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Effect of Some Biofertilizers on Growth and Chemical Composition of *Chamaedorea elegans* Mart. Seedlings

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Abstract: This study was carried out, under greenhouse condition, at the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, during two seasons of 2008 and 2009. The aim of this study was to investigate the effect of some bio-fertilizers on growth and chemical composition of *Chamaedorea elegans* Mart. seedlings (average height of 20cm,1.0 cm stem diameter)were transplanted, on 1st March in both seasons, in a mixture of sand + clay + peatmoss at (1: 1: 1 V / V/ V) in 40-cm diameter plastic pots.After 21 days the seedlings were treated with algae (Hemogreen) at 5 g /pot, Phosphorene at 5g / pot and Nitrobactrene at 5g / pot or mycorrhiza at 5 or 10 g/pot. All plants were fertilized with NPK (1: 1: 1) at 5 g/pot at monthly intervals using ammonium nitrate 33%N, calcium super phosphate 15.5% P_2O_5 and potassium sulphate 48% K_2O, as sources for N, P and K, respectively. The plants were grown under greenhouse condition for 8 months. The results revealed that mycorrhiza, Hemogreen and Nitrobactrene significantly increased plant height, while Phosphorene and mycorrhiza gave the thickest stem diameter. Phosphorene encouraged the formation of leaves, giving the heaviest leaves. Applying mycorrhiza and algae extract (Hemogreen) treatments resulted in the longest roots. All treatments of biofertilizers significantly increased the fresh and dry weights of roots, compared to the control. Applying mycorrhiza at high level (10 g/ pot) gave the heaviest fresh weight of roots. The results indicated that the low concentration of mycorrhiza was the most effective treatment on increasing chlorophylls a and b contents in addition to nitrogen percentage in leaves.

Key words: *Chamaedorea elegans* · Phosphorene · Mycorrhizae · Hemogreen · Nitrobactrene

INTRODUCTION

Chamaedorea elegans Mart (Parlor Palm) has also been listed as *Collinia elegans*. It is native to Mexico and Guatemala; it grows to a height of 2-3m. It is grown primarily in greenhouses, or under shade houses. It blooms yearly in late winter to early spring. The very small yellow flowers are followed by small black fruit. *Chamaedorea elegans* plants need full shade to low interior lighting with a well-drained evenly moist soil. This palm is one of the best indoor plants tolerating low light levels and growing very slowly. This pale green, single-stemmed, small palm is most effective when potted three or more to a container, it can also be an effective accent plant in a small scale garden. It is excellent when used for a house plant as an excellent container plant with a stately appearance or outdoors in shade or low light, but it grows best with bright indirect light areas. It prefers moderate to high humidity, but will grow in low to average home humidity making them the most common indoor palm used in mild climates.

Nowadays, biofertilization became the most important practice required to substitute chemical fertilizers for production of many ornamental plants. Mycorrhizal fungi (vesicular arbuscular mycorrhizae, VAM) are known to infect the roots of a wide range of woody temperate and tropical plants. It affects growth of most plant species as they increase and enhance uptake of phosphorus and other plant nutrients by root system, biological control of root pathogens and drought resistance [1]. VAM fungi promotes absorption of minerals especially P by the plants, stimulates growth and enhances the resistance of plant to environmental stresses and soil diseases. Yet little is known about their relationships with palms. Since most species of mycorrhiza have very wide host ranges and palms would appear to be suitable hosts,

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further studies in this area may show that mycorrhiza are very important to palms. Algae (seaweed extract) is considered as an organic biostimulant for obtaining healthy root system and help in rapid root development.

Mohammad and Prasad [2] mentioned that phosphate solubilizing bio- fertilizer (*Bacillus megaterium)* increased *Eucalyptus camaldulensis* seedlings' growth compared with unfertilized seedlings. Stalin *et al.* [3] stated that soil inoculation with VA mycorrhiza and phosphobacterium led to best germination, seedling growth and nutrient uptake in silver oak (*Grevillea robusta).* Sekar *et al.* [4] on *Syzygium sp,* stated that VA- mycorrhizal fungi significantly enhanced the total dry weight and shoot: root ratio compared with control (uninoculated) seedlings. Venkatech *et al.* [5] on *Pongamia pinnatta* seedlings, reported that treating plants with VAM enhanced shoot and root length besides to the total dry matter. Rajendran *and* Devaraj [6] on *Casuarina equisetifolia*, reported that phosphobacterium and VAM increased seedling length and biomass significantly compared with the control plants. Dubey and Ginwad [7] reported that mycorrhiza increased the absorption area of the roots and provided host plants with nutrient (N, P, K, Ca, Na, Zn and Cu).

