19 at 2 and 4 g/pot

HA= Humic Acid at 3 and 6 ml/L

Table 3: Effect of light intensity, fertilization treatments and their interactions on dry weight of shoots as well as fresh and weights of roots of *Chamadoria elegans* during the 2014 and 2015 seasons

	First season (2014)				Second season (2015)			
	Light intensity(A)				Light intensity(A)			
*Fertilization treatments (B)	Full sun (100%)	Lathe house (30%)	Green house (21%)	Mean (B)	Full sun (100%)	Lathe house (30%)	Green house (21%)	Mean (B)
				Dry weight of shoots (g/plant)				
Control	3.37	3.94	4.60	3.97	12.73	14.17	15.53	14.14
NPK at 2 g/ pot	4.09	4.35	7.20	5.21	14.25	17.17	20.15	17.19
NPK at 4g/ pot	1.95	2.69	6.26	3.63	9.85	10.25	18.87	12.99
HA at 3 ml/L	4.57	5.74	7.52	5.94	15.64	18.08	23.70	19.14
HA at 6 ml/L	5.22	7.07	9.48	7.26	18.95	22.29	27.71	22.98
Mean (A)	3.84	4.76	7.01	----	14.28	16.39	21.19	----
L.S.D. (0.05)								
A	0.53				0.75			
B	0.68				0.97			
AX B	1.18				1.68			
				Fresh weight of roots (g/plant)				
Control	2.11	2.74	6.27	3.71	5.12	7.05	9.72	7.30
NPK at 2 g/ pot	3.35	4.62	9.35	5.77	13.40	21.03	24.80	19.74
NPK at 4g/ pot	2.49	3.74	4.89	3.71	11.58	18.87	20.95	17.13
HA at 3 ml/L	4.09	6.09	8.94	6.37	14.18	22.88	28.90	21.99
HA at 6 ml/L	5.27	7.96	12.52	8.58	16.47	24.19	32.85	24.50
Mean (A)	3.46	5.03	8.39	----	12.15	18.80	23.44	----
L.S.D. (0.05)								
A	0.43				0.55			
B	0.56				0.71			
AX B	0.97				1.23			
				Dry weight of roots (g/plant)				
Control	0.95	1.54	1.92	1.47	1.93	2.78	4.18	2.96
NPK at 2 g/ pot	1.71	2.10	2.98	2.26	5.02	7.08	12.50	8.20
NPK at 4g/ pot	1.35	1.70	3.36	2.14	2.84	5.95	8.05	5.61
HA at 3 ml/L	2.40	2.71	3.41	2.84	7.66	10.22	14.06	10.65
HA at 6 ml/L	2.63	3.39	4.06	3.36	8.67	12.54	16.96	12.72
Mean (A)	1.81	2.29	3.15	----	5.22	7.71	11.15	----
L.S.D. (0.05)								
A	0.35				0.54			
B	0.46				0.69			
AX B	0.79				1.20			

* NPK= Kirstalon, 19-19-19 at 2 and 4 g/pot
HA= Humic Acid at 3 and 6 ml/L

protein production, it also could inhibit auxins activity which regulate metabolism that adversely influence on pigments synthesis and carbohydrates accumulation which in turn affecting plant growth and development [39-40]. Therefore, Chamaedorea plants grown in full sunlight condition may be received excess amount of radiation above their requirement which resulted in reducing growth parameters of such plants and this reflecting it's sensitively to higher radiation levels.

Effect of Fertilization Treatments: The data recorded in Tables (2 and 3) showed that, fertilization treatments had a favorable effect on vegetative growth parameters of *Chamaedorea elegans* Mart plants. In both seasons, in most cases, treating the plants with either chemical NPK rates (2 or 4 g/pot) or organic HA concentrations (3 or 6 ml/L) significantly increased values of studied growth parameters as compared to those registered with the control plants (unfertilized plants). The only exceptions to the obtained trend were detected in both seasons with the plants treated with NPK at the highest rate (4 g/pot) which caused reduction in dry weight of shoots (such reduction was insignificant in the first season and significant in the second one), also application of the same treatment had no significant effect on fresh weight of roots in the first season. In both seasons, most of growth parameters were decreased as a chemical NPK rates increased from 2 to 4 g/pot. These findings are similar to those obtained by other researches and these may be due to salt toxicity resulted from excessive chemical fertilization rate [13, 41]. However, all of tested parameters were increased steadily with raising HA concentrations compared the control plants. Also, data clearly revealed that application of organic HA treatments was generally more effective than chemical fertilization one for increasing the recorded data. Among the two tested concentrations of HA, the most effective one was the highest concentration (6 ml/L) which resulted in the highest mean values, whereas the lowest values were obtained from untreated control plants. Similar results of increases vegetative growth parameters due to application of HA treatments were reported by numerous authors [21, 28, 42, 43].

