

## Evaluation of eco-friendly substrates for sustainable cultivation of *Dracaena reflexa* cv. Song of India cut foliage

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### Abstract

The quality of cut foliage is significantly influenced by growing media, with traditional media such as red earth and sand being non-renewable and unsustainable. This study aims to determine the sustainable, eco-friendly substrates for *Dracaena reflexa* cv. Song of India cut foliage to increase the growth, yield, and quality. The experiment was laid out in CRBD with 9 treatments and 3 replications, utilized various combinations of garden soil, red earth, sand, farmyard manure (FYM), burnt rice husk, and cocopeat. Among the different treatments, T8 (Garden soil + burnt rice husk + FYM + coco peat at 2:1:1:1 v/v) showed the best performance in growth and yield attributes, viz., plant height, spread, leaf numbers, leaf area, chlorophyll content, root length, and fresh weight. Yield and quality characteristics like number of cut stems, visual scoring, freshness index, colour index, and vase life were also noted as high in T8. Control (T0)-Garden soil recorded the minimum across these parameters. These findings indicate that combination of garden soil, burnt rice husk, FYM, and cocopeat is the most effective and sustainable alternative for improving the yield, growth, and quality of *Dracaena reflexa* cv. Song of India cut foliage.

**Key words:** *Dracaena reflexa* cv. Song of India, media, yield parameters, quality indices, vase life, cut foliage

### Introduction

Cut foliage, an eminent segment of the floriculture industry chiefly serves as fillers, lining, and background in flower arrangements. They also enhance their elegant appeal through added freshness, color, and diversity. The cut foliage industry has experienced substantial growth within the floriculture sector (Pacifi *et al.*, 2007). Most foliage plants are utilized significantly for decorative purposes individually or in coupling with flowers and are native to tropical and subtropical climates. This rising trend is associated with the cost diversification between flower and nursery production, increasing the demand for fresh foliage in the floral market. The Netherlands holds a leading position in this sector, performing as the world's leading exporter (33 %) and importer (19 %) of cut foliage (Ollaji *et al.*, 2022). In India, *D. reflexa*, commonly known as "Song of India," is cultivated for multifaceted applications, including cut foliage, bouquet assembly, floral arrangements, ornamental landscaping, indoor gardening, edging, and container gardening. It belongs to the Asparagaceae family and was previously classified as *Pleomele reflexa*; this plant is renowned for its palm-like appearance characterized by a crown of leaves and a top mature stem. Its vibrant evergreen foliage and resilient nature under low-light conditions with minimal maintenance requirements make it a popular choice for indoor cultivation (Athulya and Singh, 2021).

Among the various factors, the quality of cut foliage is mainly influenced by growing media. It can profoundly influence plant growth, nutrient assimilation, water retention, and overall physiological health (Okunlola *et al.*, 2018). A typical and traditional growing media includes a mixture of red earth, sand, and farmyard manure (FYM), routinely used as a growing media. However, red earth and sand are non-renewable and

pose challenges in transportation and extraction. In the Cauvery Delta, coconut and paddy cultivation produce cocopeat and burnt rice husk, which are more sustainable alternatives for container gardening because cocopeat's water-holding capacity reduces frequent watering, while burnt rice husk improves aeration and drainage and provides phosphorus for healthy root development. In spite of its significance, more research remains to be done focusing on the impact of different growing media on the production of ornamental plants, particularly *D. reflexa* cv. Song of India as cut foliage.

The present study endeavors to minimize the despoiling and pervasive utilization of soil and to identify the optimum, eco-friendly growing media for the growth, yield, and quality attributes of *D. reflexa* cv. Song of India.

### Materials and methods

**Experimental location and design:** The study was conducted at the Department of Horticulture, Annamalai University, Annamalainagar, during the year 2023-2024. The experimental design employed a Completely Randomized Block Design (CRBD) with nine distinct treatments, each replicated three times.

