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Optimizing soilless growing media for compact growth of *Philodendron xanadu*

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Abstract

The study on optimizing soilless growing media for compact growth of *Philodendron xanadu* was conducted at the Department of Floriculture and Landscaping, College of Agriculture, Vellanikkara, India. The experiment was laid out in a completely randomized design with five different growing media, viz., M_1: cocopeat (50%) + vermicompost (30%) + perlite (10%) + vermiculite (10%), M_2: cocopeat (50%) + vermicompost (20%) + neem cake (10%) + perlite (10%) +vermiculite (10%), M_3: coco chips (50%) + vermicompost (30%) + perlite (10%) + vermiculite (10%), M_4: coco chips (50%) + vermicompost (20%) + neem cake (10%) + perlite (10%) + vermiculite (10%) and M_5: cocopeat (60%) + vermicompost (20%) + perlite (20%). The study revealed that plants grown in media M_2 and M_4 showed significant variations and superior performance in vegetative and root parameters. These media also exhibited the highest chlorophyll content and favorable physical and chemical properties, enhancing nutrient uptake and plant growth cost-effectively. The inclusion of cocopeat in M_2 and coco chips in M_4, along with organic amendments such as vermicompost, perlite, and vermiculite, provided excellent water retention, aeration, and nutrient content, promoting root and vegetative growth. Additionally, the neem cake amendment contributed to the superior performance of plants in these media. Conclusively, these growing media M_2 and M_4 are recommended for achieving the compact growth of *Philodendron xanadu*, emphasizing the potential of optimized soilless growing media for sustainable and efficient ornamental horticulture.

Key words: *Philodendron xanadu*, soilless growing media, cocopeat, coco chips, vermicompost, perlite, vermiculite and neem cake

Introduction

Floriculture, an aesthetic branch of Horticulture, has emerged as a potential money-earning industry throughout the world. Foliage plants are one of the essential components of the floriculture industry and are commonly used as potted plants and for cut foliage. With rapid urbanization leading to reduced green spaces, the demand for potted ornamental foliage plants for interiorscaping has surged. These plants enhance the aesthetic view of indoors and provide a valuable weapon in the fight against the rising level of indoor air pollution by absorbing gaseous air pollutants, microbes, and dust particles to purify the indoor air.

Among a large number of indoor foliage plants available for interiorscaping, *Philodendron xanadu* is a popular ornamental foliage plant in the family Araceae. It is highly valued for its attractive lobed leaves and shade tolerance, requiring minimal maintenance. It thrives in tropical, subtropical, and warm temperate climates, making it a preferred choice for landscape and interior design.

Selecting the appropriate growing media is crucial for cultivating potted ornamental foliage plants. The ideal medium should be affordable, readily available, and provide essential nutrients for plant metabolism, growth, and development. Traditional soil is often unsuitable due to issues such as bulkiness, the presence of disease-causing organisms, poor drainage, and compaction (Sengupta and Banerjee, 2012).

Soilless culture systems refer to the method of growing plants that do not require the use of soil, or soilless culture is a method of growing plants in media that helps to alleviate soil-related issues in traditional crop cultivation (Murumkar *et al.,* 2012). Soilless growing media are popular among growers due to their consistency, good aeration, reproducibility, and low bulk density, which reduce shipping and handling costs. Hence, there is a need to test the efficacy of such a soilless growing medium on potted plants for their compact growth. This study was conducted with the objective of evaluating different soilless growing media on *P. xanadu* and analyzing the cost of various media combinations.

Materials and methods

The experiment was conducted at the Department of Floriculture and Landscaping, College of Agriculture, Vellanikkara, Kerala, during 2020-21. One-year-old plants of *P. xanadu* were used for the study. The experiment was laid out in a completely randomized design with five different growing media compositions, each with three replications. Pots of 8-inch size were filled with various proportions of growing media components, *viz.,* cocopeat, coco chips, vermicompost, perlite, vermiculite, and neem cake, on a volume-by-volume (v/v) basis according to the treatments. Following growing media were prepared by thoroughly mixing the components in the specified proportions:

M_1: Cocopeat (50%) + vermicompost (30%) + perlite (10%) + vermiculite (10%). M_2: Cocopeat (50%) + vermicompost (20%) + neem cake (10%) + perlite (10%) +vermiculite (10%). M_3: Coco chips (50%) + vermicompost (30%) + perlite (10%) + vermiculite (10%). M_4: Coco chips (50%) + vermicompost (20%) + neem cake (10%) + perlite (10%) + vermiculite (10%). M_5: Cocopeat (60%) + vermicompost (20%) + perlite (20%)