The superior stimulating effect of the organic HA treatments on increasing the vegetative growth parameter (compared to chemical one) may be attributed to HA enhancing the uptake of oxygen, micro and macro nutrient, increasing cell membrane permeability, root and cell elongation, respiration, photosynthetic activity, N metabolism, protein synthesis and decreasing water evaporation from soils [17, 22, 44]. Furthermore, HA has direct cytokinin, auxin or gibberellin that play an important role in enhancing the enzymatic activities of the plants, along with indirect effect on plant metabolism [19, 45]. Moreover, organic HA compound (DICA) used in this investigation contain fulvic acid, amino acids and nutrient elements (N, P and K) which play a vital role in various physiological processes within the plant. Fulvic acid increases the cellular energy and regulation of plant metabolism, transports vitamins into the cell and accelerates cellular division which promoting plant growth and development. It chelates and binds scores of minerals into a bio-available form used by cells and enhances the permeability of cell membranes [20, 46]. Amino acids affect the physiological activities in plant growth and development like cell differentiation, metabolism and serve as a source of carbon and energy also synthesize different organic compounds such as protein, enzymes vitamins and hormones which influence on various processes leading to plant growth [47]. In addition, nutrient elements in HA ameliorate soil fertility, decrease soil nutrient deficiency and improve water and nutrient availability by forming chelates of different nutrients [48].

Effect of Interaction Between Light Intensity and Fertilization Treatments: The data presented in Tables (2 and 3) revealed that in most cases, under the same light intensity level, organic HA treatments gave significantly higher values for the most of vegetative growth parameters than those obtained by chemical treatments. In both seasons, the highest values of the studied parameters were obtained from plants grown under the lowest light intensity of green house (21%) and received HA at the highest concentration (6 ml/L). On contrary, the lowest values were resulted from plants grown under full sunlight condition and received no fertilization treatments in most cases.

Chemical Constituents

Total Chlorophylls and Carotenoids Content: As shown in Table (4), the data showed that, the synthesis and accumulation of total chlorophylls (a+b) and carotenoids pigments in leaves of *Chamaedorea elegans* Mart plants were significantly higher in leaves of plants grown under lower light intensities (30 or 21%) than those grown under full sunlight (100%), with generally superior for the lowest light intensity (21%) in this respect. The results of increased the total chlorophylls content as a result of reduced light intensity levels are in accordance with those obtained by prior researches on other plants [7, 9-11, 34-36], whereas increasing carotenoids content as a result of reduced light intensity are in agreement with finding with previous study [49].

The augmentation of chlorophylls content in leaves of shaded plants (received lower light intensity levels) was explained in other document Kramer and Kozlowski [50] who stated that, the synthesis and photo degradation of photosynthetic pigments are mainly controlled by light. The excess light intensity destroys chlorophylls by photo-oxidation which causing decrease in the total chlorophyll content. Additionally, shade plants are usually containing a large leaf area with high number of chloroplasts as an adaptation to shade due to increase light absorption [6].

The Data obtained in Table (4) also revealed that fertilization treatments were very beneficial in terms of increasing the total chlorophylls and carotenoids content in leaves of *Chamaedorea elegans*. In both seasons, treating the plants with any rate of the different fertilization types (chemical NPK or organic HA) significantly increased the recorded mean values, as compared to untreated control plants. In both seasons, application of chemical NPK at the lowest rate (2 g /pot) was generally more effective than the highest one (4 g/pot). When the two types of fertilization were applied at the different concentrations, organic HA was generally more effective than chemical one, with superiority for the highest concentration (6 ml/L) which scored the highest mean values, in most cases, compared to the control. The results of increases the total chlorophylls or carotenoids contents due to chemical NPK treatments are consistent with those reported by previous studies [13, 14, 16]. While increased these pigments as a result of HA treatments are in harmony with those documented by other researches [21, 43, 51].

Table 4: Effect of light intensity, fertilization treatments and their interactions on total chlorophylls, carotenoids, total carbohydrates contents in shoots of *Chamadoria elegans* during the 2014 and 2015 seasons