Our goal is to reduce chemical inputs for environmental and health reasons through studying the effects of biofertilizers on growth of palm plants to provide growers with useful information about bio-nutrition program of these plants.

MATERIALS AND METHODS

This study was carried out at the Experimental Nursery of Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza during two successive seasons 2008 and 2009. The objective of this study was to investigate the effect of biofertilizers (algae extract (Hemogreen), bacteria (Phosphorene and Nitrobactrene) and mycorrhiza) on growth and chemical constituents of *Chamaedorea* palm seedlings. Uniformly seedlings of *Chamaedorea* palm (average height of 20cm, 1.0 cm stem diameter) were used in this study.

Biofertilizers were obtained from the centre of biofertilization, Faculty of Agriculture, Ain Shams University, Egypt.

On 1st March in both seasons, the seedlings were planted in 40-cm diameter plastic pots, filled with a mixture of sand + clay + peat moss at (1: 1: 1 V / V/ V). The physical and chemical analyses of soil are presented in Table 1. After 21 days from transplanting, seedlings were treated with algae (Hemogreen) at 5 g /pot, Phosphorene at 5g / pot and Nitrobactrene at 5g / pot or mycorrhiza at 5 or 10 g/pot. All plants were fertilized with NPK (1: 1: 1) at 5 g/pot at monthly intervals using ammonium nitrate 33%N, calcium super phosphate 15.5% P_2O_5 and potassium sulphate 48% K_2O, as sources for N, P and K, respectively. The plants were grown under greenhouse condition for 8 months.

At the end of each season, the following data were recorded: plant height (cm), stem diameter (3 cm above soil surface), number of leaves and leaflets / plant, length of leaves(cm), fresh and dry weights of leaves and roots (g/plant) and root length (cm). The recorded data on vegetative growth characteristics were statistically analyzed [8]. Treatment means were compared by using LSD at 5% level of probability. Also, chlorophylls (a and b) and caroteniods contents (mg/g FW) in leaves [9], total carbohydrates content in leaves and roots (%DW) [10] and nitrogen, phosphorus and potassium contents in leaves and roots (%DW) [11].

RESULTS AND DISCUSSION

Vegetative Growth

Plant Height: The response of height of *Chameadorea elegans* seedlings to the application of biofertilizers is shown in Table 2. The obtained data indicated that there were significant differences, in all treatments, in comparison with the control. In first season, algae (Hemogreen) treatment increased the plant height from 52.67 to 76.33 cm. Supplying the *Chameadorea elegans* seedlings with Nitrobactrene increased the plant height to 64.33 cm. Also, mycorrhiza in both concentrations increased the plant height to 62.00 and 61.33 cm, respectively. In the second season, mycorrhiza at 5 g/pot

Table1: Mechanical and chemical analysis of the used soil

Clay	Sand	Silt	E.C	pH	W.H.C
41.45	34.03	25.25	1.22	7.2	34.56
HCO_3 Meq/l	SO_4 Meq/l	O.M %	N%	P%	K%
1.53	56	1.35	0.77	0.25	0.35

Table 2: Effect of biofertilizers on plant height, stem diameter, number of leaves of *Chameadorea elegans* Mart seedling

	Plant height (cm)		Stem diameter (mm)		number of leaves	
Biofertilizers	2008	2009	2008	2009	2008	2009
Control	52.67	52.33	12.62	12.22	7.67	7.00
Hemogreen	76.33	73.00	14.13	14.14	8.67	11.00
Phosphorene	53.67	52.33	16.40	16.15	11.67	10.33
Nitrobactrene	64.33	59.67	13.45	13.53	9.33	10.00
Mycorrhiza 1	62.00	73.33	14.50	14.78	10.33	13.33
Mycorrhiza 2	61.33	65.33	15.74	15.15	8.33	8.67
LSD at 5 %	11.01	13.27	2.07	2.61	1.26	2.18

Table 3: Effect of biofertilizers on number of leaflets; leaf length; Fresh and dry weights of leaves of *Chameadorea elegans* seedling

