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Effect of potting media and nano urea on phenological and physiological parameters of philodendron (*Philodendron scandens*)

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Abstract

An experiment was conducted to evaluate the “Effect of potting media and nano urea on phenological and physiological parameters of *Philodendron scandens*” under container-grown conditions. The study was carried out at the College of Horticulture, Mojerla, SKLTSHU, India, during December 2021-May 2022. The experiment was laid out in a Factorial Randomized Block Design with six nano urea levels (control, conventional urea @ 2 g L⁻¹, and nano urea @ 0.5-2.0 ml L⁻¹) and four potting media compositions. Enriched substrates significantly reduced days to bud sprouting (8.77 days) and full leaf expansion (3.32 days) compared to red earth alone. Nano urea @ 2 ml L⁻¹ recorded the highest Leaf Area Index at 65, 95 and 125 days after planting (1.89, 5.14 and 13.49, respectively), particularly when combined with red earth + cocopeat + FYM (1:1:1). Relative Growth Rate and Specific Leaf Weight were not significantly influenced, whereas Specific Leaf Area showed significant variation among treatments. The results indicate that optimized substrate composition coupled with nano urea application improves physiological efficiency and vegetative growth of *Philodendron*.

Keywords: Nano fertilizer, leaf area index, relative growth rate, specific leaf weight, and specific leaf area

Introduction

Ornamental foliage plants constitute an important segment of the horticultural industry due to their aesthetic value, adaptability to indoor environments, and increasing use in landscaping, vertical gardens, and interior decoration. Among these, *Philodendron* (*Philodendron scandens*), belonging to the family Araceae, is widely cultivated for its attractive heart-shaped leaves, shade tolerance, and ease of vegetative propagation. Commercial success of *Philodendron* production depends largely on the rapid establishment of cuttings, uniform vegetative growth, and superior leaf quality, which are strongly influenced by growing media composition and nutrient management practices.

Potting media play a crucial role in container-grown ornamental plants by providing physical support, moisture, aeration, and nutrients required for optimal growth. An ideal growing medium should possess adequate porosity, high water-holding capacity, good drainage, and sufficient nutrient availability (Kämpf, 2005) [7]. Red earth is commonly used in nursery production due to its availability and low cost; however, it is often deficient in organic matter and nutrients and exhibits poor aeration, which can limit root growth and early plant establishment (Abad *et al.*, 2002) [1]. Incorporation of organic amendments such as cocopeat and farmyard manure (FYM) has been reported to significantly improve the physical and chemical properties of growing media, leading to enhanced root proliferation, nutrient uptake, and vegetative growth in ornamental crops (Kavana and Chandrashekar, 2012; Kaushal *et al.*, 2020) [9, 8].

Cocopeat, a by-product of the coconut industry, is widely used as a growing medium component due to its high water-holding capacity, good aeration, and resistance to microbial degradation (Evans *et al.*, 1996). Farmyard manure serves as a rich source of organic carbon and essential macro- and micronutrients, improves microbial activity, and enhances nutrient availability in the

root zone (Masood *et al.*, 2014) [13]. Several studies have demonstrated that growing media enriched with cocopeat and FYM significantly reduce the time required for bud sprouting and leaf emergence while improving overall plant vigor in ornamental species (Kipkosgei *et al.*, 2003; Ngetich *et al.*, 2011) [13, 14].

Nitrogen is a key macronutrient governing vegetative growth, leaf expansion, chlorophyll synthesis, and photosynthetic efficiency. Conventional nitrogen fertilizers often exhibit low nutrient use efficiency due to losses through leaching, volatilization, and immobilization (Shamsudin *et al.*, 2012) [16]. Recent advances in nanotechnology have led to the development of nano fertilizers, particularly nano urea, which offers improved nutrient use efficiency through controlled release, enhanced foliar absorption, and efficient translocation within plant tissues (Suman Kantwa *et al.*, 2022) [17]. Foliar application of nano urea has been reported to improve growth, leaf area, and biomass accumulation in several agricultural and horticultural crops (Ahmed *et al.*, 2016; Khalil *et al.*, 2019) [2, 10]. However, scientific information on the response of ornamental foliage plants, especially *Philodendron*, to nano urea application remains limited.

Phenological parameters such as days to bud sprouting and full leaf expansion are critical indicators of early establishment and vigor in vegetatively propagated plants. Physiological parameters including Leaf Area Index (LAI), Relative Growth Rate (RGR), Specific Leaf Area (SLA), and Specific Leaf Weight (SLW), provide insights into photosynthetic efficiency, biomass allocation, and leaf functional traits (Williams, 1946; Kvet *et al.*, 1971; Pearce *et al.*, 1968) [19, 12, 15]. These parameters are highly responsive to both substrate conditions and nitrogen availability and are useful in evaluating the growth efficiency and ornamental quality of foliage plants.

