Journal of Dry Zone Agriculture, 2026, 12(1):1-10
© 2026 Faculty of Agriculture, University of Jaffna, Sri Lanka
DOI: https://doi.org/10.4038/jdza.v12i1.130

Research Article:

Evaluation of locally available materials as polybag nursery media for coconut (*Cocos nucifera* L.) seedlings

M.P.S.L. Dharmasena[1], K.G. Ketipearachchi[1*], A.B.M. Jesfar[2], P.O.P. Weerasinghe[1], B.P. Siriwardena[1], and S.L. Nawarathna[1]

[1]Department of Agro-Technology, University of Colombo Institute for Agro-Technology Rural Science, Weligatta, Hambantota, Sri Lanka

[2]Sri Lanka Institute of Advanced Technological Education, Hardy Advanced Technological Institute, Ampara, Sri Lanka

Received on December 03, 2025; Accepted on October 09, 2026

Abstract

Coconut nurseries in Sri Lanka encounter significant challenges with conventional potting media due to the high cost of cow dung and the limited availability of coir dust. There is a need to develop an alternative potting medium for coconut nurseries using locally available materials. Therefore, this study was conducted at the coconut seedling nursery of the Coconut Cultivation Board, Ampara, Sri Lanka, from September 2024 to May 2025. The experiment was laid out in a Completely Randomized Design (CRD) with 4 treatments and 25 replicates per treatment. The treatments consisted of a conventional potting medium (T1: coir dust, cow dung and topsoil) as the control and three alternative formulations: T2 (paddy husk, charcoal and topsoil), T3 (paddy husk, bagasse and topsoil) and T4 (paddy husk, compost and topsoil), with all components mixed at a ratio of 3:2:1 (v/v), respectively. Coconut seedlings (CRIC60) were grown for 16 weeks, with growth parameters monitored regularly. According to the results, T1 (control; 10.6 cm) and T4 (10.2 cm) produced statistically similar collar girth values in the 16th week. All treatments showed no significant differences ($p > 0.05$) in the number of fully opened leaves and leaf width. Plant height was significantly higher in T1 (83.0 cm) in the 16th week. Treatment T4 recorded the highest number of roots (12.4) and the highest root volume (8.9 mL), while root length did not differ significantly among treatments. Compared to the control (T1), seedlings grown in T4 produced 67.6% more roots and 46.1% greater root volume, indicating enhanced root development. Therefore, the use of paddy husk: compost: topsoil (3:2:1) mixture (T4) could therefore be recommended as an alternative growing medium for coconut nurseries aiming to produce vigorous seedlings.

Keywords: coconut; coir dust; nursery media; seedling

Cite this article:
Dharmasena, M.P.S.L., Ketipearachchi, K.G., Jesfar, A.B.M., Weerasinghe, P.O.P., Siriwardena, B.P., & Nawarathna, S.L. (2026). Evaluation of locally available materials as polybag nursery media for coconut (*Cocos nucifera* L.) seedlings. *Journal of Dry Zone Agriculture, 12*(1), 1-10

*Corresponding author: gayathri@uciars.cmb.ac.lk
Postal address: Department of Agro-Technology, University of Colombo Institute for Agro-Technology Rural Science, Weligatta, Hambantota, Sri Lanka.

This article is published under the terms of a Creative Commons Attribution-Non-Commercial 4.0 International License (CC BY-NC 4.0). (https://creativecommons.org/licenses/by-nc/4.0/)