	First season (2014)				Second season (2015)			
	Light intensity(A)				Light intensity(A)			
*Fertilization treatments (B)	Full sun (100%)	Lathe house (30%)	Green house (21%)	Mean (B)	Full sun (100%)	Lathe house (30%)	Green house (21%)	Mean (B)
				Total chlorophylls content (mg/g FW)				
Control	0.73	1.13	1.27	1.05	1.06	1.29	1.69	1.35
NPK at 2 g/ pot	1.11	1.23	1.29	1.21	1.28	1.72	1.80	1.60
NPK at 4g/ pot	0.88	1.22	1.35	1.15	1.19	1.45	1.80	1.48
HA at 3 ml/L	1.37	1.30	1.40	1.36	1.41	1.96	2.09	1.82
HA at 6 ml/L	1.28	1.33	1.56	1.39	1.37	1.94	2.24	1.85
Mean (A)	1.07	1.24	1.37	----	1.26	1.67	1.92	----
L.S.D. (0.05)								
A	0.03				0.04			
B	0.04				0.05			
AX B	0.08				0.09			
				Carotenoids content (mg/g FW)				
Control	0.10	0.18	0.21	0.16	0.35	0.50	0.63	0.49
NPK at 2 g/ pot	0.30	0.35	0.34	0.33	0.55	0.76	0.76	0.69
NPK at 4g/ pot	0.26	0.28	0.37	0.30	0.48	0.68	0.88	0.68
HA at 3 ml/L	0.29	0.59	0.42	0.43	0.61	0.95	0.89	0.82
HA at 6 ml/L	0.28	0.43	0.43	0.38	0.78	0.78	0.94	0.83
Mean (A)	0.24	0.37	0.35	----	0.56	0.73	0.82	----
L.S.D. (0.05)								
A	0.02				0.03			
B	0.03				0.03			
AX B	0.05				0.06			
				Total carbohydrates (% of dry matter)				
Control	32.09	30.08	30.80	30.99	41.53	42.84	35.95	40.10
NPK at 2 g/ pot	37.67	36.89	39.58	38.04	42.74	33.45	34.55	36.91
NPK at 4g/ pot	34.71	36.07	36.60	35.79	43.41	29.06	35.42	35.96
HA at 3 ml/L	39.40	37.85	34.05	37.10	46.67	40.59	34.67	40.64
HA at 6 ml/L	42.20	41.31	40.13	41.21	48.74	46.10	37.70	44.18
Mean (A)	37.21	36.44	36.23	----	44.62	38.41	35.66	----
L.S.D. (0.05)								
A	1.23				1.56			
B	1.59				1.82			
AX B	2.75				3.33			

* NPK= Kirstalon, 19-19-19 at 2 and 4 g/pot
HA= Humic Acid at 3 and 6 ml/L

The increase in chlorophyll contents as a result of HA treatments may be due to it accelerates N and NO_3 absorption, boosts N metabolism and protein production which contributing to augment the level of chlorophyll [52].

As for the effect of interaction between light intensity and fertilization treatments, the data presented in Table (4) revealed that under the same level of light intensity, in most cases, organic HA treatments were more effective than chemical one for increasing total chlorophylls and carotenoids contents. In both seasons, the lowest values of total chlorophylls and carotenoids contents were resulted from plants grown under full sunlight and received no fertilization treatments (control). On the other hand, the highest values of total chlorophylls contents were resulted from plants grown under green house with the lowest light intensity (21%) and supplied with HA at the highest concentration (6 ml/L), whereas the highest values of carotenoids contents were obtained from plants grown under light intensity of 30% and received HA at the lowest concentration (3 ml/L).

Total Carbohydrates (% of Dry Matter): It is evident from the data in Table (4) that in both seasons, the values of total carbohydrates percentage in dry shoots were reduced in parallel with reducing light intensity level from 100% or 30 to 21%. Accordingly, the highest values (37.21 and 44.62% in first and second seasons, respectively) were obtained from plants grown under full sunlight, whereas the lowest percentage (36.23 and 35.66% in first and second seasons, respectively) were resulted from plants grown under the lowest level of light intensity (21%). In the first season, reduced light intensity from 30 to 21% resulted in insignificant reduction in the recorded mean values, whereas this reduction was significant in second one as compared to full sunlight grown plants. Such results of reduced total carbohydrates contents due to reduced light intensity levels are similar with the findings of previous researchers on other plants [53-55].

The data presented in Table (4) also pointed out that, the accumulation of total carbohydrates percentage in response to NPK chemical treatments was differed from one season to others. In the first season, plants received any rate of chemical NPK (2 or 4 g/pot) resulted in significant higher mean values than those recorded with the untreated control plants, while in the second one, these values were decreased significantly compared to the control. However, In most cases, application of organic HA treatments caused significant increase in carbohydrates values in both seasons compared to untreated control plants, with only one exception detected in the second season with plants supplied with HA at the lowest concentration (3 ml/L) which had insignificantly higher values than unfertilized control plants. Similar increases in the carbohydrates percentage as a result of HA treatments have been demonstrated by prior studies [21, 25, 26, 28, 56].

Concerning the effect of interaction between light intensity and fertilization treatments The data tabulated in Table (4) showed that, In both seasons, the highest values of total carbohydrates percentage (42.20, 48.74% in two seasons, respectively) were obtained from plants grown under full sunlight and treated with organic HA at the highest concentration (6 ml/L). On the other hand, the lowest values (30.08%) were resulted in the first season from plants grown under 30% light intensity received no fertilization treatments (control), whereas the lowest values (29.06 %) were resulted in the second season from plants grown under the same light intensity (30%) and fertilized with NPK chemical at the highest rate (4 g/pot).

