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Influence of light regimes and growing media fortified with empty fruit bunch waste on growth of syngonium (*Syngonium podophyllum*)

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Abstract
The effect of different light regimes and growing media fortified with oil palm mill waste on growth and quality of syngonium (*Syngonium podophyllum*) was studied at Dr. YSRHU-COH, Venkataramannagudem, during the year 2023. The experiment was conducted at four varied locations having different light levels and four compositions of growing media in factorial concept. Among the growth parameters studied plant height was found to differ significantly at all growth stages due to light regimes, media composition and their interactions. Syngonium plants grown inside the room recorded the highest plant height followed by those grown on staircase. The lowest plant height was recorded under coconut tree shade. Among different growing media, the media comprising of red soil: empty fruit bunch waste (1:2) recorded maximum plant height followed by red soil: empty fruit bunch waste (1:1). The lowest plant height was observed in red soil. With respect to the effect of interactions, the highest plant height was registered by the combination of inside the room + red soil: empty fruit bunch waste (1:2) followed by staircase + red soil: empty fruit bunch waste (1:2). The lowest plant height was observed in plants grown under coconut tree shade + red soil. Observations on other vegetative parameters *viz.*, plant spread, number of leaves, leaf length, leaf width, leaf area, petiole length, petiole girth followed similar trend.

Keywords: Syngonium, light intensity, growing media

Introduction
Landscaping has become an important component to beautify the surroundings for improving mental and physical health of people. According to Thomas (2014) [13] it was revealed that indoor air contains 12 times more pollution than outdoor air due to paints, carpets, furnishing and microbial growth in the surroundings. The demand for indoor plants with air purifying properties is on increase, during recent years posterior to Covid-19 pandemic. Among the wide range of foliage plants, *Syngonium podophyllum*, is recognized as attractive and hardy plant adaptable to many climatic conditions. It is commonly called as arrowhead. Syngoniums are herbaceous evergreen ornamental foliage plants belonging to the family *Araceae* and native of Mexico. The plant has a wide range of utility as indoor potted plants, table tops, terrariums, and in vertical frames.

The main aspect considered to be affecting plant growth and quality is light intensity. Light intensity, received by plant is important for proper plant growth of indoor plants. Quality of light and its wavelength is an important aspect for photosynthesis and growth. Chlorophyll synthesis is also affected by the light intensity. Modification in light not only affects plant morphology and plant physiology but also has the most important influence on production.

Under local horticultural conditions palm oil processing industry generates a variety of mill residue one of them is empty fruit bunch waste (EFB) fibre. For instance, oil palm waste is suitable as raw material for composting to reduce the volume and recycle the nutrients. All the waste products are good source of plant nutrients like N, P, K, Ca and Mg (Vakilli *et al*., 2015) [14]. The physicochemical and biological properties of a growing medium will affect plant growth and directly influence roots growth. Furthermore, the planting medium must be porous and well drained to permit free roots penetration, secure anchorage, and have sufficient nutrients to support crop growth (Khan *et al*., 2006) [4].

Material and Methods
The present experiment was laid out in a factorial completely randomized block design (FCRD) with two factors at Department of Floriculture and Landscape Architecture, Dr.

YSRHU - College of Horticulture, Venkataramannagudem from February, 2023 to April, 2023. The four different light regimes (corridor, staircase, inside the room, coconut tree shade) are selected as factor I and four different ratios of growing media (red soil: EFB (1:1), red soil: EFB (1:2), red soil: EFB (2:1) and red soil) as factor II with two replications. The prepared media was filled into polybags of 12 inches and plants of one month age are transplanted in polybags on February 1st, 2023. Total plants per replication were sixteen. Observations for plant height, plant spread, number of leaves, leaf length, leaf width, leaf area, petiole length and petiole girth were recorded at 30, 45, 60, 75 and 90 DAP.

Results and Discussion Plant height (cm)

A perusal of data (Table 1 and Figure 1) revealed that the influence of light regimes, growing media and their interactions on plant height was found significant at 90 DAP.

Syngonium plants grown inside the room recorded the highest plant height (37.95 cm) followed by those grown on staircase (35.25 cm). The lowest plant height (28.78 cm) was recorded under coconut tree shade. Among different growing media, the media comprising of red soil: empty fruit bunch waste (1:2) recorded maximum plant height (40.56 cm) followed by red soil: empty fruit bunch waste (1:1) (35.95 cm). The lowest plant height (25.03 cm) was observed in red soil.