**Experimental treatments and media composition:** This study aims to find a combined media mixture that may be an alternative to the traditional combination of red earth, sand, and farmyard manure (FYM). Because of the low availability and high cost of the sand and red earth, the treatments are formed accordingly: T<sub>0</sub> (control) with garden soil, T<sub>1</sub> (Red earth + sand + farm yard manure (FYM) at a ratio 1:1:1 v/v), T<sub>2</sub> (Garden soil + burnt rice husk at a 2:1 ratio v/v), T<sub>3</sub> (Garden soil + farm yard manure (FYM) at a 2:1 ratio v/v), T<sub>4</sub> (Garden soil + cocopeat at a 2:1

ratio v/v), T<sub>5</sub> (Garden soil + burnt rice husk + FYM at a 2:1:1 ratio v/v), T<sub>6</sub> (Garden soil + burnt rice husk + cocopeat at a 2:1:1 ratio v/v), T<sub>7</sub> (Garden soil + FYM + cocopeat at a 2:1:1 ratio v/v), and T<sub>8</sub> (Garden soil + burnt rice husk + FYM + cocopeat at a 2:1:1:1 ratio v/v).

**Plant selection and maintenance:** Uniformly sized healthy *D. reflexa* cv. Song of India plants, approximately 15 cm in height, were selected for potting in 60 cm containers. The potting media were formulated by blending different substrates *viz.*, garden soil, burnt rice husk, FYM, and cocopeat in ratios specified by the treatment protocol. The control group was cultivated solely in garden soil. Based on media moisture and prevailing climatic conditions, plants received irrigation weekly and routine maintenance, including pest control and other protective measures, was undertaken as required.

**Biometric and quality assessments:** Biometric assessments encompassing growth, physiological, and yield parameters including, plant height (cm), plant spread (cm<sup>2</sup>), number of leaves/plant, leaf length (cm), leaf width (cm), leaf area (cm<sup>2</sup>), chlorophyll content (SPAD), root length (cm), single leaf weight (g), shoot fresh weight/plant (g), root fresh weight/plant (g), total fresh weight/plant (g), dry matter production (g), number of cut stems/plant and number of CUT stems/m<sup>2</sup> were documented at 270 days after planting (DAP). Plant spread was measured by averaging the distances between the plant's widest points in the north-south and east-west directions. Additionally, quality attributes such as visual scoring, freshness index, and color index of the harvested foliage were assessed using Hedonic sensory evaluation methods (Abinaya and Karuppaiah, 2018). Vase life under room temperature conditions was recorded with and without pulsing treatments. The fifth leaf from the apex was designated as the index leaf for biometric evaluations. The relative leaf chlorophyll content was determined using a portable chlorophyll meter (SPAD 502) as SPAD index.

**Physiochemical analysis of growing media:** The physiochemical analysis carried out includes, nitrogen (N), phosphorous (P), potassium (K), pH, organic carbon, water holding capacity and EC. The available nitrogen in the growing media was estimated by the alkaline potassium permanganate method (Subbaiah and Asija, 1956), the available phosphorus was estimated