In this context, the present investigation was undertaken to study the effect of different potting media compositions and nano urea levels on phenological and physiological parameters of *Philodendron scandens*. The study aims to identify an optimal combination of substrate and foliar nitrogen management that enhances early establishment, vegetative growth, and leaf quality, thereby contributing to sustainable and efficient nursery production of ornamental foliage plants. Materials and Methods

Experimental Site and Plant Material

The study was conducted at the College of Horticulture, Mojerla, PG Research Block, Wanaparthy, Sri Konda Laxman Telangana State Horticultural University, during the *Rabi* season of 2021-2022. *Philodendron scandens* (Heart leaf *Philodendron*), a member of the family Araceae, was used as the experimental material. Stem cuttings, 15 cm in length with four nodes, were collected from healthy donor plants. The experiment was laid out in a Factorial Randomized Block Design (FRBD) with two factors: potting media composition and nano urea levels. The study consisted of 24 treatment combinations, replicated three times, with 10 plants per replication. Polybags of 10 × 12 inches were used, and planting was carried out in the second fortnight of December 2021. Four potting media combinations were evaluated: Red Earth (control), Red Earth + Cocopeat (1:1) Red Earth + Cocopeat + Farmyard Manure (1:1:1) and Red Earth + Cocopeat + Farmyard Manure (2:1:1). Nano urea containing 4% N (40,000 mg L⁻¹, particle size 20-50 nm) was applied at four concentrations (0.05%, 0.1%, 0.15%, and 0.2%). Urea (46% N) was applied at 0.2%. Spray solutions were prepared in 1 L of distilled water. Foliar applications commenced at 35 days after planting and were

repeated every 15 days for three months, totaling six sprays. Stem cuttings were treated with Carbendazim (12%) + Mancozeb (63%) solution for 10 minutes, followed by 1000 ppm IBA for 15 minutes. Cuttings were planted in polybags with two nodes below the media surface and two nodes above. Watering was applied with a fine rose can. Irrigation was performed every two days from December to February and on alternate days from March to May. Media was loosened every 10 days, and a weekly weeding was performed to maintain optimal growth conditions.

Phenological Observations

Phenological traits were recorded as follows:

- **Days to bud sprouting:** Number of days from planting to leaf emergence.
- **Days to full leaf expansion:** Number of days from leaf emergence to full expansion. Average values were calculated for all observations.

Physiological Observations

Physiological parameters were measured at 65, 95, and 125 days after planting:

Physiological parameters

All the physiological parameters like LAI (Leaf Area Index) at RGR (Relative Growth Rate, g g⁻¹ day⁻¹), SLA (Specific Leaf Area, cm² g⁻¹), SLW (Specific Leaf Weight, g cm⁻²) were measured at 65, 95, 125 days after planting.

Leaf Area Index (LAI)

LAI was recorded by measuring the ratio of the leaf area of the plant to the total ground area occupied by the plant. It was expressed numbers proposed by Williams (1946).

$$LAI = \frac{\text{total leaf area of the plant}}{\text{ground area occupied by the plant}}$$

Relative Growth Rate (RGR g g⁻¹ day⁻¹)

The relative growth rate of the leaf expresses the total leaf dry weight increase in a time interval in relation to the initial weight or dry matter increment per unit biomass per unit time and is expressed as unit dry weight/ unit dry weight/ unit time (g g⁻¹ day⁻¹), proposed by Williams (1946).

$$RGR \text{ of a leaf} = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1}$$

Where W₁ and W₂ are leaf dry weight at t₁ and t₂, respectively, are time t₁ and t₂ interval in days.

Specific Leaf AREA (SLA cm² g⁻¹)

Specific leaf area was measured by taking the ratio of leaf area to the leaf dry weight, and it was expressed in cm² g⁻¹, proposed by Kvet *et al.* (1971).

$$SLA = \frac{\text{leaf area}}{\text{dry leaf weight}} \text{ cm}^2 \text{ g}^{-1}$$

Specific Leaf weight (g cm⁻²)

Specific leaf weight is a measure of leaf weight per unit area. It was measured by taking the ratio of leaf weight to the leaf area

and expressed in g cm^{-2} , as suggested by Pearce *et al.* (1968).

$$\text{SLW} = \frac{\text{leaf weight}}{\text{leaf area}} \text{ g cm}^{-2}$$

Results and Discussion

Phenological Parameters: Phenological traits are critical indicators of successful plant establishment, early vigor, and adaptive growth responses under varying substrate conditions. In vegetatively propagated ornamental crops such as *Philodendron*, early phenological events like bud sprouting and leaf expansion largely determine subsequent growth performance, canopy development, and aesthetic quality. In the present study, phenological observations were recorded during the initial stages of cutting establishment, prior to the imposition of nano urea treatments, to exclusively evaluate the influence of potting media composition on early growth responses.

Number of Days for Bud Sprouting: The number of days required for bud sprouting differed significantly among the potting media treatments (Table 1). The shortest duration for bud sprouting was observed in Red Earth + Cocopeat + FYM (1:1:1; M3) and Red Earth + Cocopeat + FYM (2:1:1; M4), both recording 8.77 days, whereas Red Earth alone (M1) exhibited a markedly delayed bud sprouting period of 21.61 days. The early initiation of bud sprouting in M3 and M4 can be attributed to the improved physical, chemical, and biological properties of these substrates. Cocopeat significantly enhances water-holding capacity, porosity, and aeration, thereby ensuring adequate oxygen supply to developing roots and meristematic tissues, which is essential for cell division and bud break (Kavana and Chandrashekar, 2012; Kaushal *et al.*, 2020) [9, 8]. The presence of FYM further improves nutrient availability by supplying readily mineralizable nitrogen, phosphorus, potassium, and trace

elements, which stimulate enzymatic activity and meristem differentiation (Masood *et al.*, 2014) [13]. In contrast, Red Earth (M1) is comparatively compact, low in organic matter, and deficient in readily available nutrients, resulting in poor root proliferation and delayed physiological activation of buds. Similar reductions in sprouting time due to enriched growing media have been reported in strawberry (Kipkosgei *et al.*, 2003) [13], spider plant, and palm (Ngetich *et al.*, 2011) [14]. These findings clearly demonstrate that substrate composition plays a pivotal role in regulating early metabolic activity and the successful establishment of *Philodendron* cuttings.