With respect to the effect of interactions, the highest plant height was registered by the combination of inside the room + red soil: empty fruit bunch waste (1:2) (44.80 cm) followed by staircase + red soil: empty fruit bunch waste (1:2) (41.60 cm). The lowest plant height (21.30 cm) was observed in plants grown under coconut tree shade + red soil.

As evident from the above data, plants grown inside the room were taller among the different locations with various light regimes. The light intensity inside the room was relatively less compared to other locations *i.e.*, corridor, stair case and coconut shade. Syngonium plants grown under low light intensity recorded maximum plant height. It might be due to better auxin transport in plants under low light condition as reported by Vinod *et al*. (2015) [15]. Aasha (1986) [1] reported that low light intensity in foliage plant *Aglaonema* resulted in a significant increase in plant height.

Among the growing media, the one containing red soil: empty fruit bunch waste (EFB) (1:2) was found to record maximum plant height as compared to red soil: EFB (1:1), red soil: EFB (2:1) and red soil alone. Several reports summarized by Siregar *et al*. (2017) [11] indicated that soil phosphate availability was enhanced by addition of organic matter or compost to the soil. Thus, red soil: EFB compost (1:2) might had increased height of plant due to a higher proportion of organic matter.

Plant spread (cm2)

The plant spread varied significantly at 90 DAP under the influence of light regimes, growing media and their interactions (Table 1).

Syngonium plants grown inside the room recorded the highest plant spread (1127.23 cm2) followed by those grown on staircase (1054.38 cm2). The lowest plant spread was recorded under coconut tree shade (914.28 cm2). Maximum plant spread among the growing media, was recorded in the medium comprising of red soil: empty fruit bunch waste (1:2) (1235.34 cm2) followed by red soil: empty fruit bunch waste (1:1) (1074.07 cm2). The lowest plant spread was recorded in red soil (802.23 cm2).

Among the interactions, the highest plant spread was recorded by the combination of inside the room + red soil: empty fruit bunch waste (1:2) (1347.92 cm2) followed by staircase + red soil: empty fruit bunch waste (1:2) (1271.47 cm2). The lowest plant spread was observed in plants grown under coconut tree shade + red soil (709.66 cm2).

The above results indicated that plant spread was maximum inside the room among the different locations with various light regimes. Syngonium plants displayed consistent increase in growth with decreasing light level and inhibition of growth under open field conditions as observed by Parminder *et al*. (2014) [5]. The findings in the present study are also in consonance with this.

The potting media comprising of red soil: empty fruit bunch waste (EFB) (1:2) was found to record maximum plant spread, which could be due to adequate amount of nutrients present in that medium. This might be due to versatile properties of plant-based compost containing adequate quantities of N, P, K and several micronutrients essential for plant growth besides, organic matter. These results are in close conformity with the findings of Preeti *et al.* (2018) [7].

Number of leaves

Significant differences were observed in number of leaves (90 DAP) under the influence of different light regimes, growing media and their interactions as presented in Table 1 and Figure 2.

Syngonium plants grown inside the room have developed a greater number of leaves (21.53) followed by staircase (21.41). Less number of leaves were observed in plants grown under coconut tree shade (21.16). The influence of different growing media revealed that the medium comprising of red soil: empty fruit bunch waste (1:2) had greater number of leaves (21.58) followed by red soil: empty fruit bunch waste (1:2) (21.42). Least number of leaves were observed in red soil (21.10).

The interactions between light regimes and growing media revealed that more number of leaves were registered by the combination of inside the room + red soil: empty fruit bunch waste (1:2) (21.80) followed by plants grown on stair case + red soil: empty fruit bunch waste (1:2) (21.65). Less number of leaves were observed in plants grown under coconut tree shade + red soil (20.94).

Leaf length (cm)

The data pertaining to leaf length recorded at 90 DAP revealed significant differences among the light regimes, growing media and their interactions as presented in Table 2.

The observations indicated that syngonium plants grown inside the room have developed maximum leaf length of 19.95 cm followed by those grown on staircase (19.33 cm). Minimum leaf length was observed under coconut tree shade (18.30 cm). Red soil: empty fruit bunch waste (1:2) has maximum leaf length of 20.05 cm followed by red soil: empty fruit bunch waste (1:2) (19.45 cm). Minimum leaf length was observed in red soil (18.18 cm).