	Number of leaflets		Leaf length (cm)		Fresh weight of leaves (g)		Dry weight of leaves (g)	
Biofertilizers	2008	2009	2008	2009	2008	2009	2008	2009
Control	21.67	20.67	33.00	35.33	40.41	42.34	12.02	13.08
Hemogreen	22.67	23.33	59.33	62.00	56.78	55.06	20.80	16.55
Phosphorene	21.33	22.67	45.33	47.67	71.90	76.45	24.31	26.65
Nitrobactrene	22.33	22.67	48.67	47.67	50.60	53.42	20.88	19.73
Mycorrhiza 1	24.33	24.33	47.33	47.00	59.65	63.44	17.67	19.67
Mycorrhiza 2	23.00	24.33	44.67	46.00	64.70	66.32	23.24	23.00
LSD at 5 %	1.57	2.29	12.12	9.98	7.65	6.42	2.67	3.45

gave the tallest seedlings (73.33 cm). There is no significant difference between Hemogreen and mycorrhizae. It can be concluded that Hemogreen, Nitrobactrene and mycorrhiza were the most effective biofertilizers in increasing the height of *Chamaedorea* seedlings. These results are in harmony with Asghari *et al.* [12] who found that seedlings height was increased significantly with inoculation with different strains of mycorrhizal fungi.

Stem Diameter: The response of stem diameter of *Chameadorea elegans* seedlings to the different treatments of biofertilizers is shown in Table 2. The data showed differences between the stem thicknesses in the different treatments and control plants, Phosphorene treatment significantly increased the plant stem diameter in both seasons to 16.40, 16.15 mm compared to 12.62 and 12.22 mm for the control, respectively. Also, supplying *Chameadorea elegans* seedling with mycorrhiza at both concentrations increased the stem diameter of seedling in both seasons. Regarding the effect of Hemogreen on the stem diameter of plants, there was no significant increase in stem diameters of plants compared to the control. It can be concluded that Phosphorene and mycorrhizal fungi were the most effective on increasing the stem diameter of *Chameadorea elegans* seedling. These results are in line with Stalin *et al.* [3] on *Grevillea robusta* and James *et al.* [13] on senna, demonstrated that inoculation with mycorrhizal fungi increased stem diameter

Number of Leaves: As shown in Table 2, in both seasons all treatments of biofertilizers (except mycorrhiza at high level) significantly increased the number of leaves as compared with the control. In the first season, applying Phosphorene treatment increased the number of leaves, which reached to 11.67 compared with 7.67 leaves/plants resulted from the control. Using mycorrhizal fungi increased the number of leaves at low concentration in both seasons; other biofertilizers treatments gave intermediate effect. Generally, it can be concluded that treating *Chamaedorea* seedlings with biofertilizers significantly increased the formation of leaves which may be due to the increase in nitrogen content in the soil as a result of N fixation and phosphorus from phosphate dissolving bacteria and mycorrhiza as well as growth promoting substances such as indole acetic acid and gibberellins produced by all organisms used. These results are in agreement with results obtained by James [13] on senna.

Number of Leaflets: As shown in Table 3, the data indicated that mycorrhiza at both concentrations in both seasons increased the number of leaflets. Also supplying *Chameadorea elegans* seedling with algae extract

Table 4: Effect of biofertilizers on root length, fresh and dry weights of roots of *Chameadorea elegans* seedling

	Root length (cm)		Fresh weight of roots (g)		Dry weight of roots (g)	
Biofertilizers	2008	2009	2008	2009	2008	2009
Control	42.30	45.64	23.56	26.73	6.93	8.43
Hemogreen	53.80	50.64	40.44	47.80	14.37	16.20
Phosphorene	45.87	51.70	38.95	44.97	11.88	13.64
Nitrobactrene	46.44	47.66	38.00	40.06	11.52	13.25
Mycorrhiza 1	63.66	66.78	44.20	39.76	13.60	11.02
Mycorrhiza 2	62.43	63.55	51.12	51.64	14.87	15.88
LSD at 5 %	5.66	4.24	4.60	5.53	2.98	2.63

(Hemogreen) significantly increased the number of leaflets in the second season from 20.67 to 23.33 leaflets. There was no significant difference between Hemogreen and mycorrhiza. Other biofertilization treatments gave intermediate effect.