1. Introduction

Coconut (*Cocos nucifera* L.) is a major plantation crop in Sri Lanka (Periyapperuma et al., 2023), ranking the country as the world's fourth largest exporter of fresh and dried coconut products (Export Development Board, 2025). This growing economic demand for coconuts requires increased domestic coconut production. Coconut is propagated mainly through seeds, and the direct planting of coconut seeds in the field is not recommended because of non-uniform germination (Harries, 2012). Therefore, proper selection and planting of good-quality seed nuts must be done to ensure a productive plantation (Thomas et al., 2019). Generally, coconut seeds should be raised in a nursery for about 7-10 months before field establishment (Coconut Research Institute of Sri Lanka, 2018a). Coconut seedlings can either be produced in polybags or in nursery beds to ensure the production of healthy, high-quality planting material. The general potting mixture for raising coconut seedlings in polybags is a 3:2:1 mixture of coir dust, cow dung, and topsoil (Coconut Research Institute of Sri Lanka, 2018a). The high cost of cow dung and the limited availability of coir dust present major constraints in non-traditional coconut-growing regions, particularly in the dry zone, where alternative organic materials such as sawdust, paddy husk, straw, bagasse, and weed residues are abundant. Even within the coconut triangle (i.e., the main area of coconut cultivation in Sri Lanka, centred around Kurunegala, Puttalam, and Gampaha districts), coir dust increases the cost of producing polybag-grown seedlings because of its increasing demand in the export market (Bandaranayake et al., 1997). Several locally available agricultural by-products have been selected as alternative components of nursery growing media due to their favourable physical properties and availability. Paddy husk was selected as an alternative substrate component because of its granular structure, chemical stability, high mechanical strength, and ability to improve aeration and drainage, in addition to its abundant availability and low cost (Awang et al., 2009; El Sharkawi et al., 2014). Charcoal has also been recognized as a potential substrate amendment due to its porous structure, which can increase substrate porosity, reduce bulk density, and improve water-holding capacity, thereby enhancing root zone aeration and water availability (Khan et al., 2024). Sugarcane bagasse was selected due to its availability and previously demonstrated potential as an alternative growing medium component for nursery production of plantation crops, particularly sugarcane (Singh et al., 2021). Compost was included as an organic nutrient source due to its ability to improve nutrient availability, organic matter content, and microbial activity in growing substrates. Ismail et al. (2020) investigated the effects of various growing media containing topsoil, sand, oil palm fruit fibre, and coco peat on the vegetative growth of coconut seedlings grown in polybags and reported that media supplemented with organic materials and coco peat improved seedling growth performance. Similarly, studies on coconut nursery production have mainly focused on conventional materials such as coir, soil, sand, and organic manures, while there have been limited studies done using locally available agricultural residues. Therefore, the present study was designed to evaluate the potential of locally available organic materials, including paddy husk, charcoal, bagasse, and compost, as alternative components of coconut nursery media.

2. Materials and Methods

2.1. Experimental site

The experiment was carried out at the coconut seedling nursery of the Coconut Cultivation Board, Ampara, Sri Lanka, located at a latitude of 7.3000^0N and a longitude of 81.670^0E, during the period from September 2024 to May 2025.

2.2. Establishment of pre-nursery

The nursery was established according to the recommendations of the Coconut Research Institute of Sri Lanka (2018a). A raised bed was prepared to accommodate five rows of seed nuts, with a spacing of 15 cm between each row. Seed nuts of the variety CRIC60

were collected from the isolated seed garden at Ambakelle. The variety CRIC60 was selected for this study as it is recommended by the Coconut Research Institute of Sri Lanka (2018b) for cultivation in all coconut-growing areas of the country and is suitable for large-scale plantations due to its high yield of 12,000-15,000 nuts/ha. The collected nuts were placed vertically in the bed with the perianth facing upward.

2.3. Experimental design and treatments

The experiment was laid out in a Completely Randomized Design (CRD) with 4 treatments (Table 1) and 25 replicates for each treatment. Each polybag containing a single coconut seedling was considered an independent experimental unit.

2.3.1. Preparation of polybags for planting

Black polythene bags (500-gauge; 28 cm × 40 cm) were taken and filled with potting media (9 L per bag), leaving 3 cm from the top edge of the bag. For this purpose, different potting media were prepared based on the different treatments. The experiment used clean, raw paddy husk; air-dried fresh bagasse; well-decomposed compost; dry cow dung; and topsoil free from stones and debris.

2.3.2. Seedling selection from pre-nursery bed, transplanting and aftercare management

150 days after nursery establishment, seedlings with uniform bud growth, uniform size, and similar germination time were selected and transplanted into the prepared polybags, placed at a spacing of 30 cm × 30 cm. All aftercare management practices were done according to the recommendations provided by the Coconut Research Institute of Sri Lanka (2018a). Accordingly, irrigation was provided at 3-day intervals and a fertilizer mixture comprising urea, muriate of potash (MOP), triple superphosphate (TSP), and kieserite in a ratio of 1.5:2:1:1, respectively, was applied at a rate of 70 g per polybag following the recommendation of the Coconut Research Institute of Sri Lanka (2018a).

2.4. Data collection and analysis

Quantitative parameters such as girth at collar (circumference of the stem at the collar region of the seedling – Figure 01), number of fully opened leaves, leaf width (maximum width of a fully opened leaf – Figure 1), root length (length from the base of the stem to the tip of the longest root), root volume (water displacement method – Figure 2), root number (number of primary roots emerging from the base of the stem), and seedling height (length from the base of the stem to the tip of the longest fully opened leaf – Figure 01) were measured. Leaf colour, measured using a leaf colour chart (Department of Agriculture, 2026), was recorded as a qualitative parameter to estimate the relative greenness of coconut leaves (Figure 2). Collected data were analyzed separately for each week using one-way analysis of variance (ANOVA). Statistical analysis was performed using Minitab statistical software (version 19.2020.1, 64-bit; Minitab, LLC, USA), and mean separation was done using Tukey's test at a 5% significance level. Although 25 replicates were maintained for each treatment for the other measurements, leaf colour was assessed using five replicates per treatment at the 16th week. Accordingly, five seedlings were randomly selected from each treatment. The leaf colour data were analysed using the Kruskal–Wallis test. The pairwise post-hoc comparisons was conducted using Mann-Whitney U tests with Bonferroni correction.