N, P and K (% of Dry Matter): The obtained data of chemical analysis of shoots (Table 5) showed that in most cases, the accumulation of N or P % were significantly lower in shoots of plants grown under lower light intensities (30, 21%) than those grown under full sun light. The only one exception to this general trend was recorded in the first season with plants grown under the light intensity of lathe house (30%) which resulted in significant increase in P % compared to other tested light intensities (100 or 21%). The results of reduced N or P % due to expose the plants to low light intensity levels are consistent with those obtained by prior studies [41, 55]. However, the accumulation of K % showed a different trend in response to expose the plants to different levels of light intensity. In both seasons, the values of K % in shoots were increased steadily as the light intensity level was decreased from 100 or 30 to 21%. In the first season, the increments in the recorded mean values was statistically insignificant, whereas in the second season exposing the plants to lower light intensities (30, 21%) resulted in significantly higher values than full sunlight grown plants. The augment accumulations of K % as a result of decreasing light intensity levels are in agreement with the results of previous researches [11, 57].

As for the effect of fertilization treatments, the data in Table (5) showed that, in most cases, uptake and accumulation of N, P and K % were increased significantly in shoots of plants supplied with either chemical NPK or organic HA treatments compared to control plants. The only exceptions to this general trend were detected in the first season with the plants treated with chemical NPK at the highest rate (4 g/pot) which had insignificantly higher values of P% in their shoots than the control. The data also in Table (5) revealed that, organic HA treatments appeared to be generally more effective than chemical one, among the two concentration of HA, applying the highest concentration (6 ml/L) was more effective for increasing N and P%. The results of increasing N, P or K % as a result of chemical NPK treatments are similar to those obtained by previous studies [13, 14, 16], while increasing the accumulation of such nutrients due to HA treatments are in conformity with that recorded by other researches [21, 28, 43, 51].

Increasing the uptake and accumulation of these nutrients by application of HA may be due to indirect effects of these substances on improving soil properties like fertility, structure, water holding capacity, cation exchange capacity, aggregation, permeability, aeration, microbial activity, availability and transport of nutrients

Table 5: Effect of light intensity, fertilization treatments and their interactions on N, P and K% in shoots as well as phenols and indoles contents in leaves of *Chamadoria elegans* during the 2014 and 2015 seasons

	First season (2014)				Second season (2015)			
	Light intensity(A)				Light intensity(A)			
*Fertilization treatments (B)	Full sun (100%)	Lathe house (30%)	Green house (21%)	Mean (B)	Full sun (100%)	Lathe house (30%)	Green house (21%)	Mean (B)
				N (% dry matter)				
Control	2.25	1.35	1.62	1.74	1.88	1.76	2.04	1.89
NPK at 2 g/ pot	2.41	2.55	2.38	2.45	2.86	2.40	2.13	2.46
NPK at 4g/ pot	2.98	2.51	1.64	2.38	2.39	2.87	2.65	2.64
HA at 3 ml/L	2.66	2.97	2.73	2.79	3.19	2.17	2.35	2.57
HA at 6 ml/L	3.15	3.20	3.11	3.15	3.81	3.16	3.16	3.38
Mean (A)	2.69	2.52	2.30	----	2.83	2.47	2.47	----
L.S.D. (0.05)								
A	0.04				0.02			
B	0.05				0.03			
AX B	0.09				0.05			
				P (% dry matter)				
Control	0.11	0.19	0.18	0.16	0.35	0.15	0.18	0.23
NPK at 2 g/ pot	0.13	0.24	0.20	0.19	0.50	0.39	0.27	0.39
NPK at 4g/ pot	0.19	0.14	0.17	0.17	0.43	0.19	0.18	0.27
HA at 3 ml/L	0.24	0.28	0.12	0.21	0.51	0.48	0.37	0.45
HA at 6 ml/L	0.25	0.40	0.23	0.29	0.69	0.49	0.50	0.56
Mean (A)	0.18	0.25	0.18	----	0.50	0.34	0.30	----
L.S.D. (0.05)								
A	0.02				0.02			
B	0.03				0.02			
AX B	0.05				0.04			
				K (% dry matter)				
Control	1.07	0.98	0.90	0.94	1.00	1.16	1.09	1.08
NPK at 2 g/ pot	1.37	1.21	1.27	1.28	1.28	1.47	1.31	1.35
NPK at 4g/ pot	1.12	1.22	1.27	1.20	1.22	1.27	1.44	1.31
HA at 3 ml/L	1.41	1.47	1.37	1.42	1.29	1.68	1.58	1.52
HA at 6 ml/L	1.15	1.49	1.59	1.41	1.18	1.23	1.59	1.33
Mean (A)	1.26	1.27	1.28	----	1.19	1.36	1.40	----
L.S.D. (0.05)								
A	0.03				0.02			
B	0.04				0.03			
AX B	0.08				0.05			
				Phenols content (mg/100g F.W)				
Control	141.3	160.7	137.7	146.6	143.4	169.0	130.4	147.6
NPK at 2 g/ pot	146.2	182.4	150.9	159.8	147.7	184.6	149.5	160.6
NPK at 4g/ pot	191.0	170.4	149.7	170.4	154.5	192.1	150.9	165.8
HA at 3 ml/L	175.2	184.7	159.4	173.1	193.7	198.0	139.3	177.0
HA at 6 ml/L	170.2	178.5	140.4	163.0	173.8	176.3	133.0	161.0
Mean (A)	164.8	175.3	147.6	----	162.6	184.0	140.6	----
L.S.D. (0.05)								
A	2.3				3.3			
B	3.0				4.3			
AX B	5.2				7.5			
				Indoles content (mg/100g F.W)				
Control	118.7	132.7	120.2	123.9	119.5	121.1	121.6	120.7
NPK at 2 g/ pot	130.7	142.1	122.0	131.6	131.2	140.9	158.9	143.7
NPK at 4g/ pot	127.1	141.8	137.9	135.6	138.6	145.3	139.2	141.0
HA at 3 ml/L	136.8	132.8	128.4	132.7	123.5	158.3	125.4	135.7
HA at 6 ml/L	132.4	161.9	171.9	155.4	136.5	175.2	130.0	147.2
Mean (A)	129.1	142.3	136.1	----	129.9	148.2	135.0	----
L.S.D. (0.05)								
A	2.4				2.4			
B	3.0				3.0			
AX B	5.3				5.6			