Leaf Length: As shown in Table 3, data indicated that all treatments of biofertilizers significantly increased leaves length. In both seasons, applying Hemogreen gave the highest increment in leaves length, which recorded 59.33 in the first season and 62.00 in the second one, compared to control and other treatments. Next came Nitrobactrene, which increased the leaves length to 48.67cm in first season and to 47.67cm in the second one. In first season it was found that the application of both Phosphorene and Nitrobactrene had no significant effect, but in the second season all treatments significantly increased the leaves length, compared to control recording 33cm and 35.33 cm in first and second seasons, respectively.

Fresh and Dry Weights of Leaves: Table 3 indicated that all treatments increased the fresh and dry weights of leaves of *Chameadorea elegans* seedling. In both seasons, Phosphorene and the high level of mycorrhiza were the most effective treatments in this concern. Regarding the effect of Hemogreen, it was found that this treatment as well as Nitrobactrene was the least effective on fresh and dry weights of seedlings, compared with the other treatments, but they significantly increased it as compared to the control. It can be concluded that using Phosphorene and mycorrhiza at high level were the most effective in increasing fresh and dry weights of *Chamaedorea* seedlings.These results are in harmony with those mentioned by Asghari *et al.* [12] and James *et al.* [13] on senna, they found increased weights with inoculation with different strains of mycorrhizal fungi.

Root Length: As shown in Table 4, the data indicated that all treatments of biofertilizers significantly increased root length. In both seasons, applying mycorrhiza and algae extract (Hemogreen) resulted in the longest roots, which reached to 63.66 and 66.78 cm with the application of mycorrhiza at the low level, compared with 42.30 and 45.64 cm root length resulted from the control plants in both seasons, respectively. Venkatech *et al.* [5] on *Pongamia pinnatta* obtained similar results.

Fresh and Dry Weights of Roots: Data in Table 4 indicated that all treatments of biofertilizers significantly increased the fresh and dry weights of roots as compared to the control. In both seasons, applying mycorrhiza treatment at high level gave the heaviest fresh weight of roots. In the first season, the heaviest dry weight of roots was recorded with mycorrhiza treatment at the high level, but in the second season it resulted with the treatment of algae. Generally, it can be included that biofertilizers significantly increased the formation of roots which may be due to the increase in nitrogen content in the soil as a result of N fixation and phosphorus from phosphate dissolving bacteria as well as growth promoting substances such as indole acetic acid and gibberellins produced by all organisms used. These results are in agreement with Sekar *et al.* [4] on *Syzygium montanum,* Venkatech *et al.* [5] on *Pongamia pinnatta*

Chemical Constituants

Pigments Content: Data in Table 5 showed the effect of biofertilization on the contents of chlorophyll a; b and carotenoids in leaves of *Chameadorea elegans*. The results indicated that in both seasons, the low concentration of mycorrhiza and Nitrobactrene were the most effective treatments in increasing the content of Chl.a. It is clear from data that the highest content of chlorophyll b was also recorded when the seedlings were inoculated with mycorrhizal fungi at the low level. Regarding the effect of biofertilization on the content of caroteniods, the obtained data indicated that in both seasons, the highest values of caroteniods in the leaves of *Chameadorea elegans* was recorded with Hemogreen treatment.

Table 5: Effect of biofertilizers on chlorophylls a; b and carotenoids in leaves of *Chameadorea elegans* seedling

	Pigments content mg/ g FW					
	First season			Second season		
Biofertilizers	Chl. a	Chl. b	Carotene	Chl. a	Chl. b	Carotenoids
Control	0.270	0.392	0,241	0.304	0.367	0.322
Hemogreen	1.467	0.560	0.438	1.782	0.742	0.546
Phosphorene	0.672	0.425	0.339	0.428	0.494	0.387
Nitrobactrene	1.456	0.814	0.435	1.242	0.530	0.533
Mycorrhiza 1	2.042	1.135	0.425	2.580	1.692	0.509
Mycorrhiza 2	1.277	0.973	0.424	1.565	0.876	0.533

Table 6: Effect of biofertilizers on total carbohydrates in leaves and roots of *Chameadorea elegans* seedling