Table 1. Treatments of the experiment

Treatment Code	Description (Ingredients for potting mixture)	Ratio
T1 (control)	coir dust: cow dung: topsoil	3:2:1
T2	paddy husk: charcoal: topsoil	3:2:1
T3	paddy husk: bagasse: topsoil	3:2:1
T4	paddy husk: compost: topsoil	3:2:1

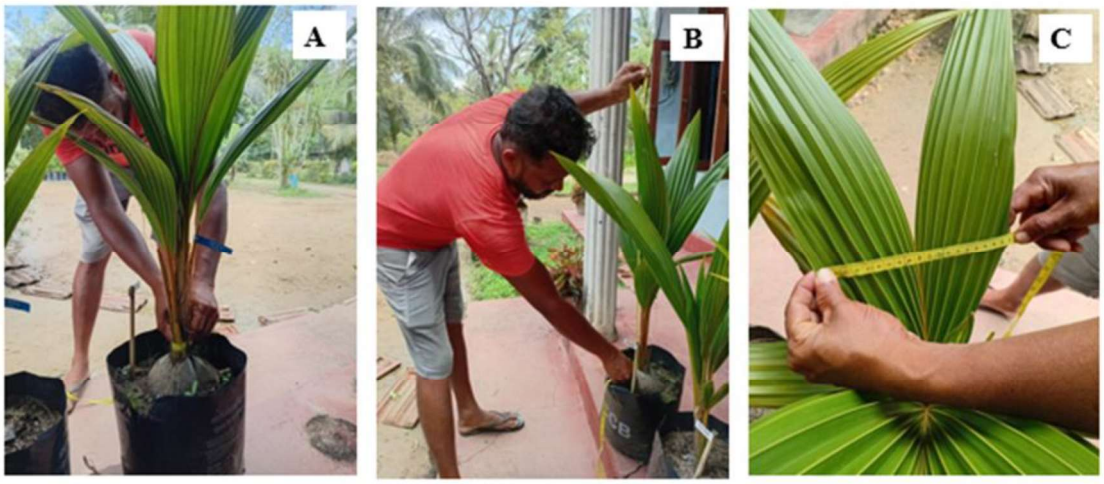

Figure 1. Measurement of collar girth (A), seedling height (B), and leaf width (C) of coconut seedlings



Figure 2. Measurement of root volume of coconut seedlings using the water displacement method



Figure 3. Estimation of leaf colour of coconut seedlings using the leaf colour chart

3. Results and Discussion

3.1. Collar girth (cm)

There were no significant differences in collar girth among the treatments during the first 14 weeks ($p>0.05$). In the 16th week, significant ($p<0.05$) differences were observed. Treatments T2 and T3 showed significantly lower collar girth compared to the control (T1), while T4 did not differ significantly from the control.

Table 1: Collar girth (cm) of coconut seedlings during the experiment as affected by growing media

T	Weeks after planting							
	2nd	4th	6th	8th	10th	12th	14th	16th
T1 (C)	6.02[a] ± 0.12	6.10[a] ± 0.14	6.96[a] ± 0.13	7.20[a] ± 0.08	7.76[a] ± 0.11	8.28[a] ± 0.15	9.24[a] ± 0.15	10.64[a] ± 0.12
T2	6.18[a] ± 0.12	6.22[a] ± 0.12	6.92[a] ± 0.14	7.36[a] ± 0.12	7.84[a] ± 0.12	8.16[a] ± 0.13	8.96[a] ± 0.12	9.56[b] ± 0.13
T3	6.24[a] ± 0.14	6.36[a] ± 0.15	6.92[a] ± 0.15	7.12[a] ± 0.12	7.84[a] ± 0.13	8.08[a] ± 0.14	9.12[a] ± 0.15	9.64[b] ± 0.15
T4	6.04[a] ± 0.14	6.16[a] ± 0.16	6.80[a] ± 0.12	6.92[a] ± 0.14	7.76[a] ± 0.15	8.16[a] ± 0.17	9.00[a] ± 0.16	10.24[a] ± 0.18
p	0.602	0.636	0.863	0.078	0.950	0.830	0.549	<0.001