Number of Days for Full Leaf Expansion: The duration required for full leaf expansion was also significantly influenced by potting media composition. The shortest time for full leaf expansion was recorded in M3 (3.32 days), followed by M4 (4.38 days), while M1 (6.24 days) required the longest period. Rapid leaf expansion in M3 and M4 can be attributed to the synergistic interaction between cocopeat and FYM, which ensures continuous moisture availability, improved aeration, and sustained nutrient supply. Cocopeat maintains uniform substrate moisture, preventing transient water stress that can delay cell enlargement, while FYM enhances nutrient uptake efficiency and supports metabolic processes involved in leaf cell elongation and differentiation (Masood *et al.*, 2014) [13]. Faster leaf expansion increases the photosynthetically active surface area at an early stage, enabling higher carbohydrate production and improved energy availability for subsequent vegetative growth. Similar observations have been reported in ornamental crops grown under organic-enriched substrates, where rapid leaf expansion was associated with enhanced plant vigor and canopy development (Kipkosgei *et al.*, 2003; Ngetich *et al.*, 2011) [13, 14]. The results emphasize that optimized substrate composition is crucial for achieving early vegetative uniformity and improved growth efficiency in *Philodendron*.

Table 1: Effect of composition of potting media on number of days taken for sprouting (days) and number of days taken for full leaf expansion (days) in *Philodendron scandens*

Media composition	Number of days taken for sprouting (days)	Number of days taken for full leaf expansion (days)
M ₁	21.61	6.24
M ₂	15.50	5.02
M ₃	8.77	3.32
M ₄	10.52	4.38
M ₁ : Red earth M ₃ : Red earth + Cocopeat + FYM (1:1:1)		
M ₂ : Red earth + Cocopeat (1:1) M ₄ : Red earth + Cocopeat + FYM (2:1:1)		

Physiological Parameters: In the present investigation, Leaf Area Index (LAI), Relative Growth Rate (RGR), Specific Leaf Area (SLA), and Specific Leaf Weight (SLW) were evaluated at 65, 95 and 125 days after planting (DAP).

Leaf Area Index (LAI): LAI exhibited significant variation due to nano urea levels, potting media, and their interactions (Tables 2a, 2b; Fig. 1a, b, c). LAI progressively increased with plant age across all treatments. At 65 DAP, LAI ranged from 0.68 (N0M1) to 1.89 (N5M3); at 95 DAP, from 1.88 to 5.14; and at 125 DAP, from 4.67 to 13.49, with the maximum consistently recorded under N5M3. The superior LAI observed in nano urea-treated plants, particularly at 2 ml L⁻¹ (N5), can be attributed to the high nitrogen use efficiency of nano urea, which facilitates rapid

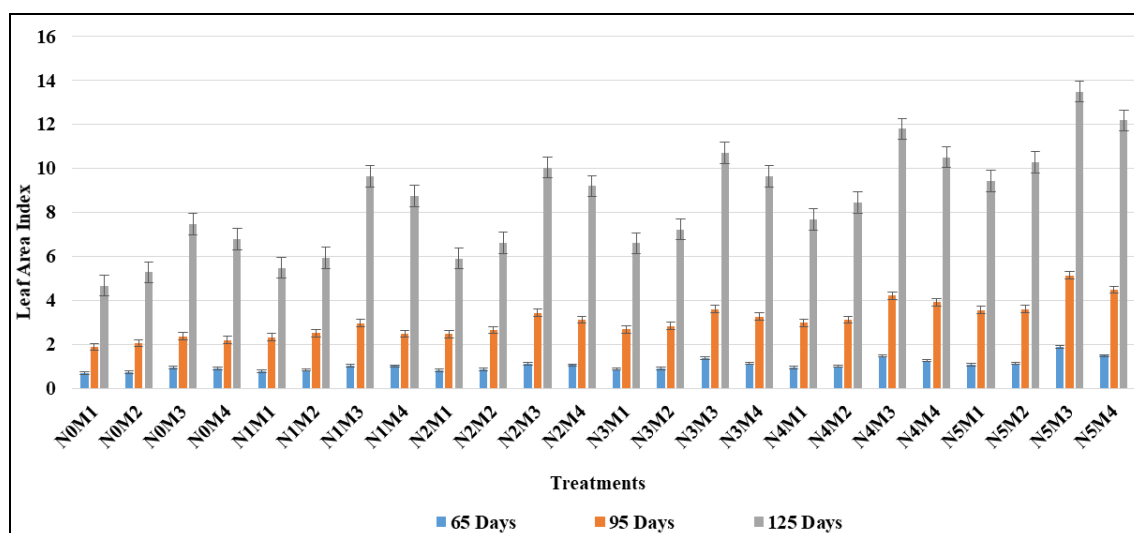
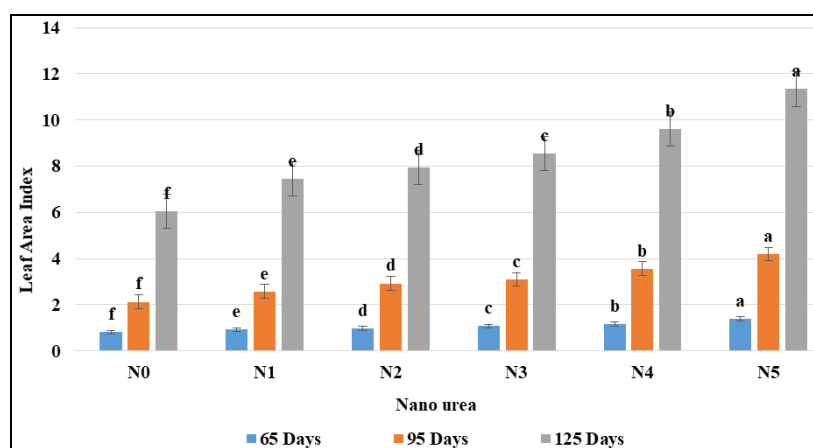
absorption through foliar tissues and efficient translocation within the plant system. Nitrogen plays a vital role in chlorophyll synthesis, protein formation, and enzymatic activity, all of which directly influence leaf expansion, leaf number, and plant height (Ahmed *et al.*, 2016) [2]. The interaction with enriched potting media (M3 and M4) further enhanced LAI due to improved root growth, sustained nutrient availability, and favorable moisture regimes. Higher LAI translates into greater photosynthetic surface area, resulting in enhanced carbohydrate production and dry matter accumulation. These findings are in agreement with earlier reports in ornamental and field crops, where nano fertilizers significantly increased leaf area and biomass due to improved nutrient efficiency (Khalil *et al.*, 2019) [10].