* NPK= Kirstalon, 19-19-19 at 2 and 4 g/pot
HA= Humic Acid at 3 and 6 ml/L

[17, 18, 58] which caused better development root systems and thus increasing nutrients absorption by the roots. Moreover, HA may interact with the phospholipids structures of cell membranes and acts as carriers of nutrients through them [59]. Humic substances influence the solubility of many elements by building complex forms or chelating agents of humic matter with metallic cations [60].

Regarding the effect of interaction between light intensity and fertilization treatments the data in Table (5) indicated that, within each fertilization treatments, plants grown under the lower light intensities (30, 21%) had significantly higher K% in their shoots than those plants grown under full sunlight in most cases. Within each light intensity level, plants treated with any rate of either chemical NPK or organic HA had significantly higher N, P or K % in their shoots than those obtained from untreated control plants in most cases. Under the same level of light intensity, organic HA treatments were more effective than chemical one with the superiority of highest concentration (6 ml/L) which resulted the highest values of nutrients under three tested light intensities.

Phenols and Indoles Contents: It is obvious from Table (5) that in both seasons, the contents of phenols were significantly higher in leaves of plants grown under 30 % light intensity (lathe house) than those grown under other light intensities (100% or 21%). However, plants grown under lower light intensities (30 or 21%) contained significantly higher indoles in their leaves than those grown under full sunlight (100%).

Concerning the effect of fertilization treatments, the data in Table (5) demonstrated that, fertilization treatments had pronounced effects on increasing phenols and indoles contents in in leaves of plants. In both seasons, application any rate of either chemical NPK or organic HA resulted in significant increase in the recorded mean values compared to unfertilized control plants. In both seasons, the highest values of phenols content were obtained from application of HA at the lowest concentration (3 ml/L), whereas the highest values of indoles content were resulted from application of HA at the highest concentration (6 ml/L). Increase phenols contents as a result of HA are in agreement with findings of previous researches [61-63].

The increases in phenol contents (the compounds linked to shikimic pathway) may be due to HA enhanced the expression of the phenylalanine (tyrosine) ammonia-lyase that catalyses the first main step in the biosynthesis and accumulation of phenols which play a significant role in regulation mechanism of plant metabolic processes and thus overall plant growth [64, 65].

Data in the same Table (5) disclosed that, within each fertilization treatments, in most cases, plants grown under the lower light intensities (30, 21%) had significantly higher indoles content in their leaves than those plants grown under full sunlight. Within each light intensity level, in most cases, plants supplied with any rate of either chemical NPK or organic HA had significantly higher contents of phenols and indoles than those obtained from untreated control plants. In most cases, application of organic HA was more effective than chemical one for increasing phenol contents with the lowest concentration (3 ml/L) and indole contents with the highest one (6 ml/L).

CONCLUSION

From the obtained results, it can be concluded that for the best growth and good quality of *Chamaedorea elegans,* the plants should grow under shade conditions namely lower light intensity levels (30% to 21%) and supplied with humic acid at rate 6ml/L/ pot every 3 weeks as soil drenching.