Table 1. Physico-chemical properties of growing media time of planting

Treatments	Nutrients status of the growing media (%)				Water holding capacity (%)	pH	Electrical conductivity (dS/m)
	Nitrogen	Phosphorus	Potassium	Organic carbon			
T <sub>0</sub>	1.06 <sup>c</sup>	0.35 <sup>g</sup>	2.40 <sup>b</sup>	1.02 <sup>f</sup>	18.25 <sup>c</sup>	7.0 <sup>a</sup>	0.37 <sup>f</sup>
T <sub>1</sub>	1.47 <sup>b</sup>	0.48 <sup>e</sup>	1.80 <sup>cd</sup>	8.85 <sup>e</sup>	80.25 <sup>b</sup>	6.2 <sup>d</sup>	1.10 <sup>e</sup>
T <sub>2</sub>	1.08 <sup>c</sup>	0.73 <sup>d</sup>	1.70 <sup>de</sup>	9.45 <sup>e</sup>	20.00 <sup>e</sup>	6.4 <sup>bcd</sup>	2.01 <sup>a</sup>
T <sub>3</sub>	1.14 <sup>d</sup>	0.70 <sup>d</sup>	1.86 <sup>c</sup>	10.45 <sup>d</sup>	52.30 <sup>d</sup>	7.1 <sup>a</sup>	0.97 <sup>d</sup>
T <sub>4</sub>	1.12 <sup>de</sup>	0.41 <sup>f</sup>	1.65 <sup>e</sup>	15.12 <sup>c</sup>	94.24 <sup>a</sup>	6.3 <sup>cd</sup>	0.24 <sup>g</sup>
T <sub>5</sub>	1.25 <sup>c</sup>	0.80 <sup>c</sup>	1.88 <sup>c</sup>	15.17 <sup>c</sup>	90.00 <sup>b</sup>	6.5 <sup>bc</sup>	0.94 <sup>d</sup>
T <sub>6</sub>	1.16 <sup>d</sup>	0.78 <sup>c</sup>	1.87 <sup>c</sup>	15.14 <sup>c</sup>	93.54 <sup>ab</sup>	6.6 <sup>b</sup>	0.83 <sup>e</sup>
T <sub>7</sub>	1.30 <sup>c</sup>	0.85 <sup>b</sup>	1.89 <sup>c</sup>	16.20 <sup>b</sup>	90.10 <sup>b</sup>	6.3 <sup>cd</sup>	1.00 <sup>d</sup>
T <sub>8</sub>	2.70 <sup>a</sup>	1.43 <sup>a</sup>	2.70 <sup>a</sup>	20.38 <sup>a</sup>	95.27 <sup>a</sup>	6.5 <sup>bc</sup>	1.35 <sup>b</sup>
S.Ed	0.02	0.01	0.05	0.33	1.82	0.13	0.03
CD (P=0.05)	0.05	0.03	0.11	0.71	3.90	0.28	0.06

calorimetrically using a Klett Summerson calorimeter with a red filter at 600 nm (Olsen, 1954), the available potassium in the growing media was estimated using Flame Photometer (Hanway and Heidal, 1952), the available organic carbon was estimated using chromic acid wet oxidation method (Walkley and black, 1934). The water-holding capacity of the media was analyzed by oven drying method. The pH of the growing media was determined using a pH meter (Jackson, 1973), the EC of the media was estimated by a conductivity bridge (Jackson, 1973).

**Statistical analysis:** The collected data were analyzed (ANOVA) using WASP 1.0 statistical package. The treatment means were compared by Duncan's new multiple range test (DNMRT) at a 5% probability level.

## Results and discussion

**Effect of media on plant height and spread:** The media compositions showed a significant influence in the *Dracaena's* growth parameters (Table 2), indicating that the highest values for plant height and plant spread were achieved with T<sub>8</sub> (Garden soil + burnt rice husk + FYM + cocopeat in a 2:1:1:1 ratio v/v), recording 59.78 cm and 244.37 cm<sup>2</sup>, respectively followed by T<sub>1</sub> (Red earth + sand + FYM in a 1:1:1 ratio v/v) with values of 53.64 cm and 231.12 cm<sup>2</sup>. On the other hand, the plant height

Table 2. Effect of different types of substrates on growth and physiological parameters of *D. reflexa* cv. Song of India at 270 days after planting