The experiment was conducted within a protected structure cladded with 200-micron UV stabilized film, with the sides covered by 50% shade net to maintain optimal growing conditions. Temperature, light intensity, and humidity were carefully monitored to ensure consistency across treatments. The average temperature was maintained between 25-30°C, with relative humidity around 70-80%. The light intensity was regulated to provide adequate but not excessive light for the *P. xanadu* plants. Uniform management practices were applied to all treatments throughout the experiment. Plants were irrigated on alternate days at a rate of 0.5 liters per pot. Fertilization, pest, and disease management were carried out as per standard horticultural practices.

The observations on vegetative parameters were recorded at monthly intervals, while root parameters were assessed at the end of the study. The physical properties, chemical properties, and nutrient status (NPK) of the media were also evaluated during the experiment. The collected data were statistically analyzed using OP-STAT (HAU, Hisar) to compare the effects of the different media compositions. Analysis of variance (ANOVA) was conducted to determine the significance of differences among the treatments.

The selection of treatments for this study was meticulously planned to evaluate the efficacy of various soilless growing media components in promoting the compact growth of *Philodendron xanadu.* The rationale behind choosing specific proportions of each growing media component was based on their physical and chemical properties that influence plant growth, nutrient uptake, and overall plant health. Cocopeat and coco chips were chosen for their excellent water retention and aeration properties. Vermicompost was included for its nutrient content and microbial activity, while perlite and vermiculite were added to improve aeration and drainage. Neem cake was incorporated for its potential pest-repellent properties and nutrient content. These components are readily available and widely used in horticulture, ensuring the study's findings can be easily replicated and applied by growers. The proportions were determined based on previous research findings, existing literature on soilless media components, and their known benefits for ornamental plant cultivation. Each treatment was designed with a comprehensive understanding of the individual and combined effects of the media combinations. Economic considerations also played a significant role in the selection process. The chosen ingredients balance cost and performance, making the findings relevant for large-scale applications. The goal was to address specific growth requirements of *Philodendron xanadu*, such as water retention, nutrient availability, aeration, and pest resistance.

Results

Vegetative parameters: The data revealed significant influences of different soilless growing media compositions on the vegetative parameters of *P. xanadu* (Table 1). Media M_2 and M_4 demonstrated superior performance with respect to plant height (37.67cm and 37.72cm, respectively), plant spread (116.28cm and 118.11cm, respectively), number of leaves (34.11 and 34.05, respectively), leaf length (12.64cm and 11.93cm, respectively), leaf width (5.81cm and 5.59cm, respectively), petiole length (19.21cm and 19.55cm, respectively), leaf area (1330.16cm^2 and 1206.11cm^2, respectively), leaf longevity (169.8 days), leaf production interval (7.35 days and 7.16 days, respectively), shoot girth (3.15cm and 3.27cm, respectively), shoot length (7.25cm and 7.52cm, respectively), fresh weight of the leaves (125.83g and 152.42g, respectively), and dry weight of the leaves (32.09g and 37.89g, respectively). M_1 also performed well in terms of plant height, petiole length, and shoot length.

Root parameters: The root characteristics were significantly affected by the soilless growing media. The highest root volume was recorded in M_4 with 187.5 cm^3, while both media M_2 and M_4 showed the highest number of lateral roots (64.75 and 69.17) and longest roots (62.75cm and 55.67cm), respectively. M_5 also showed a substantial root length (59.33cm). No significant differences were observed in the fresh and dry weight of roots across different growing media (Table 1).

Media properties: The physical and chemical properties of the soilless growing media played a crucial role in influencing plant growth. M_5 had the highest water-holding capacity (311%) due to the highest proportion of cocopeat.