	Total carbohydrates content % DW			
	First season		Second season	
Biofertilizers	Leaves	Roots	Leaves	Roots
Control	12.36	27.11	14.15	19.16
Hemogreen	27.17	30.44	19.22	31.12
Phosphorene	26.17	29.11	24.11	27.47
Nitrobactrene	23.11	33.19	26.18	30.12
Mycorrhiza 1	30.21	36.20	24.45	38.00
Mycorrhiza 2	35.22	33.81	29.18	33.25

Table 7: Effect of biofertilizers on Nitrogen; Phosphorus and Potassium contents in leaves and roots of *Chameadorea elegans* seedling

	Nitrogen content (% DW)			
	First season		Second season	
Biofertilizers	Leaves	Roots	Leaves	Roots
Control	1.42	1.31	1.70	1.10
Hemogreen	1.90	2.40	2.00	2.50
Phosphorene	1.42	2.23	1.92	2.30
Nitrobtrene	2.02	3.20	2.90	3.31
Mycorrhiza1	2.50	3.30	2.80	3.60
Mycorrhiza2	2.00	3.00	2.50	3.00
Phosphorus content (% DW)				
Control	0.24	0.20	0.19	0.22
Hemogreen	0.30	0.48	0.40	0.34
Phosphorene	0.38	0.30	0.33	0.32
Nitrobtrene	0.22	0.36	0.38	0.26
Mycorrhiza1	0.48	0.41	0.39	0.39
Mycorrhiza2	0.44	0.46	0.35	0.37
Potassium content (% DW)				
Control	0.88	0.67	1.02	0.97
Hemogreen	2.24	2.18	2.02	2.21
Phosphorene	1.76	1.28	1.27	1.19
Nitrobtrene	2.81	1.27	2.44	1.18
Mycorrhiza1	2.25	2.67	2.56	2.80
Mycorrhiza2	2.57	2.62	2.18	2.20

Total Carbohydrates Content (%DW): Data on the effect of biofertilizers treatments on total carbohydrates in leaves and roots of *Chameadorea elegans* are arranged in Table 6. All treatments increased the content of carbohydrates in the leaves in both season, it is obvious that treating seedlings with mycorrhiza markedly increased the total carbohydrates content in leaves comparing with control and other treatments. Also,

Hemogreen treatment markedly increased the carbohydrates content in leaves. As for roots, in both seasons, treating seedlings with mycorrhiza increased the total carbohydrates content in roots to maximum values. In conclusion, treating the *Chameadorea elegans* with mycorrhiza, Hemogreen, Nitrobactrene and Phosphorene were the effective on increasing the accumulation rate of carbohydrates in leaves and roots. These results are in agreement with results of previous studies [14, 15].

N, P and K Contents: The response of N,P and K contents in the leaves and roots of *Chameadorea elegans* seedlings to the different treatments of biofertilization are presented in Table 7.The results show that treating the seedlings with mycorrhizal fungi by low concentration (5 cm/plant) increased the content of nitrogen in the leaves and roots to the highest values in both seasons. Similar results were reported by Koreish *et al*. [16] who found that treating plants with VAM treatment increased N and P uptake compared with untreated plants. The response of phosphorus content in leaves and roots to the different types of biofertilizers treatments revealed that plants receiving different treatments (except Nitrobactrene) trended to accumulate more phosphorus in leaves as well as roots more than the control plants. Mycorrhiza and Hemogreeen greatly increased the phosphorus content in leaves and roots compared to other treatments and the control. As for the effect of biofertilizers treatments on the content of potassium, the obtained results indicated that in both seasons, the highest K content in leaves was recorded with the application of Nitrobactrene and mycorrhiza (2.81, 2.57% in the first season and 2.44and 2.56in the second one, respectively) giving the highest values, comparing with control (0.88 and 1.02% DW in first and second seasons, respectively).Whereas, the other treatments gave an intermediate effect in this respect. The content of potassium content in roots indicated that in both seasons, the highest K content was recorded with mycorrhiza and Hemogreen treatments. Dubey and Ginwal [7] obtained similar results.

CONCLUSION

The obtained results revealed that mycorrhiza at low level (5 g/40-cm diameter plastic pot) and algae significantly enhanced *Chamaedorea* seedling growth and increased the contents of chlorophylls a; b and nitrogen content in leaves.Phosphorene encouraged the formation of leaves. All treatments of biofertilizers significantly increased the fresh and dry weights of roots.

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