With respect to the interactions, maximum leaf length was registered by the combination of inside the room + red soil: empty fruit bunch waste (1:2) (20.90 cm) followed by staircase + red soil: empty fruit bunch waste (1:2) (20.30 cm) and inside the room + red soil: empty fruit bunch waste (1:1) (20.30 cm). Minimum leaf length was observed in plants

grown under coconut tree shade + red soil (17.20 cm).

Leaf width (cm)

The data presented in Table 2 revealed that leaf width (90DAP) exhibited significant differences under the influence of different light regimes, growing media and their interactions. Among different light regimes, syngonium plants grown inside the room have developed maximum leaf width (12.15 cm) followed by staircase (11.24 cm). Minimum leaf width was observed under coconut tree shade (10.23 cm). The medium containing red soil: empty fruit bunch waste (EFB) (1:2) has maximum leaf width of 12.20 cm followed by red soil: EFB (1:2) (11.39 cm). Minimum leaf width was observed in red soil (10.08 cm).

Maximum leaf width was recorded inside the room + red soil: empty fruit bunch waste (EFB) (1:2) (13.20 cm) followed by inside the room + red soil: EFB (1:1) (12.70 cm). Minimum leaf width was observed in plants grown under coconut tree shade + red soil: empty fruit bunch waste (2:1) (9.60 cm).

Leaf area (cm2)

A perusal of data regarding leaf area was recorded at 90 DAP exhibited significant differences among the light regimes, growing media and their interactions as presented in Table 2 and Figure 3.

The data revealed that plants grown inside the room have developed maximum leaf area cm2) followed by plants placed on staircase (1471.05 cm2). Minimum leaf area was observed under coconut tree shade (1466.36 cm2). On the other hand, among the growing media, maximum leaf area was attained in the medium comprising of red soil: empty fruit bunch waste (1:2) of 1475.55 cm2 followed by those grown in red soil: empty fruit bunch waste (1:2) (1471.97 cm2). Minimum leaf area was observed in red soil (1464.58 cm2).

As comprehensible from the above data maximum leaf area was recorded by the combination of inside the room + red soil: empty fruit bunch waste (1:2) (1480.80 cm2) followed by staircase + red soil: empty fruit bunch waste (1:2) (1475.40 cm2). Minimum leaf area was observed in plants grown under coconut tree shade + red soil (1460.30 cm2). These interaction effects closely followed the order of merit as recorded in individual factor main effects in the present study.

The above data indicated that maximum number of leaves, leaf length, leaf width and leaf area were recorded in syngonium plants grown inside room. The light intensity inside room was relatively less compared to other locations *i.e.*, corridor, stair case and coconut shade. As low light, low temperature, high humidity could have provided favourable conditions for mitotic activity, there might be formation of more activity of cell division and cell enlargement increasing leaf production and size of leaf, leaf area of plant. According to findings of Sharma *et al.* (1992) [9] decrease in light intensity (2000-3000 lux) resulted in an increase in number of leaves in *Aglaonema costatum*. Similar results on leaf size were obtained by Swetha *et al.* (2014) [12]. Patterson (1980) [6] recorded similar effect on growth by shading in cogon grass (*Imperata cylindrica*). It was found that leaf area increased with decrease in light intensity as was also observed in the present study.

The growing media, containing red soil: empty fruit bunch waste (EFB) (1:2) recorded maximum number of leaves, leaf length, leaf width and leaf area as compared to red soil: EFB (1:1), red soil: EFB (2:1) and red soil alone. Empty fruit bunch waste compost could have allowed maximum air and nutrients to reach the root system eventually resulting in a better and vigorous growth of syngonium plants. Sahni *et al.* (2008) [8] reported that plant-based compost composed of higher total pore space and high organic matter supporting production of more number of leaves. Organic matter has ability to store and release plant nutrients for a prolonged period of time which would be responsible for an increased leaf area.

Petiole length (cm)

The observations on petiole length recorded at 90 DAP revealed significant differences under the influence of light regimes, growing media and their interactions (Table 3).

The plants grown inside the room have recorded maximum petiole length (18.28 cm) followed by those on staircase (17.30 cm). Minimum petiole length was observed in syngonium plants grown under coconut tree shade (15.00 cm).

The medium comprising of red soil: empty fruit bunch waste (1:2) recorded maximum petiole length of 18.10 cm followed by red soil: empty fruit bunch waste (1:1) (17.50 cm). Minimum petiole length was observed in red soil alone (14.88 cm).