Table 1. Effect of different soilless growing media on vegetative and root parameters of *P. xanadu*

Growing media	M_1	M_2	M_3	M_4	M_5	SE(m)	CD (0.05)
Plant height (cm)	36.16	37.67	31.06	37.72	29.22	0.74	2.19
Plant spread (cm)	110.61	116.28	107.72	118.11	105.16	2.23	6.62
Total no. of leaves	30.22	34.11	26.72	34.05	21.89	0.98	2.91
Leaf length (cm)	11.60	12.64	11.27	11.93	10.75	0.25	0.73
Leaf width (cm)	5.29	5.81	5.08	5.59	4.76	0.17	0.50
Petiole length (cm)	18.63	19.21	18.67	19.55	17.64	0.38	1.14
Leaf area (cm^2)	981.98	1330.16	810.40	1206.11	597.74	48.95	145.43
Leaf longevity (days)	163.80	169.80	161.40	169.80	159.00	1.49	4.44
Leaf production interval (days)	8.06	7.35	8.22	7.16	11.72	0.22	0.65
Shoot girth (cm)	3.01	3.15	2.96	3.27	2.70	0.07	0.21
Shoot length (cm)	7.12	7.25	6.98	7.52	6.39	0.14	0.41
Fresh weight of leaves/plant (g)	106.08	125.83	102.17	152.42	88.5	5.25	15.60
Dry weight of leaves/plant (g)	28.96	32.09	26.12	37.89	24.24	2.48	7.37
Fresh weight of roots/plant (g)	49.41	50.00	60.91	63.00	54.08	4.43	NS
Dry weight of roots/ plant (g)	5.21	6.60	6.76	6.84	5.85	0.76	NS
Root length (cm)	45.75	62.75	46.33	55.67	59.33	3.24	9.62
No. of lateral roots	53.75	64.75	55.42	69.17	51.83	2.76	8.21
Root volume (cm^3)	173.33	160.41	163.75	187.50	162.5	5.08	15.09

M_4 had the lowest bulk density and highest porosity, attributed to the inclusion of coco chips. Media containing cocopeat had a pH below 7, while those with coco chips had the highest pH values. All media maintained favorable electrical conductivity (EC) levels. M_2 had the highest available nitrogen (N), while M_4 had the highest available phosphorus (P) and potassium (K) content (Table 2).

Table 2. Physical and chemical properties of different soilless growing media

Growing media		M_1	M_2	M_3	M_4	M_5
WHC (%)		222	271	238	251	311
Bulk density (g/cm^3)		0.19	0.17	0.13	0.12	0.16
Porosity (%)		91.00	89.00	92.00	93.00	88.00
pH	Before	6.75	6.82	6.92	7.15	6.85
	After	6.86	6.91	7.10	7.22	6.98
EC (dS/m)	Before	0.84	0.81	0.86	0.88	0.79
	After	0.58	0.63	0.66	0.71	0.52
N (%)	Before	0.29	0.34	0.31	0.28	0.26
	After	0.32	0.20	0.32	0.17	0.22
P (%)	Before	0.036	0.035	0.034	0.0037	0.033
	After	0.038	0.037	0.036	0.039	0.035
K (%)	Before	0.28	0.23	0.22	0.34	0.27
	After	0.07	0.13	0.16	0.12	0.15

The highest total chlorophyll content was noticed in M_4. While the highest plant nutrient content and uptake of N, P and K was observed in M_2 (Table 3).

Table 3. Effect of different soilless growing media on plant nutrient content, plant nutrient uptake, and total chlorophyll content of *P. xanadu*

Growing media		M_1	M_2	M_3	M_4	M_5	CD (0.05)
Plant nutrient content	N (%)	2.32	2.41	1.94	1.83	1.73	0.14
	P (%)	0.27	0.31	0.25	0.26	0.25	0.03
	K (%)	3.24	3.49	2.53	2.71	2.31	0.41
Plant nutrient uptake	N (g/plant)	0.67	0.77	0.5	0.69	0.42	0.15
	P (g/plant)	0.08	0.09	0.06	0.10	0.06	0.02
	K (g/plant)	0.93	1.12	0.66	0.84	0.56	0.22
Total chlorophyll (mg /g)		0.71	0.82	0.73	1.05	0.68	0.15

Cost analysis: The cost analysis of soilless growing media combinations highlights M4 as the most suitable option, with the lowest weight (1.41 kg) and moderate cost (Rs. 32.10). This combination, consisting of coco chips, vermicompost, neem cake, perlite, and vermiculite, also provides excellent aeration, making it ideal for lightweight and well-aerated applications (Table 4).