REFERENCES

1. Odenwald, N. and J. Turner, 2006. Identification Selection and Use of Southern Plants for Landscape Design. 4th Ed. Claitor's Publishing Division. Baton Rouge, Louisiana, pp: 119.
2. Zhang, S.M.K. and L. Chen, 2003. Response of photosynthetic plasticity of *Paeonia suffruticosa* to changed light environments. Environ. Exper. Bot., 49: 121-133.
3. Sousa, P.É.A., R.M.I. Dos Santos, F.H.V. Aguiar and C.G.Q. De Senna, 2003. The influence of light intensity on anatomical structure and pigment contents of *Tradescantia pallida* (Rose) Hunt. cv. *purpurea* boom (Commelinaceae) leaves. Braz. Arch. Biol. Techn., 46: 617-624.
4. De Carvalho, G.J.F., B.D.C. De Sousa, J.U. Dos Santos, A.V. Fernandes, S.P. Barbosa and M.S. Buckeridge, 2005. Photosynthesis and stress indicators in young rosewood plants (*Aniba rosaeodora*) under different light intensities. Braz. J. Plant Physiol., 17: 325-334.
5. Givnish, T.J., 1988. Adaptation to sun and shade: a whole-plant perspective. Aust. J. Plant Physiol., 15: 63-92.

6. Prasad, S., S. Prasad and U. Kumar, 1998. Principles of Horticulture. Agro Botanica.
7. Gunadasa, H.K.S.G. and P.K. Dissanayake, 2012. Optimization of quality in exported *Polyscias balfouriana*" Marginata" by using different shade levels. J. Agri. Sci., 2(7): 58-65.s
8. Badawy, E.M., A.M. Abou Dahah, A.Z. Sarhan and H.A. Mansour, 1987. Effect of growth location and NPK fertilization rate on growth of *Chamaedorea elegans* and *C. constricta.* Acta Horticulturae, 205: 257-265.
9. Alvarenga, A.A., M.C. Evaristo, C.L.J. Erico and M.M. Marcelo, 2003. Effect of different light levels on the initial growth and photosynthesis of *Croton urucurana* Baill. In Southeastern Brazil, R. Arvore, Vicosa-MG., 27(1): 53-57.
10. Alabdaly, H.M.M.S. and F.J.M. Alkhalidy, 2016. The effect of shading and spraying different levels of coconut water on phenotypic traits of *Coleus blumei* potted plants. J. Genet. Environ. Resour. Conserv., 4(3): 210-214.
11. Singh, P., R.K. Dubey and K. Singh, 2014. Effect of shade levels on growth and frond production in boston fern [*Nephrolepis exaltata* (L.) Schott]. Asian J. Hort., 9(2): 377-381.
12. Lumis, G., P. Purvis and L. Taurins, 2000. Flood irrigation of container grown *Euonymus* and *Thuja* as affected by fertilizer rate and substrate. J. Envir. Hort., 18(1): 13-17.
13. Abd El-Aziz, N.G., 2007. Stimulatory effect of NPK fertilizer and benzyladenine on growth and chemical constituents of *Codiaeum variegatum* L. plant. Am.-Eurasian J. Agric. Envi. Sci., 2(6): 711-719.
14. El-Naggar, A.H., N.M. Esmaiel and A.A. El-Naggar, 2016. Effect of mineral and bio- fertilization on vegetative growth and flowering of *Anthurium andreanum* L. plants under greenhouse conditions. Alexandria Science Exchange Journal, 37(1): 1-9.
15. Wanderley, C.S., R.T. Faria and M.U. Ventura, 2012. Chemical fertilization, organic fertilization and pyroligneous extract in the development of seedlings of areca bamboo palm (*Dypsis lutescens*). Acta Sci., Agron., 34(2): 163-167.
16. Habib, A., 2012. Effect of NPK and growing media on growth and chemical composition of fishtail palm (*Caryota mitis* Lour). Life Sci. J., 9(4): 3159- 3168.
17. Sharif, M., R.A. Khattak and M.S. Sarir, 2002. Effect of different levels of lignitic coal derived humic acid on growth of maize plants. Commun. Soil Sci. Plant Anal., 33: 3567-3580.
18. Tan, K.H., 2003. Humic Matter in Soil and Environment, Principles and Controversies. Marcel Dekker, Inc., Madison Avenue, New York.
19. Kalaichelvi, K., C. Chinnusamy and A. Arul Swaminathan, 2006. Exploiting the Natural Resource - Lignite Humic Acid in Agriculture - A Review, Agric. Rev., 27(4): 276-283.
20. Fahramand, M., H. Moradi, M. Noori, A. Sobhkhizi, M. Adibian, S. Abdollahi and K. Rigi, 2014. Influence of humic acid on increase yield of plants and soil properties, Intl. J. Farm & Alli Sci., 3(3): 339-341.
21. Farahat, M.M., A.A.M. Mazhar and M.H. Mahgoub, 2012. Response of *Khaya senegalensis* seedlings to irrigation intervals and foliar application of humic acid. J. Hort. Sci. & Ornamen. Plants, 4 (3): 292-298.
22. Baldotto, M.A. and L.E.B. Baldotto, 2013. *Gladiolus* development in response to bulb treatment with different concentrations of humic acids. Revista Ceres, 60(1): 138-142.
23. Yazdani, B., A. Nikbakht and N. Etemadi, 2014. Physiological effects of different combinations of humic and fulvic acid on *Gerbera*. Commun. Soil Sci. Plant Anal., 45(10): 1357-1368.
24. Manda, M., M.G. Dumitru and C. Nicu, 2014. Effects of humic acid and grape seed extract on growth and development of *Spathiphyllum wallisii* Regel. South West J. Hortic Biol Environ, 5(2): 125-136.
25. El-Fouly, A.S., B.A. El-Sayed and S.M. Shahin, 2014. Effect of foliar spraying with humic acid and chelated microelements on growth and quality of goodluck (*Cordyline terminalis* (L.) Kunth) Plant. Minufiya J. Agric. Res., 39(2): 205-213.
26. Abdel-Fattah, G.H., B.A. El-Sayed and S.A.M. Khenizy, 2009. Response of *Dracaena* and *Ruscus* to humic acid and biofertilizer supply. Annals of Agric. Sci, Moshtohor, 47(1): 111-119.
27. El-Sayed, A.B. and S.A. El-Shai, 2008. Effect of growing media and humic acid on schefflera *(Brassaia actinophylla*) quality. J. Agric. Sci., Mansoura Univ., 33(1): 371-381.
28. Mazhar, A.A.M., S.I. Shedeed, N.G. Abd El-Aziz and M.H. Mahgoub, 2012. Growth, flowering and chemical constituents of *Chrysanthemum indicum* L. plant in response to different levels of humic acid and salinity. J. Appl. Sci. Res., 8(7): 3697-3706.
29. Lichtenthaler, H.K., 1987. Chlorophylls and Carotenoids: Pigments of Photosynthetic Biomembranes. In: Packer L. and Douce R., editors. Methods Enzymol. London: Academic Press, pp: 350-382.