T- treatments, C- Control, Values represent mean ± standard error. Values in each column followed by the same letter are not significantly different at the 0.05 probability level according to Tukey's test

The lack of significant differences from 02-14 weeks may be attributed to the initial reliance of seedlings on the endosperm reserves (Beveridge et al., 2022) and limited interaction with the external growth media. Treatments T2 and T3 showed smaller girth diameters. This suggests that by the final stages of nursery development, the traditional media formulation (T1) and the paddy husk with compost alternative (T4) provided superior support for stem development compared to the other alternatives. This notable performance of T4 could be associated with the presence of compost, which enhances nutrient availability (Larney et al., 2006), improves moisture retention (Martínez-Blanco et al., 2013), and supports soil life and soil microbial activity (Stan et al., 2009). Additionally, paddy husk contributes to better aeration (Milla et al., 2013) due to its unique physical structure and its rigid, lightweight, and highly porous nature (El Sharkawi et al., 2014), creating a more balanced medium for root growth. Although the control treatment (T1) produced the highest girth diameter, the comparable performance of T4 demonstrates that it can serve as an effective and sustainable alternative to traditional nursery media for producing coconut seedlings with good stem girth.

3.2 Seedling height

The analyzed results for coconut seedling height are shown in Table 3. At the 4th week, T1 showed a significantly greater height compared to T3 and T4, but no difference with T2. This indicates that during the early growth phase of the coconut seedlings, the combination of coir dust and cow dung provided a more favourable medium for shoot elongation. Coir dust is known to enhance moisture retention and improve aeration (Fornes et al., 2003; Amran et al., 2024), while cow dung provides readily available nutrients and stimulates beneficial microbial activity (Dhiman et al., 2021). These characteristics likely supported more vigorous early growth relative to the other organic substrates. From the 6th to 12th week, no significant differences were observed among the treatments of the experiment. However, by the 14th and 16th weeks, T1 showed significantly (p<0.005) higher plant height compared to the other treatments. The consistent height advantage of the control treatment suggests that the traditional coir dust and cow dung mixture provides optimal conditions for vertical growth of coconut seedlings throughout the nursery period.

The addition of cow dung enhances nutrient availability and microbial activity (Siebielec et al., 2023), while coir dust improves aeration, moisture retention, and overall soil structure, ensuring consistent seedling development throughout the nursery period (Suthamathy & Seran, 2009). While our study focused on coconut seedling height during the early growth stage, another study conducted by Ismail et al. (2020), using similar sub-

strates such as topsoil, sand, oil palm fruit fibre, and coco peat, also reported significant height differences at the 9-month stage, despite differences in specific treatment combinations

Table 2: Height (cm) of coconut seedlings during the experiment as affected by growing media

T	Weeks after planting							
	2nd	4th	6th	8th	10th	12th	14th	16th
T1 (C)	30.26^{a} ± 1.13	38.36^{a} ± 1.25	47.64^{a} ± 1.53	54.00^{a} ± 1.34	59.5^{a} ± 1.53	65.92^{a} ± 1.78	74.88^{a} ± 1.69	83.08^{a} ± 2.08
T2	27.82^{a} ± 0.93	34.40^{ab}± 1.02	43.88^{a} ± 1.63	49.40^{a} ± 1.42	55.52^{a} ± 1.67	61.60^{a} ± 1.79	67.44^{b} ± 2.01	72.8^{b} ± 2.16
T3	25.80^{a} ± 1.00	34.16^{b} ± 1.02	43.72^{a} ± 1.34	49.88^{a} ± 1.34	55.64^{a} ± 1.68	60.24^{a} ± 1.87	65.12^{b} ± 1.80	71.20^{b} ± 2.02
T4	26.66^{a} ± 0.79	34.16^{b} ± 1.20	43.84^{a} ± 1.19	51.00^{a} ± 1.24	56.36^{a} ± 1.34	63.20^{a} ± 1.55	68.36^{b} ± 1.47	75.36^{b} ± 1.90
p	0.094	0.023	0.156	0.075	0.228	0.130	0.001	<0.001

T- treatments, C- control. p – p-value. *Values represent mean ± standard error. Values in each column followed by the same letter are not significantly different at the 0.05 probability level according to the Tukey test*

Table 3: Number of fully open leaves and leaf width (cm) as affected by growing media

Treatment code	Number of fully open leaves	Leaf width (cm)
T1 (C)	5.2^{a} ± 0.20	19.4^{a} ± 1.36
T2	5.2^{a} ± 0.20	17.0^{a} ± 1.38
T3	5.0^{a} ± 0.00	18.6^{a} ± 0.87
T4	5.2^{a} ± 0.20	18.0^{a} ± 1.14
p value	0.801	0.564

T- treatments, C- control, p – p-value. *Values represent mean ± standard error. Values in each column followed by the same letter are not significantly different at the 0.05 probability level according to Tukey's test*.