Table 4. Cost analysis of different soilless growing media combinations

Media	Quantity of each component/ pot (v/v)	Weight of growing media/ pot (kg)	Cost of growing media/pot (Rs.)
M_1	Cocopeat (0.80 kg), vermicompost (0.90 kg), perlite (0.10 kg) and vermiculite (0.16 kg)	1.96	29.60
M_2	Cocopeat (0.80 kg), vermicompost (0.60 kg), neem cake (0.25 kg), perlite (0.10 kg), vermiculite (0.16 kg)	1.91	34.10
M_3	Coco chips (0.30 kg), vermicompost (0.90 kg), perlite (0.10 kg), vermiculite (0.16 kg)	1.46	27.60
M_4	Coco chips (0.30 kg), vermicompost (0.60 kg), neem cake (0.25 kg), perlite (0.10 kg), vermiculite (0.16 kg)	1.41	32.10
M_5	Cocopeat (0.96 kg), vermicompost (0.60 kg), perlite (0.20 kg)	1.76	29.60

Discussion

The aesthetic appeal of potted ornamental foliage plants is greatly influenced by several factors, such as plant height and spread, and the fullness of the pot depends on the number of leaves and their area. The leaf production interval determines the number of leaves and directly influences the appearance of potted plants. Parameters such as leaf length and width also affect the presentability of potted ornamental foliage plants, as they contribute to the overall leaf area. Additionally, the fresh weight of the leaves defines their turgidity and freshness, which are important quality parameters for potted ornamental foliage plants.

From the experiment, it was observed that the plants grown in media M_2 and M_4 exhibited all the quality criteria for potted ornamental foliage plants. The primary components of these media were cocopeat in M_2 and coco chips in M_4, each constituting 50% of the overall composition of the growing media. Additionally, both M_2 and M_4 included elements such as vermicompost, neem cake, vermiculite, and perlite. The improved plant performance observed in these media can likely be attributed to the beneficial effects of these media components.

Cocopeat, as a growing media component, enhances aeration and water-holding capacity, promotes root growth, and improves nutrient uptake by plants. It contains significant amounts of nitrogen, calcium, magnesium, phosphate, and potassium. Additionally, cocopeat exhibits resistance to both bacterial and fungal growth. These benefits are supported by studies on various plants, such as *Epipremnum aureum* (Khayyat *et al.*, 2007), *Aglaonema* (Swetha *et al.*, 2014; Rashidha *et al.,* 2021), and *Asparagus spengeri* (Sankari *et al.,* 2019).

Coco chips provide excellent porosity, aeration to the growing medium, serving as a reservoir of both macro and micronutrients, gradually releasing these nutrients into the medium. They also provide a stable anchor for plant roots. Positive impacts of using coco chips as a constituent in growing media have been documented by various researchers, including Muraleedharan and Karuppaiah (2015), Sumathi *et al*. (2018) in anthuriums, Hariyanto *et al*. (2019), and Sanghamitra *et al*. (2019) in orchids.

Incorporating vermicompost into a growing medium positively impacts plant growth and development by influencing both vegetative growth and root formation. Vermicompost had higher and more soluble levels of nutrients such as nitrogen, phosphorous, potassium, calcium, and magnesium. Moreover, it enhances the physical structure of the medium and enriches it with beneficial microorganisms. An improvement in growth due to vermicompost in potted ornamentals has been reported by Kayalvizhi *et al*. (2013) in *Asparagus densiflorus*, Fatmi and Singh (2017) in *Codiaeum*, and Sandeep *et al*. (2018) in *Nephrolepis.*

Neem cake, an organic component in both M_2 and M_4 media, showed outstanding performance for the potted plants in this study. Its organic nature and high NPK content likely provided continuous nourishment to the plants, leading to improved growth and enhanced the appearance of the potted foliage plants. The inclusion of organic supplements like neem cake has a positive influence on the physical, chemical, and biological characteristics of the growing medium. In addition to its positive effects on plant growth, yield, and media characteristics, neem cake is also known for its insecticidal and fungicidal properties (Khan and Saxena, 1997). The nematicidal properties of neem cake were reported by Jothi *et al*. (2004) in Crossandra. Improvement in plant growth and yield by the addition of neem cake into the growing medium was reported by Singh (2006) in *Anthurium andreanum* and Karim *et al*. (2017) in Tuberose.