30. Dubois, M., F. Smith, K.A. Gilles, J.K. Hamilton and P.A. Rebers, 1956. Colorimetric method for determination of sugar and related substances. Anal. Chem., 28(3): 350-356.
31. Westerman, R.L., 1990. Soil Testing and Plant Analysis. 3rd Ed. Soil Science Society of America, Inc. MadisonWisconsin, USA.
32. Selim, H.H.A., M.A. Fayek and A.M. Sweidan, 1978. Reproduction of Bricher apple cultivar by layering. Annals of Agric., Moshtohor, 9: 157-166.
33. Snedecor, G.W. and W.G. Cochran, 1989. Statistical Methods. 7th Ed. Iowa State Univ. Press. Ames Iowa, USA, ppp: 381.
34. Aasha, K. and S.R. Nair, 1992. Effect of varying light intensities on the growth and development of indoor foliage plants. South Indian Horti., 40(1): 64-66.
35. Yanping, F., Y. Rangcai and G. Zhihua, 1998. Effects of shading on the growth and photosynthetic characteristics in *Spathiphyllum palls*. Acta Hortic., 25: 270-273.
36. Gaurav, A.K., D.V.S. Raju, T. Janakiram, K. Swaroop, B. Singh, R. Jain and S. Gopalakrishnan, 2014. Microclimate modification under different shade levels and its effect on the growth of *Dracaena fragrans*. J. Ornamen. Plants, 17(1-2): 12-17.
37. Srikrishnah, S., S. Sutharsan, R. Thanusha and A. Paskaran, 2017. Effect of graded shade levels on the growth and qualities of *Dracaena sanderiana var.* 'Celes'. Res. J. Agri. For. Sci., 5(3): 1-4.
38. Barber J. and B. Andersson, 1992. Too much of a good thing: light can be bad for photosynthesis. Trends Biochem Sci., 17(2): 61-66.
39. Bangerth, F.C.J. and J. Gruber, 2000. Mutual interaction of Auxin and cytokinins in regulation correlative dominance. Plant Growth Reg., 32: 205-217.
40. Tegg, R.S. and P.A. Alane, 2004. A comparison of the performance and growth of a range of turf species under shade. Australian Exp. Agric., 44: 353-358.
41. El-Naggar, A.H.M. and Y.A.A. Ahmed, 2016. Effect of light intensity and NPK fertilization on growth of *Yucca rupicola*, L. J. Advan. Studies Agric. Biol. Environ. Sci., 3(1): 32-41.
42. Arancon, N.Q., S. Lee, C.A. Edwards and R. Atiyeh, 2003. Effect of humic acids derived from cattle, food and paper-waste vermicompost on growth of green house plants. Pedobiologia, 47: 741-744.
43. Zhang, L., X.Y. Sun, Y. Tian and X.G. Gong, 2014. Biochar and humic acid amendments improve the quality of composted green waste as a growth medium for the ornamental plant *Calathea insignis*. Sci. Hort., 176: 70-78.
44. Nardi, S., D. Pizzeghello, A. Muscolo and A. Vianello, 2002. Physiological effects of humic substances on higher plants. Soil Biol. Biochem., 34(11): 1527-1536.
45. Piccolo, A., S. Nardi and G. Concheri, 1992. Structural characteristics of humic substances as regulated to nitrate uptake and growth regulation in plant systems, Soil Biol. Biochem., 24: 373-380.
46. Jackson, W.R., 1993. Humic, fulvic and microbial balance: Organic Soil Conditioning: An Agricultural Text and Reference Book, Jacks. Res. Cent., pp: 958.
47. Goss, J.A., 1973. Amino Acid Synthesis and Metabolism. In Physiology of Plants and their Cells. Pergamon Press, Inc., New York.
48. Sanchez-Sanchez, A., J. Sanchez-Andreu, M. Juarez, J. Jorda and D. Bermudez, 2002. Humic substances and amino acids improve effectiveness of chelate FeEDDHA in lemon trees. J. Plant Nutr., 25: 2433-2442.
49. Zervoudakis, G., S. George, K. George and K. Eleni, 2012. Influence of light intensity on growth and physiological characteristics of common sage (*Salvia officinalis* L.). Braz. Arch. Biol. and Technol., 55(1): 89-95.
50. Kramer, P.J. and T. Kozlowiski, 1979. Physiology of Wood Plants. New York: Academic Press, pp: 811.
51. Ibrahim, H.E., H.G.H. El-Fadaly and A.A.M. El-Naggar, 2016. Study on the response of statice plants (*Limonium sinuatum*, L.) to humic acid application. Alexandria Sci Exchange J., 37(3): 515-528.
52. Haghighi, M., M. Kafi and P. Fang, 2012. Photosynthetic activity and N metabolism of lettuce as affected by humic acid. Intl. J. Veget. Sci., 18: 182-189.
53. Reyes, T., T.A. Nell, J.E. Barrett and C.A. Conover, 1996. Irradiance level and fertilizer rate affect acclimatization of *Chamaedorea elegans* Mart. Hort. Sci., 31: 839-842.
54. Sul, J.H., J. Hong, J.E.Ko, C.H. Pak and B.H. Kwack, 1997. Effect of light intensity, uniconazole and gibberellin on leaf variegation of *Codiaeum variegatum* 'Yellow Jade' J. Korean Soc. Hort. Sci., 38: 278-282.