3.3. Number of fully opened leaves and leaf width

The number of fully opened leaves (Table 4) showed no significant differences (p>0.05) among treatments, with the mean values being nearly identical across all treatments. This uniformity suggests that all four potting media formulations equally supported the development and expansion of functional leaves in coconut seedlings. This parameter is important as fully open leaves contribute to photosynthesis and overall plant vigor, and the results indicate that the alternative media could replace the traditional formulation without compromising this aspect of seedling development. Leaf width measurements (Table 4) showed no significant differences among the treatments. This suggests that all four potting media formulations provided adequate conditions for leaf expansion in coconut seedlings. From a practical standpoint, since leaf width was not significantly affected by the choice of medium, nursery operators may select among the alternative potting mixtures (T2, T3, or T4) based on local availability of materials and ease of preparation without compromising seedling leaf development. This flexibility is valuable for coconut nursery management, particularly where traditional materials like coir dust and cow dung (T1) may be limited or more expensive

3.4. Leaf colour

According to the analyzed results shown in Table 5, leaf colour showed significant differences among treatments, with T4 showing the highest score, indicating greener leaves compared to other treatments. The pairwise post-hoc comparisons using Mann-Whitney U tests with Bonferroni correction were conducted to identify specific group differences.

According to the results, only T3 and T4 were significantly different (p=0.016) in pairwise comparison. According to Jangilwad & Chandel (2021), a leaf colour chart is typically employed at critical growth stages to determine whether adjustments to the recommended nitrogen fertilizer rate are required. T3 shows lower leaf colour according to the mean rank. Bagasse is a carbon-rich material with a relatively high carbon-to-nitrogen ratio, and its decomposition may temporarily immobilize nitrogen through microbial activity, reducing nitrogen availability for plant uptake (Xu et al., 2023; Hadiyarto et al., 2019). Since nitrogen is a major component of chlorophyll molecules and plays an essential role in leaf greenness (Dubey et al., 2014), reduced nitrogen availability may have contributed to lower leaf colour intensity. Therefore, the findings of the present experiment emphasize the importance of substrate nutrient composition in maintaining adequate nitrogen availability for healthy coconut seedling development

Table 4: Leaf colour of coconut seedlings as affected by treatments

Treatment	n	Median leaf colour score	Mean rank
T1 (control)	5	4	10.9
T2	5	4	10.9
T3	5	4	5.1
T4	5	5	15.1
Kruskal-Wallis test			
χ^2 (adjusted for ties)		8.68	
df		3	
p value		0.034*	

**Significant at p<0.05*

3.5. Root growth parameters

The number of roots (Table 6) showed significant differences between the treatments, with T4 producing more roots compared to all other treatments. This indicates that the paddy husk and compost mixture (T4) significantly enhanced root proliferation by 67.6% compared to the traditional media (T1). This could be attributed to improved aeration, water-holding capacity, and nutrient availability in the compost-based media, which are critical factors for root development (Koç & Acar, 2015). It is also important to note that the rooting pattern of coconut palms varies depending on both the age of the tree and the type of soil in which it is cultivated (Maheswarappa et al., 2000). Therefore, under the conditions of the present experiment, the robust root development in T4 suggests that this alternative medium could potentially lead to better field establishment of coconut seedlings.

Maximum root length (Table 6) showed no significant differences between treatments in this experiment. Although statistically insignificant, T4 showed a marginally higher value compared to the other treatments. This suggests that under the experimental conditions, the applied treatments did not have a pronounced effect on root elongation. However, Chan & Elevitch (2006) reported that the depth of roots of coconut depends mainly on the physical characteristics of the soil in which it grows. Hence, it can be inferred that the above result might have occurred due to the short experimental duration, as root responses take longer to manifest compared to shoot responses. The root volume measurement of the coconut seedlings (Table 6) showed significant differences among treatments, with T4 having produced the largest volume of roots compared to other treatments. The higher root volume observed in T4 may be attributed to the beneficial effects of compost on both nutrient availability and the physical and biological properties of the growing medium (Adugna, 2016)

Table 5: Root growth parameters of coconut seedlings (number of roots, maximum root length (cm), and root volume (mL)) as affected by growing media

Treatment code	Number of roots	Maximum root length (cm)	Root volume (mL)
T1 (control)	$7.4^{bc} \pm 0.40$	48.00 ± 2.39	$6.120^{c} \pm 0.08$
T2	$8.4^{b} \pm 0.24$	54.80 ± 1.24	$6.120^{c} \pm 0.05$
T3	$6.6^{c} \pm 0.24$	61.00 ± 1.87	$7.76^{b} \pm 0.15$
T4	$12.4^{a} \pm 0.51$	68.00 ± 1.87	$8.94^{a} \pm 0.11$
p value	<0.001	0.111	<0.001

Values represent mean ± standard error. Values in each column followed by the same letter are not significantly different at 0.05 probability level according to Tukey's test.