With respect to the treatment combinations, maximum petiole length was registered inside the room + red soil: empty fruit bunch waste (1:2) (19.80 cm) followed by those grown on staircase + red soil: empty fruit bunch waste (1:1) 19.10 cm. Minimum petiole length was observed in plants grown under coconut tree shade + red soil (12.10 cm).

Petiole girth (mm)

The data pertaining to petiole girth was recorded at 90 DAP exhibited significant differences under the influence of various light regimes, growing media and their interactions (Table 3).

Syngonium plants grown inside the room have developed maximum petiole girth (3.78 mm) followed by those placed on staircase (3.60 mm). Minimum petiole girth was observed under coconut tree shade (3.33 mm). The growing medium comprising of red soil: empty fruit bunch waste (1:2) had maximum petiole girth (4.05 mm) followed by those grown in red soil: empty fruit bunch waste (1:2) (3.73 mm). Minimum petiole girth was observed in red soil (3.08 mm).

Among the interactions, maximum petiole girth was registered by the combination of inside the room + red soil: empty fruit bunch waste (1:2) (4.30 mm) followed by corridor + red soil: empty fruit bunch waste (1:2) (4.20 mm). Minimum petiole girth was observed in plants grown under coconut tree shade + red soil (2.80 mm).

From the above-mentioned data, maximum petiole length and girth were recorded inside room, among various light regimes or locations. The maximum petiole length and girth might be due to increase in cell number, as well as cell elongation under low light conditions (inside the room) compared to other locations *i.e.*, corridor, stair case and coconut shade. The reasons are in agreement with Gaurav *et al.* (2015) [3] who stated that the petiole length was at the highest under low light conditions. Chowdhuri *et al.* (2021) [2] reported that maximum petiole girth in Asparagus was found under low light intensity which is in agreement with the findings of the present study.

Maximum values of petiole length and girth were observed in potting mixture, containing red soil: empty fruit bunch waste

(EFB) (1:2) compared to red soil: EFB (1:1), red soil: EFB (2:1) and red soil alone. Singh and Nair (2003) [10] stated that growing media consisting of plant-based compost resulted in maximum petiole length and petiole girth of indoor plants.

Table 1: Plant height (cm), plant spread (cm2) and number of leaves as influenced by light regime, growing media and their interactions in syngonium.

Light Regime (L)	Plant height (cm)					Plant spread (cm2)					Number of leaves				
	Growing Media (G)														
	G1	G2	G3	G4	Mean of G	G1	G2	G3	G4	Mean of G	G1	G2	G3	G4	Mean of G
Corridor (L1)	34.60	38.93	28.40	23.10	31.26	1,006.80	1,183.30	876.93	717.76	946.20	21.35	21.50	21.20	21.09	21.29
Staircase (L2)	38.20	41.60	33.10	28.10	35.25	1,111.71	1,271.47	978.17	856.16	1,054.38	21.51	21.65	21.33	21.14	21.41
Inside the room (L3)	40.50	44.80	38.90	27.60	37.95	1,190.13	1,347.92	1,045.51	925.34	1,127.23	21.62	21.80	21.45	21.23	21.53
Coconut tree shade (L4)	30.50	36.90	26.40	21.30	28.78	987.65	1,138.66	821.14	709.66	914.28	21.21	21.38	21.09	20.94	21.16
Mean of L	35.95	40.56	31.70	25.03	33.31	1,074.07	1,235.34	930.44	802.23	1010.52	21.42	21.58	21.27	21.10	21.34
Factors	SE(m)		CD at 5%			SE(m)		CD at 5%			SE(m)		CD at 5%		
Light regime (L)	0.19		0.57			2.48		7.51			0.02		0.07		
Growing media (G)	0.19		0.57			2.48		7.51			0.02		0.07		
L x G	0.38		1.14			4.97		15.03			0.05		0.15		

Table 2: Leaf length (cm), Leaf width (cm) and Leaf area (cm2) as influenced by light regime, growing media and their interactions in syngonium.