55. Mansour, H.A., M.M.M. Hussein and H.A. Ashour, 2012. Response of *Paspalum vaginatum* turfgrass grown under shade conditions to paclobutrazol and trinexapac-ethyl as plant growth retardants (PGRs). J. Hort. Sci. & Ornamen. Plant, 4(2): 134-147.
56. Zaghloul, S.M., F.E.M. El-Quesni and A.A.M. Mazhar, 2009. Influence of potassium humate on growth and chemical constituents of *Thuja orintalis* L. seedlings. Ozean J. App. Sci., 2: 73-78.
57. Youssef, A.S.M. and M.A. Mady, 2013. Influence of light intensity and benzyladenine on growth performance of *Aspidistra elatior* Blume plant. Res. J. Agri. & Biol. Sci., 9(5): 248-257.
58. Marinari, S., G. Masciandaro, B. Ceccanti and S. Grero, 2000. Influence of organic and mineral fertilizers on soil biology and physical properties. Bioresource Technology, 72: 9-17.
59. Appireddy, G.K., S. Saha, B.L. Mina, S. Kundu, G. Selvakumar and H. S. Gupta, 2008. Effect of organic manures and integrated nutrient management on yield potential of ball pepper (*Capsicum annuum*) varieties and on soil properties. Arch. Agron. Soil Sci., 24: 127-137.
60. Lobartini, J.C., G.A. Orioli and K.H. Tan, 1997. Characteristics of soil humic acid fractions separated by ultrafiltration, Commun. Soil Sci . and Plant Anal., 28: 787-796.
61. Aminifard, M.H., H. Aroiee, H. Nemati, M. Azizi and H.Z.E. Jaafar, 2012. Fulvic acid affects pepper antioxidant activity and fruit quality. Afr. J. Biotechnol., 11: 13179-13185.
62. Bakry A.B., M.Sh. Sadak and M.F. El-karamany, 2015. Effect of humic acid and sulfur on growth, some biochemical constituents, yield and yield attributes of flax grown under newly reclaimed sandy soils. ARPN J. Agri. and Biol. Sci., 10(7): 247-259.
63. Abedini, T., M. Pezhman and H. Abbas, 2015. Effect of organic fertilizer and foliar application of humic acid on some quantitative and qualitative yield of pot marigold. J. Nov. Appl. Sci., 4(10): 1100-1103.
64. Canellas, L.P., F.L. Olivares, N.O. Aguiar, D.L. Jones, A. Nebbioso, P. Mazzei and A. Piccolo, 2015. Humic and fulvic acids as biostimulants in horticulture. Sci. Hort., 196: 15-27.
65. Lewis, N. and E. Yamamoto, 1990. Lignin: Occurrence, Biogenesis and Biodegradation. Annu. Rev. of Plant Physiol. Plant Mol. Biol., 41: 455-496.