T1 and T2 showed the lowest root volume, with T3 showing intermediate results. According to Dhanapal et al. (2000), in coconut palms, more roots will concentrate on the surface when there is ample moisture available. Therefore, these results of the present study strongly indicate that paddy husk combined with compost creates a more favorable environment for root development in terms of volume compared to the traditional media (T1) or the charcoal (T2) and bagasse (T3) alternatives.

The relatively lower growth performance observed in the charcoal-containing treatment (T2) may be associated with the limited nutrient contribution of charcoal compared with nutrient-rich organic amendments such as compost and cow dung. Although charcoal can improve the physical properties of growing media by increasing porosity, aeration, and water-holding capacity, it generally contains low levels of readily available nutrients required for rapid seedling growth (Glaser et al., 2002; Tayyab et al., 2018).

3.6. Limitations and future research perspectives

The present study demonstrated the potential of alternative growing media for coconut seedling production under nursery conditions. The experiment was conducted only during the nursery stage; therefore, it did not evaluate the subsequent field performance and survivability of seedlings produced in different growing media. Since field establishment is a critical indicator of seedling quality, future studies should investigate the field survival rate, early growth performance, and long-term productivity of seedlings raised in these alternative media. In addition, the present study did not analyze the physical and chemical properties of the evaluated growing media, including pH, electrical conductivity, organic carbon, organic matter, and available nutrient contents. Such characterization would provide further insight into the relationship between media properties and observed seedling growth responses. Future research should therefore incorporate comprehensive media analysis together with field validation to optimize the recommended growing medium for large-scale coconut nursery production.

4. Conclusions

The results of this study demonstrate that the traditional coconut nursery potting mixture (coir dust: cow dung: topsoil, 3:2:1) produced greater seedling height and collar girth, while alternative formulations using locally available materials also offer strong potential for sustainable nursery production. The paddy husk: compost: topsoil (3:2:1) mixture showed the greatest potential among the alternative media evaluated, producing seedlings with strong root characteristics (67.6% more number of roots and 46.08% greater root volume compared to the traditional mixture), which are promising characteristics for healthy seedling production under nursery conditions. This formulation offers coconut nursery operators a potential alternative growing medium, particularly where traditional media components are limited. The enhanced root development observed in the compost-based media indicates improved root development under nursery conditions. However, its effects on nutrient uptake and drought tolerance following field

planting remain to be investigated. In conclusion, the use of paddy husk: compost: topsoil (3:2:1) mixture shows potential as an alternative growing medium for coconut nurseries. However, substrate characterization, cost analysis, and field-performance validation are needed before broader recommendation.

Acknowledgement
The authors gratefully acknowledge the coconut seedling nursery of the Coconut Cultivation Board, Ampara, Sri Lanka; the Hardy Advanced Technological Institute, Ampara, Sri Lanka; and the University of Colombo Institute for Agro-Technology and Rural Sciences, Weligatta, Hambantota, Sri Lanka, for their valuable support and contributions towards the successful completion of this study.

Author Contributions
M.P.S.L. Dharmasena: Investigation, Data Curation, Formal Analysis, Writing. K.G. Ketipearachchi: Supervision, Methodology, Formal Analysis. A.B.M. Jesfar: Supervision, Methodology, Formal Analysis. P.O.P. Weerasinghe: Writing –Review & Editing, Visualization. B.P. Siriwardena: Methodology, Analysis. S.L. Nawaratna: Methodology, Supervision.

Data Accessibility
The data used in this study were obtained from the original research conducted at the Coconut Seedling Nursery of the Coconut Cultivation Board, Ampara, Sri Lanka.

Declaration of conflict of interest
The authors declare no conflicts of interest.

Funding Information
This research received no specific funding.