Table 2a: Effect of nano urea levels and composition of potting media on Leaf Area Index at 65 and 95 days after planting *Philodendron scandens*

Media Composition	Nano Urea Levels													
	65 Days After Planting							95 Days After Planting						
	N ₀	N ₁	N ₂	N ₃	N ₄	N ₅	MEAN	N ₀	N ₁	N ₂	N ₃	N ₄	N ₅	MEAN
M1	0.678	0.78	0.828	0.872	0.942	1.059	0.86 ^d	1.882	2.328	2.471	2.671	2.979	3.553	2.647 ^d
M2	0.722	0.832	0.857	0.905	1.00	1.128	0.907 ^c	2.046	2.507	2.646	2.835	3.117	3.604	2.792 ^c
M3	0.938	1.041	1.117	1.359	1.469	1.887	1.302 ^a	2.358	2.958	3.425	3.599	4.209	5.137	3.615 ^a
M4	0.89	1.008	1.055	1.132	1.26	1.477	1.137 ^b	2.189	2.481	3.122	3.256	3.912	4.476	3.239 ^b
MEAN	0.807 ^f	0.915 ^e	0.965 ^d	1.067 ^c	1.168 ^b	1.388 ^a		2.119 ^f	2.569 ^e	2.916 ^d	3.09 ^c	3.554 ^b	4.193 ^a	
	S.E.M			C.D. 5%				S.E.M			C.D. 5%			
N	0.0051			0.0146				0.0112			0.0319			
M	0.0042			0.0119				0.0092			0.0261			
N*M	0.0102			0.0291				0.0224			0.0638			

Table 2b: Effect of nano urea levels and composition of potting media on Leaf Area Index at 125 days after planting in *Philodendron scandens*

Media Composition	Nano Urea Levels						
	N ₀	N ₁	N ₂	N ₃	N ₄	N ₅	MEAN
M ₁	4.67	5.48	5.91	6.59	7.67	9.43	6.63 ^d
M ₂	5.27	5.94	6.60	7.22	8.44	10.26	7.29 ^c
M ₃	7.46	9.63	10.04	10.71	11.79	13.49	10.52 ^a
M ₄	6.79	8.75	9.19	9.65	10.51	12.17	9.51 ^b
MEAN	6.05 ^f	7.45 ^e	7.94 ^d	8.54 ^c	9.60 ^b	11.34 ^a	
	S.E.M			C.D. 5%			
N	0.016			0.05			
M	0.013			0.04			
N*M	0.032			0.09			
N ₀ : Control (No sprays)	N ₃ : Nano urea 1 ml L ⁻¹			M ₁ : Red earth			
N ₁ : Conventional Urea 2 g L ⁻¹	N ₄ : Nano urea 1.5 ml L ⁻¹			M ₂ : Red earth + Cocopeat (1:1)			
N ₂ : Nano urea 0.5 ml L ⁻¹	N ₅ : Nano urea 2 ml L ⁻¹			M ₃ : Red earth + Cocopeat + FYM (1:1:1)			
				M ₄ : Red earth + Cocopeat + FYM (2:1:1)			

**Fig 1:** Interaction effect of nano urea levels and composition of potting media on Leaf Area Index in *Philodendron scandens***Fig 1b:** Effect of nano urea levels on Leaf Area Index in *Philodendron*

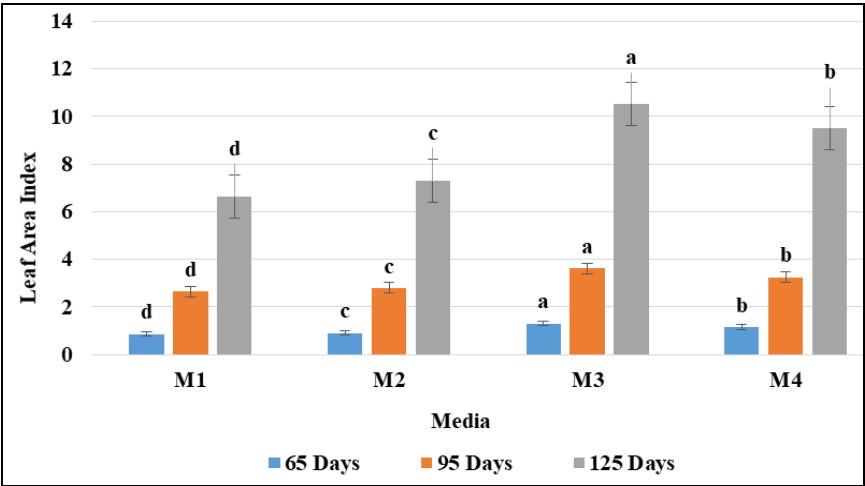


Fig 1c: Effect of composition of potting media

N ₀ : Control (No sprays)	N ₃ : Nano urea 1 ml L ⁻¹	M ₁ : Red earth
N ₁ : Conventional Urea 2 g L ⁻¹	N ₄ : Nano urea 1.5 ml L ⁻¹	M ₂ : Red earth + Cocopeat (1:1)
N ₂ : Nano urea 0.5 ml L ⁻¹	N ₅ : Nano urea 2 ml L ⁻¹	M ₃ : Red earth + Cocopeat + FYM (1:1:1)