Treatments	Plant height (cm)	Plant spread (cm <sup>2</sup> )	Number of leaves/plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm <sup>2</sup> )	Chlorophyll content SPAD	Root length (cm)	Single leaf weight (g)	Shoot fresh weight/plant (g)	Roots fresh weight/plant (g)	Total plant fresh weight (g/plant)	Dry matter production (g/plant)
T <sub>0</sub>	38.12 <sup>h</sup>	189.84 <sup>c</sup>	35.15 <sup>h</sup>	10.64 <sup>h</sup>	1.03 <sup>g</sup>	13.01 <sup>i</sup>	19.32 <sup>i</sup>	15.21 <sup>h</sup>	0.75 <sup>h</sup>	50.59 <sup>g</sup>	12.23 <sup>f</sup>	84.82 <sup>c</sup>	34.82 <sup>g</sup>
T <sub>1</sub>	53.64 <sup>b</sup>	231.12 <sup>b</sup>	81.45 <sup>b</sup>	15.44 <sup>b</sup>	2.39 <sup>b</sup>	36.90 <sup>b</sup>	41.09 <sup>b</sup>	26.54 <sup>b</sup>	2.12 <sup>b</sup>	83.45 <sup>b</sup>	17.34 <sup>b</sup>	100.79 <sup>b</sup>	53.79 <sup>b</sup>
T <sub>2</sub>	42.42 <sup>g</sup>	198.79 <sup>c</sup>	39.35 <sup>g</sup>	11.16 <sup>g</sup>	1.11 <sup>g</sup>	15.92 <sup>h</sup>	25.79 <sup>h</sup>	17.74 <sup>g</sup>	0.89 <sup>g</sup>	63.68 <sup>f</sup>	13.31 <sup>c</sup>	90.99 <sup>d</sup>	40.99 <sup>f</sup>
T <sub>3</sub>	45.34 <sup>ef</sup>	215.78 <sup>d</sup>	48.86 <sup>f</sup>	12.46 <sup>c</sup>	1.56 <sup>c</sup>	22.55 <sup>f</sup>	32.68 <sup>f</sup>	21.18 <sup>c</sup>	1.37 <sup>c</sup>	69.74 <sup>de</sup>	14.92 <sup>d</sup>	94.66 <sup>cd</sup>	46.66 <sup>d</sup>
T <sub>4</sub>	43.89 <sup>fg</sup>	209.92 <sup>d</sup>	41.21 <sup>g</sup>	11.84 <sup>f</sup>	1.38 <sup>f</sup>	20.48 <sup>g</sup>	29.29 <sup>g</sup>	19.84 <sup>f</sup>	1.28 <sup>f</sup>	66.82 <sup>c</sup>	14.49 <sup>d</sup>	92.31 <sup>d</sup>	44.31 <sup>e</sup>
T <sub>5</sub>	49.12 <sup>d</sup>	229.89 <sup>bc</sup>	60.02 <sup>d</sup>	14.05 <sup>cd</sup>	2.08 <sup>c</sup>	30.31 <sup>d</sup>	37.78 <sup>d</sup>	22.89 <sup>d</sup>	1.54 <sup>d</sup>	79.24 <sup>c</sup>	16.19 <sup>c</sup>	96.13 <sup>bcd</sup>	51.13 <sup>c</sup>
T <sub>6</sub>	47.41 <sup>de</sup>	219.69 <sup>cd</sup>	56.56 <sup>e</sup>	13.67 <sup>d</sup>	1.78 <sup>d</sup>	26.11 <sup>c</sup>	34.32 <sup>c</sup>	21.96 <sup>c</sup>	1.49 <sup>d</sup>	71.48 <sup>d</sup>	15.32 <sup>d</sup>	95.80 <sup>bcd</sup>	48.80 <sup>d</sup>
T <sub>7</sub>	51.41 <sup>c</sup>	230.00 <sup>bc</sup>	71.30 <sup>c</sup>	14.25 <sup>c</sup>	2.12 <sup>c</sup>	34.10 <sup>c</sup>	39.56 <sup>c</sup>	24.14 <sup>c</sup>	1.98 <sup>c</sup>	81.55 <sup>bc</sup>	16.78 <sup>bc</sup>	98.11 <sup>bc</sup>	51.11 <sup>c</sup>
T <sub>8</sub>	59.78 <sup>a</sup>	244.37 <sup>a</sup>	96.78 <sup>a</sup>	17.67 <sup>a</sup>	3.00 <sup>a</sup>	49.95 <sup>a</sup>	45.11 <sup>a</sup>	29.78 <sup>a</sup>	2.30 <sup>a</sup>	87.43 <sup>a</sup>	20.67 <sup>a</sup>	110.10 <sup>a</sup>	56.10 <sup>a</sup>
S.Ed	1.02	3.50	1.53	0.21	0.03	0.64	0.50	0.41	0.03	1.03	0.26	2.31	0.73
CD (P=0.05)	2.17	10.48	3.23	0.45	0.07	1.36	1.49	0.84	0.06	3.09	0.79	4.90	2.18