References

Adugna, G. (2016). A review on impact of compost on soil properties, water use and crop productivity. *Academic Research Journal of Agricultural Science and Research, 4*(3), 93–104. https://doi.org/10.14662/ARJASR2016.010

Amran, N. A., Kasim, S., Shuib, E. M., & Yusoff, M. M. (2024). Improvement of growth media quality using coconut coir dust, coconut ash, and palm kernel shell biochar. AgriHealth: *Journal of Agri-Food, Nutrition and Public Health, 5*(2), 150–173. https://doi.org/10.20961/agrihealth.v5i2.93574

Awang, Y., Shaharom, A. S., Mohamad, R. B., & Selamat, A. (2009). Chemical and physical characteristics of cocopeat-based media mixtures and their effects on the growth and development of *Celosia cristata*. *American Journal of Agricultural and Biological Sciences*, *4*(1), 63–71. https://doi.org/10.3844/ajabssp.2009.63.71

Bandaranayake, C. K., Pieris, R. R. A., & Perera, L. (1997). The suitability of optional material as a replacement for coir dust in raising coconut seedlings in polybags. *COCOS*, 12, 33–38. https://doi.org/10.4038/cocos.v12i0.2163

Beveridge, F. C., Kalaipandian, S., Yang, C., & Adkins, S. W. (2022). Fruit biology of coconut (*Cocos nucifera* L.). *Plants*, *11*(23), Article 3293. https://doi.org/10.3390/plants11233293

Chan, E., & Elevitch, C. R. (2006). *Cocos nucifera* (coconut). Species Profiles for Pacific Island Agroforestry.

Coconut Research Institute of Sri Lanka. (2018a). Nursery management and seedling selection (Advisory Circular No. A 2). https://cri.gov.lk/wp-content/uploads/2021/10/a2.pdf

Coconut Research Institute of Sri Lanka. (2018b). Planting of coconut (Advisory Circular No. A 3). https://cri.gov.lk/wp-content/uploads/2021/10/a3.pdf

Department of Agriculture. (2026). Leaf colour chart. Rice Research and Development Institute. https://doa.gov.lk/rrdi_div_soilscience_leafcolorchart/

Dhanapal, R., Maheswarappa, H. P., & Subramanian, P. (2000). Response of coconut roots to the methods of irrigation in littoral sandy soil. *Journal of Plantation Crops, 28*(3), 208–211.

Dhiman, S., Kumar, S., Baliyan, N., Dheeman, S., & Maheshwari, D. K. (2021). Cattle dung manure microbiota as a substitute for mineral nutrients and growth management practices in plants. In D. K. Maheshwari & S. Dheeman (Eds.), *Endophytes: Mineral nutrient management* (Vol. 3, pp. 77–103). Springer International Publishing. https://doi.org/10.1007/978-3-030-65447-4_4

Dubey, R. S., Srivastava, R. K., & Pessarakli, M. (2014). Physiological mechanisms of nitrogen absorption and assimilation in plants under stressful conditions. In M. Pessarakli (Ed.), *Handbook of plant and crop physiology* (3rd ed., pp. 453–486). CRC Press.

El Sharkawi, H. M., Ahmed, M. A., & Hassanein, M. K. (2014). Development of treated rice husk as an alternative substrate medium in cucumber soilless culture. *Journal of Agriculture and Environmental Sciences*, 3(4), 131–149. https://doi.org/10.15640/jaes.v3n4a10

Export Development Board. (2025). *Coconut export performance*. https://www.srilankabusiness.com /coconut/about/export-performance.html

Fornes, F., Belda, R. M., Abad, M., Noguera, P., Puchades, R., Maquieira, A., & Noguera, V. (2003). The microstructure of coconut coir dusts for use as alternatives to peat in soilless growing media. *Australian Journal of Experimental Agriculture*, 43(9), 1171–1179. https://doi.org/10.1071/EA02128

Glaser, B., Lehmann, J., & Zech, W. (2002). Ameliorating physical and chemical properties of highly weathered soils in the tropics with charcoal: A review. Biology and Fertility of Soils, 35(4), 219–230. https://doi.org/10.1007/s00374-002-0466-4

Hadiyarto, A., Soetrisnanto, D., Rosyidin, I., & Fitriana, A. (2019). Co-digestion of bagasse and water hyacinth for biogas production with variation of C/N and activated sludge. *Journal of Physics: Conference Series*, 1295(1), Article 012050. https://doi.org/10.1088/1742-6596/1295/1/012050

Harries, H. C. (2012). Germination rate is a significant characteristic determining coconut palm diversity. AoB PLANTS, 2012, Article pls045. https://doi.org/10.1093/aobpla/pls045

Ismail, B. K., Husin, M. A. B., & Zawawi, N. B. Z. (2020). Growing media effects on the performance of coconut seedlings (*Cocos nucifera* L.) at nursery stage. *International Journal of Agriculture, Forestry and Plantation*, 10, 1–8.