In the present study, perlite was also incorporated as a component in the growing media M_2 and M_4. Perlite is highly porous, lightweight, and characterized by high porosity, neutral pH, and high permeability. Khosh-Khui *et al*. (2006), reported that perlite can retain up to ten times its dry weight. Despite its relatively low nutrient content, when combined with other components of the growing medium, perlite was observed to enhance the physical characteristics of the medium, consequently leading to improved plant growth. The beneficial effect of using perlite in the growing media has been reported in various ornamental plants by Bidarnamani and Zarei (2014) in *Scindapsus aureum*, Kakhki *et al*. (2020) in *Spathiphyllum*, Jabbar *et al*. (2018) in *Gladiolus grandiflorus* and Rashidha *et al*. (2021) in *Aglaonema.*

Vermiculite was also included as one of the components in the growing media M_2 and M_4. It is a hydrated aluminum-iron-magnesium silicate characterized by its low bulk density and high water-holding capacity. Landis *et al*. (2014), reported the presence of small amounts of potassium and magnesium in vermiculite. When used as a component in growing media, vermiculite enhances certain properties of the media, such as aeration and water-holding capacity. This, in turn, improves root penetration and the uptake of nutrients by the plants. The impact of vermiculite on the growth and yield of potted ornamental plants has been reported by Sindhu *et al*. (2010) in Gerbera, Thakur and Grewal (2019) in *Chrysanthemum morifolium*, and Rashidha *et al*. (2021) in *Aglaonema*.

Plant Nutrient Status: Plant nutrient content and plant nutrient uptake are likely attributable to the favorable physical and chemical properties of the growing media. These properties in growing media M_2 and M_4 are believed to enhance root development, subsequently improving nutrient uptake and translocation from roots to the vegetative parts of the plants. This observation aligns with previous research, such as Basheer and Thekkayam (2012) in *Anthurium andreanum*, Swetha *et al*. (2014) in *Aglaonema*, and Juveriya and Ahmmed (2016) in *Codiaeum variegatum*, which also reported improved nutrient uptake with favorable growing media. Additionally, an increase in chlorophyll content can be attributed to the enhanced synthesis of chlorophyll pigments, likely influenced by the components of the growing media. The presence of organic amendments such as neem cake and vermicompost not only supplies essential nutrients but also improves the overall health of the plant, promoting higher chlorophyll synthesis. Similar results were observed by Bidarnamani and Zarei (2014) in pothos, indicating that the right composition of growing media can substantially enhance photosynthetic capacity and plant vigor.

This study presents significant practical implications for both growers and researchers in ornamental horticulture. The superior performance of media M_2 and M_4 suggests that incorporating cocopeat and coco chips, along with organic amendments like vermicompost and neem cake, can significantly enhance the growth and aesthetic quality of *Philodendron xanadu.* For growers, the findings highlight the superior performance of media formulations M_2 (cocopeat-based) and M_4 (coco chips-based), which enhance vegetative growth, root development, and nutrient uptake while being cost-effective and lighter for easier handling and transport. These benefits not only improve the aesthetic quality and marketability of the plants but also reduce production costs and pest management efforts due to the inclusion of neem cake. For researchers, the study offers a robust foundation for exploring soilless media in other ornamental species, emphasizing sustainable practices and organic amendments. The detailed analysis of physical and chemical media properties provides valuable insights into optimizing plant growth conditions, encouraging further research on nutrient dynamics and sustainable horticultural practices. Overall, these findings contribute to advancing horticultural techniques, improving plant quality, and promoting eco-friendly growing practices in the ornamental plant industry.

This study is limited by variability in media quality and specific environmental conditions, reducing reproducibility and generalizability. Future research should validate findings across diverse locations, test additional ornamental species, and explore organic amendments like biochar or compost to enhance nutrient content and sustainability, optimizing soilless media for broader applications.

In conclusion, this study identifies M2 [cocopeat (50%) + vermicompost (20%) + neem cake (10%) + perlite (10%) + vermiculite (10%)] and M4 [coco chips (50%) + vermicompost (20%) + neem cake (10%) + perlite (10%) + vermiculite (10%)] as the most effective soilless growing media for cultivating high-quality potted P. xanadu plants. These media demonstrated superior physical and chemical properties, promoting enhanced vegetative growth, root development, and nutrient uptake. The inclusion of neem cake further contributed essential nutrients and pest resistance, underscoring its value in commercial floriculture. These findings offer a practical approach to optimizing soilless media for compact and healthy P. xanadu growth.

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