and spread of the control treatment ( $T_0$ ) showed the lowest values, viz., 38.12 cm and 189.84 cm<sup>2</sup>, respectively. The rich nutrient media compositions are responsible for the notable increase in plant height and spread. Garden soil, burnt rice husk, FYM, and cocopeat provide better water retention, aeration, and nutrients than red soil, sand, and FYM, offering a more sustainable and effective growing medium (Table 1). During the early growth stage, accelerated cell division and elongation contribute to the augmented plant height and spread, likely driven by active meristematic processes. These outcomes are influenced mainly by combining the growing media's physico-chemical properties, supplementing the plants efficient nutrient uptake. Consistent with our findings, Ghehsareh *et al.* (2020) noted a positive relationship between plant height and plant spread in miniature roses about the growing media. These findings align with studies conducted by Abid *et al.* (2017) on *D. reflexa*, Sankari (2019) on *Asparagus sprengeri*, Paruchuru *et al.* (2021) on *Rosa chinensis*, and Gowshika Devi and Karuppaiah (2021) on *D. reflexa* 'Variegata'.

**Leaf characteristics and chlorophyll content:** The analysis revealed that the number of leaves/plants, leaf length, leaf width, leaf area, and chlorophyll content exhibited optimal values in  $T_8$ , recorded at 96.78, 17.67 cm, 3.00 cm, 49.95 cm<sup>2</sup>, and 45.11 SPAD, respectively followed by  $T_1$ , which recorded 81.45, 15.44 cm, 2.39 cm, 36.90 cm<sup>2</sup>, and 41.09 SPAD for the aforementioned parameters. In contrast, the control ( $T_0$ ) yielded values of 35.15, 10.64 cm, 1.03 cm, 13.01 cm<sup>2</sup>, and 19.32 SPAD, respectively (Table 2). The superior performance of  $T_8$  can be attributed to the physico-chemical characteristics of the media, including, higher total porosity, water holding capacity, lower bulk density, and optimized nutrient accumulation, notably higher nitrogen content (Table 1). These findings coincide with previous studies by Thakur and Grewal (2019) in *Chrysanthemum* and Kumar *et al.* (2022) in *Calendula officinalis*.

**Biomass and yield parameters:** In Treatment  $T_8$ , consisting of a mixture of garden soil, burnt rice husk, FYM, and cocopeat in a 2:1:1:1 v/v ratio, the following parameters such as root length (29.78 cm), single leaf weight (2.30 g), shoot fresh weight (87.43 g/plant), root fresh weight (20.67 g/plant), total plant fresh weight (110.10 g/plant), dry matter production (56.10 g/plant) (Table 2), and number of cut stems per plant (9.33) and number of cut stems per m<sup>2</sup> (36.55) (Table 3), exhibited the highest values. This was followed by  $T_1$ , which recorded values of 26.54 cm, 2.12 g, 83.45 g/plant, 17.34 g/plant, 100.79 g/plant, 53.79 g/plant, 8.00 numbers/plant, and 32.65 numbers/m<sup>2</sup> for the same parameters, respectively. In contrast, the control group ( $T_0$ ) exhibited the lowest values across these parameters such as root length (15.21 cm), single leaf weight (0.75 g), shoot fresh weight (50.59 g/plant), root fresh weight (12.23 g/plant), total plant fresh weight (84.82 g/plant), dry matter production (34.82 g/plant), number of cut stems per plant (4.00) and number of cut stems per m<sup>2</sup> (16.25). The plant biomass increase can be influenced by the multiplication of meristematic cells, forming new shoots and leaves with nitrogen-containing compounds, providing protein synthesis, and accelerating the growth and development of structural components of the plant. The enhanced root parameters observed may be attributed to the elevated phosphorus levels and the physico-chemical properties present in the growing media. Similar findings were reported by Sardoei *et al.* (2014) on zinnia, and Abid *et al.* (2017) on *D. reflexa*.