Jangilwad, M. D., & Chandel, A. C. (2021). Leaf colour charts: Tool for nitrogen management in paddy (rice). *Just Agriculture*, 6-9.

Khan, S., Irshad, S., Mehmood, K., Hasnain, Z., Nawaz, M., Rais, A., Gul, S., Wahid, M. A., Hashem, A., Abd_Allah, E. F., & Ibrar, D. (2024). Biochar production and characteristics, its impacts on soil health, crop production, and yield enhancement: A review. Plants, 13(2), Article 166. https://doi.org/10.3390/plants13020166

Koç, N., & Acar, R. (2015). The soil factors which effect on root growth in forage plants. In *Proceedings of the 2nd International Conference on Sustainable Agriculture and Environment (2nd ICSAE)* (Vols. 1–2, pp. 636–642). Selçuk University.

Larney, F. J., Sullivan, D. M., Buckley, K. E., & Eghball, B. (2006). The role of composting in recycling manure nutrients. *Canadian Journal of Soil Science*, 86(4), 597–611. https://doi.org/10.4141/S05-116

Maheswarappa, H. P., Subramanian, P., & Dhanapal, R. (2000). Root distribution pattern of coconut (*Cocos nucifera* L.) in littoral sandy soil. *Journal of Plantation Crops*, 28(2), 164–166.

Martínez-Blanco, J., Lazcano, C., Christensen, T. H., Muñoz, P., Rieradevall, J., Møller, J., Antón, A., & Boldrin, A. (2013). Compost benefits for agriculture evaluated by life cycle assessment: A review. Agronomy for Sustainable Development, 33(4), 721–732. https://doi.org/10.1007/s13593-013-0148-7

Milla, V. O., Rivera, E. B., Huang, W. J., Chien, C., & Wang, Y. M. (2013). Agronomic properties and characterization of rice husk and wood biochars and their effect on the growth of water spinach in a field test. *Journal of Soil Science and Plant Nutrition,* 13(2), 251–266. http://dx.doi.org/10.4067/S0718-95162013005000022

Periyapperuma, P. M. M. J., Dissanayake, S. N., & Jayalath, K. V. N. N. (2023). Determinants of supply response of coconut cultivation in Sri Lanka. *COCOS*, 24(1), 1–11. https://doi.org/10.4038/cocos.v24i1.5824

Siebielec, S., Marzec-Grządziel, A., Siebielec, G., Ukalska-Jaruga, A., Kozieł, M., Gałązka, A., Przybyś, M., Sugier, P., & Urbaniak, M. (2023). Microbial community response to various types of exogenous organic matter applied to soil. *International Journal of Molecular Sciences*, 24(19), 14559. https://doi.org/10.3390/ijms241914559

Singh, P., Singh, P., & Singh, J. (2021). Sugarcane bagasse: A potential and economical source for raising sugarcane nursery in sub-tropical India. *Sugar Tech*, 23(6), 1211–1217. https://doi.org/10.1007/s12355-021-01028-9

Stan, V., Virsta, A., Dusa, E. M., & Glavan, A. M. (2009). Waste recycling and compost benefits. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 37(2), 9–13. https://doi.org/10.15835/nbha3723461

Suthamathy, N., & Seran, T. H. (2009). Effect of cow manure, coir dust and paddy husk ash on physical and chemical properties of potting media. In *Proceedings of the 8th Annual Research Session*, Eastern University, Sri Lanka (pp. 185–190). Eastern University, Sri Lanka.

Tayyab, M., Islam, W., Khalil, F., Ziqin, P., Caifang, Z., Arafat, Y., Hui, L., Rizwan, M., Ahmad, K., Waheed, S., Tarin, M. W. K., & Hua, Z. (2018). Biochar: An efficient way to manage low water availability in plants. *Applied Ecology and Environmental Research*, 16(3), 2565–2583. https://doi.org/10.15666/aeer/1603_25652583

Thomas, G. V., Krishnakumar, V., Dhanapal, R., & Srinivasa Reddy, D. V. (2019). Agro-management practices for sustainable coconut production. In K. U. K. Nampoothiri, V. Krishnakumar, P. K. Thampan, & M. Achuthan Nair (Eds.), *The coconut palm (Cocos nucifera L.): Research and development perspectives* (pp. 227–322). Springer Singapore. https://doi.org/10.1007/978-981-13-2754-4_7

Xu, N., Amgain, N. R., Rabbany, A., McCray, J. M., Li, Y. C., Strauss, S. L., Mylavarapu, R., & Bhadha, J. H. (2023). Field incubation studies on nutrient mineralization of bagasse on Spodosols and Histosols in Florida. *Agriculture*, 13(5), Article 975