Relative Growth Rate (RGR): Relative Growth Rate did not differ significantly among treatments during the intervals of 65-95 DAP and 65-125 DAP (Table 3). The absence of significant variation in RGR suggests that while nano urea and enriched substrates enhanced absolute growth parameters such as LAI and leaf number, the rate of biomass accumulation per unit leaf mass remained relatively constant. This indicates that growth enhancement primarily occurred through increased leaf surface area rather than changes in metabolic efficiency or assimilate partitioning. Similar findings have been reported in ornamental species, where foliar nutrient application promoted vegetative expansion without significantly altering relative growth rates (Evans, 1972).

Specific Leaf Area (SLA): SLA exhibited significant differences among treatments at all growth stages (Tables 4a, 4b; Fig. 2a, 2b, 2c). The highest SLA values were consistently recorded in enriched media combinations, particularly M3, while the lowest values were observed under higher nano urea concentrations (N₅). Higher SLA in M3 indicates the production of thinner leaves with a larger surface area per unit dry mass, which favors rapid photosynthesis and efficient light interception. Conversely, the reduction in SLA at higher nano urea levels suggests the development of thicker leaves with

greater dry matter accumulation, reflecting enhanced structural investment. SLA is a key functional trait linking carbon gain and water-use efficiency, and higher SLA is generally associated with faster growth and greater resource acquisition (Cheng *et al.*, 2018). The results further suggest that moderate nutrient availability promotes optimal leaf morphology, while excessive nitrogen may shift biomass allocation toward leaf thickening rather than expansion (Cornelissen, 2003) [4]. FYM and cocopeat likely contributed to improved biomass accumulation and leaf development by enhancing nutrient availability and root activity (Van Averbek *et al.*, 2007) [18].

Specific Leaf Weight (SLW): Specific Leaf Weight did not show significant variation across nano urea levels, potting media, or their interactions at 65, 95, and 125 DAP (Tables 5a, 5b). The stability of SLW across treatments indicates that leaf structural integrity and density were maintained, even under enhanced nutrient availability. While LAI and SLA responded to treatments, SLW remained unchanged, suggesting balanced leaf development without excessive thickening or thinning. This is particularly desirable in ornamental foliage plants, as it ensures durability, aesthetic appeal, and physiological efficiency. Stable SLW alongside increased LAI reflects efficient biomass allocation, enabling plants to expand leaf area without compromising leaf strength.

Table 3: Effect of nano urea levels and media composition on Relative Growth Rate (g g⁻¹ day⁻¹) at 65 to 95 and 65 to 125 days after planting in *Philodendron scandens*

Media Composition	Nano Urea Levels													
	65 To 95 Days After Planting							65 To 125 Days After Planting						
	N ₀	N ₁	N ₂	N ₃	N ₄	N ₅	MEAN	N ₀	N ₁	N ₂	N ₃	N ₄	N ₅	MEAN
M ₁	0.001	0.002	0.002	0.002	0.002	0.003	0.002	0.001	0.002	0.002	0.003	0.003	0.003	0.002
M ₂	0.001	0.002	0.003	0.003	0.003	0.003	0.002	0.001	0.002	0.003	0.003	0.003	0.003	0.003
M ₃	0.001	0.003	0.004	0.004	0.006	0.010	0.005	0.001	0.003	0.004	0.004	0.005	0.008	0.004
M ₄	0.001	0.002	0.003	0.004	0.005	0.007	0.004	0.001	0.002	0.003	0.004	0.004	0.007	0.004
MEAN	0.001	0.002	0.003	0.003	0.004	0.006	0.003	0.001	0.002	0.003	0.003	0.004	0.005	0.003
	S.E.M			C.D. 5%				S.E.M			C.D. 5%			
N	NS			NS				NS			NS			
M	NS			NS				NS			NS			
N*M	NS			NS				NS			NS			
N ₀ : Control (No sprays)	N ₃ : Nano urea 1 ml L ⁻¹							M ₁ : Red earth						
N ₁ : Urea 2 g L ⁻¹	N ₄ : Nano urea 1.5 ml L ⁻¹							M ₂ : Red earth + Cocopeat (1:1)						
N ₂ : Nano urea 0.5 ml L ⁻¹	N ₅ : Nano urea 2 ml L ⁻¹							M ₃ : Red earth + Cocopeat + FYM (1:1:1)						
	N ₃ : Nano urea 1 ml L ⁻¹							M ₄ : Red earth + Cocopeat + FYM (2:1:1)						

Table 4a: Effect of nano urea levels and composition of potting media on Specific Leaf Area (cm² g⁻¹) at 65 and 95 days after planting in *Philodendron scandens*