Light Regime (L)	Leaf length (cm)					Leaf width (cm)					Leaf area (cm2)				
	Growing Media (G)														
	G1	G2	G3	G4	Mean of G	G1	G2	G3	G4	Mean of G	G1	G2	G3	G4	Mean of G
Corridor (L1)	19.30	19.80	18.70	18.20	19.00	10.90	11.90	10.10	9.80	10.68	1,471.00	1,474.20	1,466.20	1,462.52	1,468.48
Staircase (L2)	19.51	20.30	19.10	18.40	19.33	11.65	12.60	10.90	9.80	11.24	1,473.70	1,475.40	1,470.30	1,464.80	1,471.05
Inside the room (L3)	20.30	20.90	19.70	18.90	19.95	12.70	13.20	11.90	10.80	12.15	1,475.10	1,480.80	1,472.71	1,470.70	1,474.82
Coconut tree shade (L4)	18.70	19.20	18.10	17.20	18.30	10.30	11.10	9.60	9.90	10.23	1,468.10	1,471.80	1,465.25	1,460.30	1,466.36
Mean of L	19.45	20.05	18.90	18.18	19.14	11.39	12.20	10.63	10.08	11.07	1,471.97	1,475.55	1,468.62	1,464.58	1,470.17
Factors	SE(m)		CD at 5%			SE(m)		CD at 5%			SE(m)		CD at 5%		
Light regime (L)		0.10	0.29			0.06		0.19			0.90		2.71		
Growing media (G)		0.10	0.29			0.06		0.19			0.90		2.71		
L x G		0.19	0.57			0.13		0.38			1.80		5.41		

Table 3: Petiole length (cm) and Petiole width (mm) as influenced by light regime, growing media and their interactions in syngonium.

Light regime (L)	Petiole length (cm)					Petiole girth (mm)				
	Growing Media (G)									
	G1	G2	G3	G4	Mean of G	G1	G2	G3	G4	Mean of G
Corridor (L1)	17.20	17.40	15.80	15.10	16.38	3.60	4.20	3.30	2.90	3.50
Staircase (L2)	17.80	18.80	17.10	15.50	17.30	3.80	3.90	3.40	3.30	3.60
Inside the room (L3)	19.10	19.80	17.40	16.80	18.28	4.00	4.30	3.50	3.30	3.78
Coconut tree shade (L4)	15.90	16.40	15.60	12.10	15.00	3.50	3.80	3.20	2.80	3.33
Mean of L	17.50	18.10	16.48	14.88	16.74	3.73	4.05	3.35	3.08	3.55
Factors	SE(m)		CD at 5%			SE(m)			CD at 5%	
Light regime (L)	0.08			0.25		0.02			0.05	
Growing media (G)	0.08			0.25		0.02			0.05	
L x G	0.16			0.50		0.04			0.10	

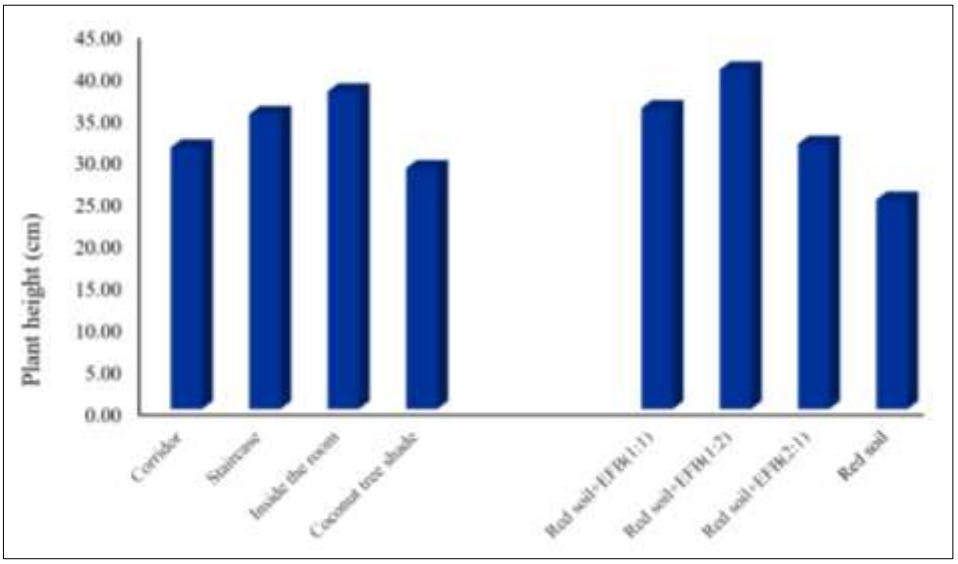

Fig 1: Effect of light regime and growing media on plant height (cm) of syngonium.