Table 3. Effect of different types of substrates on yield and quality parameters of *D. reflexa* cv. Song of India at 270 days after planting

Treatments	Number of cut stems/plant	Number of cut stems/m <sup>2</sup>	Visual scoring	Freshness index	Colour index	Vase life without pulsing (days)	Vase life with pulsing (days)
$T_0$	4.00 <sup>h</sup>	16.25 <sup>h</sup>	4.9 <sup>h</sup>	55.26 <sup>h</sup>	58.42 <sup>g</sup>	11.1 <sup>g</sup>	25.1 <sup>h</sup>
$T_1$	8.00 <sup>b</sup>	32.65 <sup>b</sup>	8.5 <sup>b</sup>	90.17 <sup>b</sup>	88.56 <sup>b</sup>	23.8 <sup>b</sup>	43.8 <sup>b</sup>
$T_2$	4.33 <sup>g</sup>	16.35 <sup>g</sup>	5.4 <sup>g</sup>	65.74 <sup>g</sup>	63.38 <sup>f</sup>	15.8 <sup>f</sup>	27.8 <sup>g</sup>
$T_3$	5.66 <sup>c</sup>	20.75 <sup>c</sup>	6.8 <sup>c</sup>	77.45 <sup>e</sup>	71.56 <sup>e</sup>	17.8 <sup>e</sup>	34.8 <sup>c</sup>
$T_4$	5.33 <sup>f</sup>	20.55 <sup>f</sup>	6.0 <sup>f</sup>	70.15 <sup>f</sup>	67.43 <sup>f</sup>	16.5 <sup>f</sup>	30.5 <sup>f</sup>
$T_5$	6.33 <sup>d</sup>	24.65 <sup>d</sup>	7.5 <sup>d</sup>	84.32 <sup>cd</sup>	80.17 <sup>cd</sup>	20.0 <sup>d</sup>	40.0 <sup>cd</sup>
$T_6$	6.00 <sup>de</sup>	24.35 <sup>d</sup>	7.0 <sup>e</sup>	81.78 <sup>de</sup>	76.73 <sup>d</sup>	18.1 <sup>e</sup>	38.1 <sup>d</sup>
$T_7$	7.33 <sup>c</sup>	28.45 <sup>c</sup>	8.0 <sup>e</sup>	88.33 <sup>bc</sup>	83.19 <sup>c</sup>	21.6 <sup>c</sup>	41.6 <sup>c</sup>
$T_8$	9.33 <sup>a</sup>	36.55 <sup>a</sup>	9.8 <sup>a</sup>	96.21 <sup>a</sup>	94.16 <sup>a</sup>	25.2 <sup>a</sup>	49.2 <sup>a</sup>
CD ( $P=0.05$ )	0.33	1.21	0.30	4.44	4.10	1.00	2.11

**Quality parameters:** In terms of quality parameters such as visual scoring, freshness index, color index, and vase life both with and without pulsing, the highest values were observed in ( $T_8$ ) (Table 3) with respective values of 9.8, 96.21, 94.16, 25.2 days and 49.2 days followed by ( $T_1$ ), which recorded 8.5, 90.17, 88.56, 23.8 days, and 43.8 days, respectively. The control ( $T_0$ ) recorded the lowest values viz., 4.9, 55.26, 58.42, 11.1 days, and 25.1 days, respectively. The optimal treatment combination, comprising a specific growing media composition, significantly influences enzyme activation, carbohydrate accumulation in plant cells, leaf carbohydrate content, and water potential. Water balance is a critical factor affecting the quality and longevity of cut flowers and foliage, as highlighted by Pal *et al.* (2015). The enhancement in vase life could be attributed to factors such as weight retention, absorption capacity, and water conductivity of leaf tissues, as reported in previous studies on *Philodendron erubescens* cv. Gold by Abinaya and Karuppaiah (2018), *Petunia* by Khandaker *et al.* (2019), and *Ochna serrulata* by Shahin and Sayed (2021).

This study concluded that the growing medium composed of garden soil, burnt rice husk, farmyard manure (FYM), and cocopeat in a 2:1:1:1 ratio (v/v) proved to be a superior growing media compared to the traditional mix of red soil, sand, and FYM for growth, physiological attributes, yield, and quality parameters of *D. reflexa* cv. Song of India. We can reduce reliance on non-renewable resources by adopting this eco-friendly mixture, thereby improve the overall efficiency of cut foliage production.

## Acknowledgments

We would like to extend our heartfelt gratitude to all individuals and institutions whose support and contributions were invaluable in completing this study.

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Received: April, 2025; Revised: April, 2025; Accepted: April, 2025