Media Composition	Nano Urea Levels													
	65 Days After Planting							95 Days After Planting						
	N ₀	N ₁	N ₂	N ₃	N ₄	N ₅	MEAN	N ₀	N ₁	N ₂	N ₃	N ₄	N ₅	MEAN
M ₁	191.81	201.83	186.50	177.35	168.99	167.04	182.25 ^b	182.05	215.22	216.25	196.43	199.24	192.23	200.24 ^b
M ₂	250.30	236.56	230.48	224.38	203.81	168.67	219.03 ^a	240.15	258.13	239.58	231.19	218.21	214.90	233.69 ^a
M ₃	265.05	270.87	265.27	226.87	201.10	196.60	237.63 ^a	287.17	292.38	271.92	245.46	210.09	177.87	247.48 ^a
M ₄	231.55	249.80	224.00	203.91	183.98	201.17	215.73 ^a	260.84	265.90	238.62	223.17	208.81	200.36	232.95 ^a
MEAN	234.68 ^a	239.77 ^a	226.56 ^{ab}	208.13 ^{bc}	189.47 ^{cd}	183.37 ^d		242.54 ^b	257.91 ^a	241.60 ^b	224.06 ^c	209.09 ^{cd}	196.34 ^d	
	S.E.M			C.D. 5%				S.E.M			C.D. 5%			
N	3.80			10.82				1.95			7.52			
M	3.10			8.83				1.59			6.14			
N*M	7.60			21.64				3.89			15.04			

Table 4b: Effect of nano urea levels and composition of potting media on Specific Leaf Area (cm² g⁻¹) at 125 days after planting in *Philodendron scandens*

Media Composition	Nano Urea Levels						
	N ₀	N ₁	N ₂	N ₃	N ₄	N ₅	MEAN
M ₁	181.86	224.31	233.00	203.80	203.66	206.41	208.84 ^b
M ₂	242.67	261.67	244.70	238.61	240.49	221.20	241.56 ^a
M ₃	305.88	297.89	270.48	236.85	204.60	171.44	247.85 ^a
M ₄	250.45	280.34	262.77	236.82	218.97	189.94	239.88 ^a
MEAN	245.21 ^{bc}	266.05 ^a	252.73 ^{ab}	229.02	216.93 ^d	197.245 ^e	
	S.E.M			C.D. 5%			
N	3.0019			8.5453			
M	2.451			6.9772			
N*M	6.0037			17.0905			
N ₀ : Control (No sprays)	N ₃ : Nano urea 1 ml L ⁻¹			M ₁ : Red earth			
N ₁ : Urea 2 g L ⁻¹	N ₄ : Nano urea 1.5 ml L ⁻¹			M ₂ : Red earth + Cocopeat (1:1)			
N ₂ : Nano urea 0.5 ml L ⁻¹	N ₅ : Nano urea 2 ml L ⁻¹			M ₃ : Red earth + Cocopeat + FYM (1:1:1)			
				M ₄ : Red earth + Cocopeat + FYM (2:1:1)			

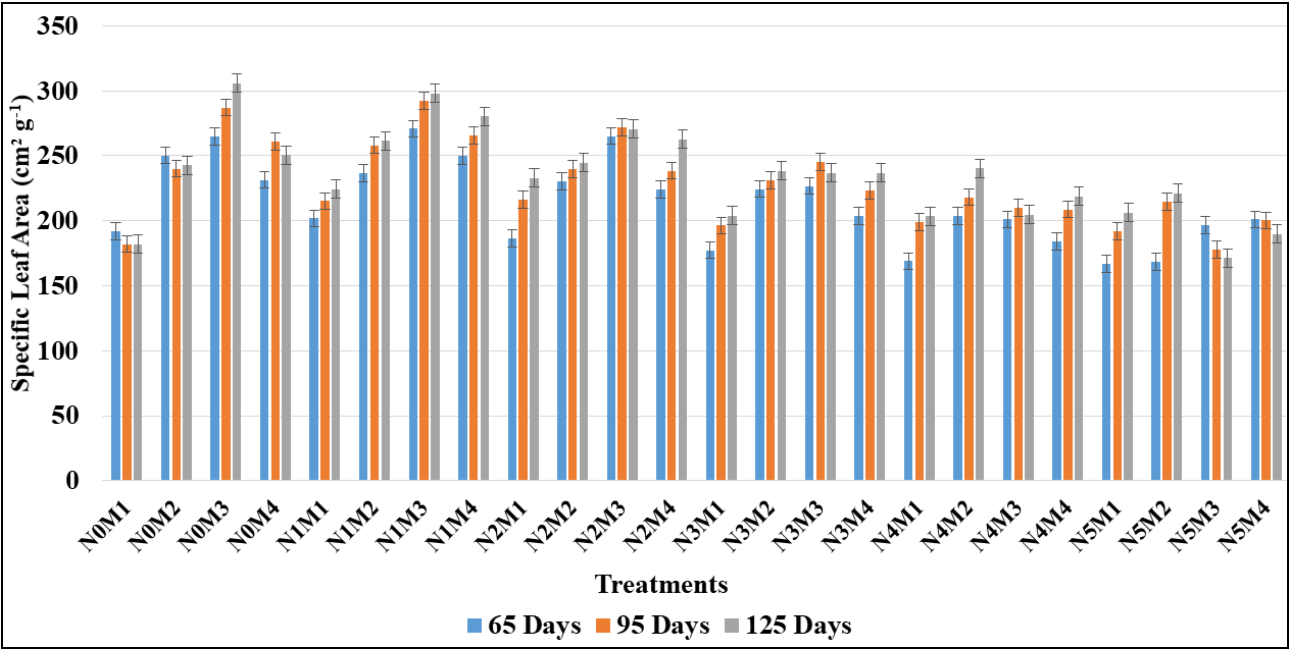


Fig 2a: Interaction effect of nano urea levels and composition of potting media on Specific Leaf Area (cm² g⁻¹) *Philodendron scandens*