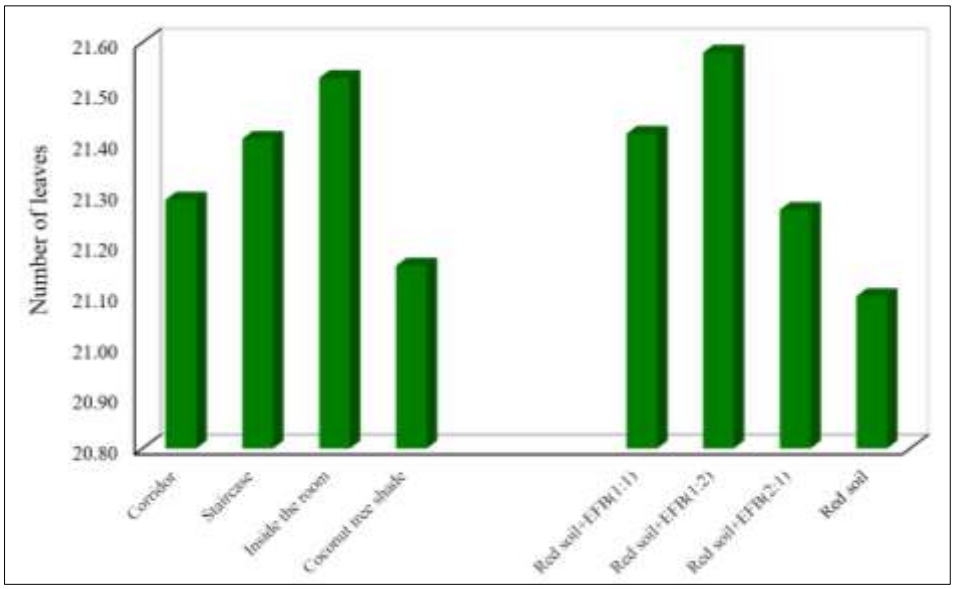

Fig 2: Effect of light regime and growing media on number of leaves of syngonium.

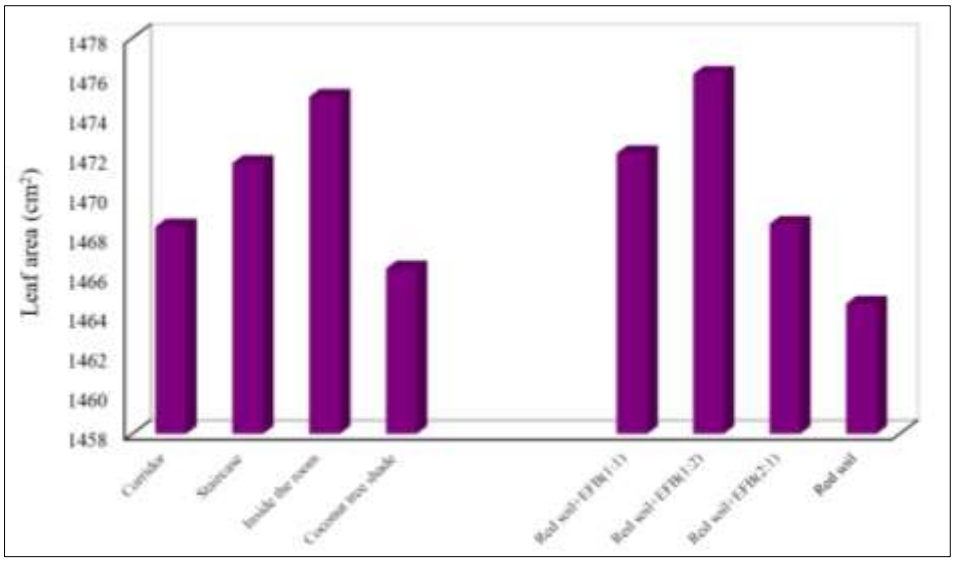

Fig 3: Effect of light regime and growing media on leaf area (cm2) of syngonium.

Conclusion

Syngonium plants were found to grow taller inside the room compared to other light regimes *i.e.*, corridor, staircase and coconut tree shade. However, among growing media, the one containing red soil: EFB (1:2) recorded maximum plant height than red soil: EFB (1:1), red soil: EFB (2:1) and red soil alone. Similarly, other growth parameters such as leaf size, leaf area, petiole length, petiole girth, number of roots, root length and total dry weight of plant were found maximum when the plants were placed inside the room and in media comprising of red soil: EFB (1:2).

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