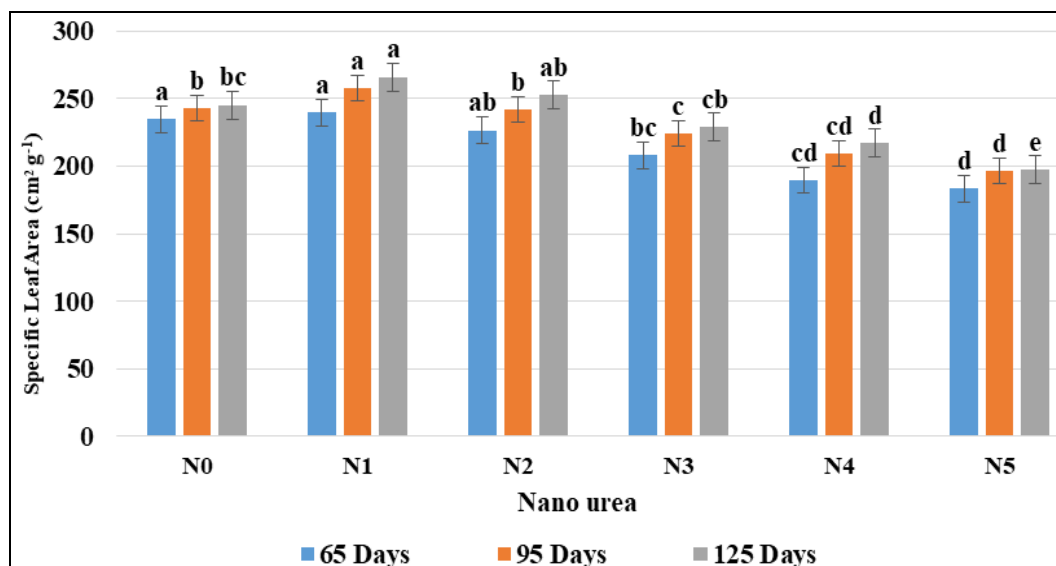


Fig 2b: Effect of nano urea levels on Specific Leaf Area ($\text{cm}^2 \text{g}^{-1}$) in *Philodendron*

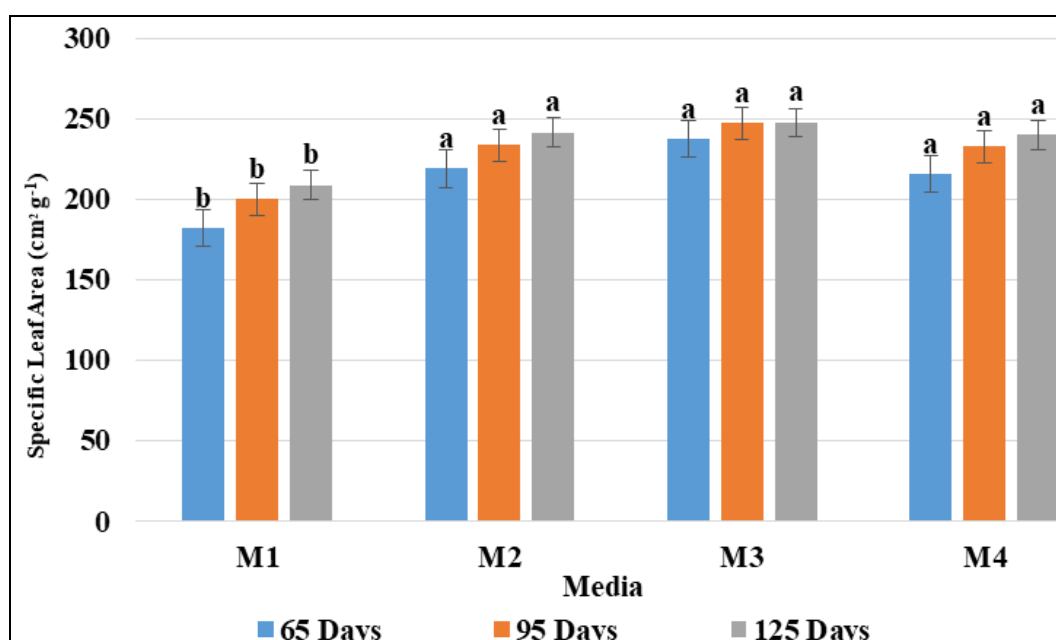


Fig 2c: Effect of composition of potting media on Specific Leaf *scandens* Area ($\text{cm}^2 \text{g}^{-1}$) *scandens*

N ₀ : Control (No sprays)	N ₃ : Nano urea 1 ml L ⁻¹	M ₁ : Red earth
N ₁ : Conventional Urea 2 g L ⁻¹	N ₄ : Nano urea 1.5 ml L ⁻¹	M ₂ : Red earth + Cocopeat (1:1)
N ₂ : Nano urea 0.5 ml L ⁻¹	N ₅ : Nano urea 2 ml L ⁻¹	M ₃ : Red earth + Cocopeat + FYM (1:1:1)
		M ₄ : Red earth + Cocopeat + FYM (2:1:1)

Table 5a: Effect of nano urea levels and composition of potting media on Specific Leaf Weight (g cm^{-2}) at 65 and 95 days after planting in *Philodendron scandens*

Media composition	Nano Urea Levels													
	65 Days After Planting							95 Days After Planting						
	N ₀	N ₁	N ₂	N ₃	N ₄	N ₅	MEAN	N ₀	N ₁	N ₂	N ₃	N ₄	N ₅	MEAN
M ₁	0.005	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.005	0.005	0.005	0.005	0.005	0.005
M ₂	0.004	0.004	0.004	0.004	0.005	0.006	0.005	0.004	0.004	0.004	0.004	0.005	0.005	0.004
M ₃	0.004	0.004	0.004	0.004	0.005	0.005	0.004	0.003	0.003	0.004	0.004	0.005	0.006	0.004
M ₄	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.005	0.005	0.005	0.004
MEAN	0.004	0.004	0.005	0.005	0.005	0.006	0.005	0.004	0.004	0.004	0.005	0.005	0.005	0.004
	S.E.M			C.D. 5%				S.E.M			C.D. 5%			
N	NS			NS				NS			NS			
M	NS			NS				NS			NS			
N*M	NS			NS				NS			NS			

Table 5b: Effect of nano urea levels and composition of potting media on Specific Leaf Weight (g cm^{-2}) at 125 days after planting in *Philodendron scandens*

Media Composition	Nano Urea Levels						
	N ₀	N ₁	N ₂	N ₃	N ₄	N ₅	MEAN
M ₁	0.006	0.005	0.004	0.005	0.005	0.005	0.005
M ₂	0.004	0.004	0.004	0.004	0.004	0.005	0.004
M ₃	0.003	0.003	0.004	0.004	0.005	0.006	0.004
M ₄	0.004	0.004	0.004	0.004	0.005	0.005	0.004
MEAN	0.004	0.004	0.004	0.004	0.005	0.005	0.004
	S.E.M			C.D. 5%			
N	NS			NS			
M	NS			NS			
N*M	NS			NS			
N ₀ : Control (No sprays)	N ₃ : Nano urea 1 ml L ⁻¹			M ₁ : Red earth			
N ₁ : Urea 2 g L ⁻¹	N ₄ : Nano urea 1.5 ml L ⁻¹			M ₂ : Red earth + Cocopeat (1:1)			
N ₂ : Nano urea 0.5 ml L ⁻¹	N ₅ : Nano urea 2 ml L ⁻¹			M ₃ : Red earth + Cocopeat + FYM (1:1:1)			
				M ₄ : Red earth + Cocopeat + FYM (2:1:1)			

Conclusion

The present investigation clearly demonstrates that both potting media composition and nano urea application play a decisive role in regulating the phenological and physiological performance of *Philodendron* during early establishment and subsequent vegetative growth. Phenological traits recorded prior to nano urea application revealed that media composition alone significantly influenced cutting establishment, emphasizing the foundational role of substrate quality in ornamental foliage crops.

Among the potting media evaluated, Red Earth + Cocopeat + FYM (1:1:1; M₃) and Red Earth + Cocopeat + FYM (2:1:1; M₄) proved superior by significantly reducing the number of days required for bud sprouting and full leaf expansion. The enhanced performance of these media can be attributed to improved physical properties such as aeration, porosity, and moisture retention, coupled with enhanced nutrient availability from FYM. In contrast, Red Earth alone (M₁) resulted in delayed bud sprouting and leaf expansion, highlighting its limitations in supporting rapid early growth due to poor nutrient status and suboptimal root zone conditions.

Physiological parameters further confirmed the beneficial effects of optimized substrates and nano urea application. Leaf Area Index (LAI) showed a consistent and significant increase with advancing growth stages, particularly under nano urea @ 2 ml L⁻¹ (N₅) in combination with enriched media (M₃ and M₄). The highest LAI recorded under these treatments reflects enhanced leaf expansion, greater photosynthetic surface area, and improved nitrogen use efficiency, all of which contribute to increased dry matter accumulation and plant vigor. The Relative Growth Rate (RGR) remained statistically unaffected by treatments, suggesting that growth enhancement occurred primarily through increased leaf area and biomass accumulation rather than changes in the relative rate of dry matter production. This stability in RGR indicates efficient physiological regulation, ensuring balanced growth even under enhanced nutrient availability. Specific Leaf Area (SLA) exhibited significant variation across treatments and growth stages, reflecting changes in leaf morphology and resource allocation. Higher SLA values observed under enriched media indicate thinner, expansive leaves conducive to rapid photosynthesis and growth, whereas reduced SLA under higher nano urea levels suggests increased leaf thickness and structural reinforcement. These responses indicate that moderate nutrient availability coupled with organic substrate enrichment optimizes leaf functional traits, while higher nitrogen levels promote denser

leaf structure. Importantly, Specific Leaf Weight (SLW) remained unaffected across treatments, indicating that improvements in leaf area and morphology did not compromise leaf structural integrity. This is particularly relevant for ornamental foliage crops, where leaf strength, texture, and durability are critical quality attributes.

Overall, the study confirms that the integration of enriched potting media, particularly M₃, with nano urea application (N₅) creates a favorable rhizosphere and nutrient environment that accelerates early establishment, enhances leaf development, and improves physiological efficiency in *Philodendron*. The combined use of cocopeat and FYM ensures optimal root growth and nutrient supply, while nano urea enhances nitrogen availability and utilization efficiency. From a practical standpoint, the findings suggest that adopting Red Earth + Cocopeat + FYM (1:1:1) along with foliar application of nano urea @ 2 ml L⁻¹ can significantly improve vegetative growth, leaf quality, and overall ornamental value of *Philodendron*. This integrated nutrient and substrate management strategy offers a sustainable and efficient approach for commercial foliage plant production, ensuring rapid establishment, improved photosynthetic performance, and superior aesthetic quality.

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