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Cocopeat Growing Medium Composition and Phosphorus Fertilizer Dose on the Growth and Yield of Taro (*Colocasia esculenta* L.)

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ABSTRACT

Taro (Colocasia esculenta L.) is a nutritionally significant tuber crop with considerable export potential, yet its productivity in Indonesia remains constrained by suboptimal cultivation practices, particularly with respect to growing medium composition and fertilizer management. This study investigated the effects of cocopeat-enriched growing medium compositions and phosphorus fertilizer doses, as well as their interaction, on the vegetative growth and yield characteristics of taro. A factorial experiment arranged in a Completely Randomized Design (CRD) was conducted from March to December 2025 at the TPH Tohudan Seed Garden, Karanganyar Regency, Central Java, Indonesia, at an altitude of 140 metres above sea level on regosol soil. Three growing medium compositions were evaluated, comprising soil and manure without cocopeat (M0), soil, cocopeat, and manure at 3:1:1 (M1), and soil, cocopeat, and manure at 3:2:1 (M2), combined with four phosphorus fertilizer doses of 0, 100, 200, and 300 kg/ha, equivalent to 0, 7.5, 15.0, and 22.5 g per plant, respectively. Each treatment combination was replicated three times, yielding 36 experimental units. Results indicated that growing medium composition exerted a highly significant effect on all vegetative parameters, including plant height, number of leaves, leaf length, stem length, and stem diameter, with the 3:1:1 ratio producing the highest mean leaf length of 32.46 cm. Phosphorus fertilizer significantly affected tuber sugar content, with the dose of 7.5 g per plant yielding the highest mean sugar content of 2.78%. No significant interaction between the two factors was detected for any parameter measured.

Keywords: *Cocopeat, Colocasia Esculenta, Growing Medium, Phosphorus Fertilizer, Taro Yield*

INTRODUCTION

Taro (*Colocasia esculenta* L.) ranks among the most economically significant tuber crops cultivated across tropical and subtropical regions of the world. It serves as a primary food source in several countries, including China and Japan, where it functions as a staple alternative to rice. Beyond Asia, taro is widely consumed in Thailand, Brazil, Hawaii, and other parts of the United States, reflecting its broad dietary importance across diverse agricultural systems. Taro corms possess a notably lower carbohydrate content of approximately 22.25% compared to 67.89% in rice, making them particularly suitable for individuals managing diabetes or adhering to dietary restrictions (Amala & Rahmawati, 2021; Tan et al., 2025). This distinctive nutritional profile has contributed to a steady increase in consumer demand at both domestic and international levels.

Despite its recognized export potential, taro production in Indonesia remains considerably below demand. Based on data from the Indonesian Central Bureau of Statistics (BPS), national taro output declined sharply from 190 tonnes in 2021 to only 33 tonnes in 2022. This downward trend reflects systemic constraints in cultivation management, including the limited adoption of improved growing media and fertilization practices. Taro cultivation in Indonesia is further restricted by its seasonal planting pattern, with farmers typically cultivating the crop only once per year at the onset of the rainy season (Maryono & Akbari, 2024; Triyoso et al., 2025). These structural limitations underscore the urgent need for evidence-based agronomic interventions capable of improving productivity throughout the growing cycle.

The selection and composition of growing media constitute a foundational determinant of plant establishment and yield performance. Growing media serve multiple biological functions, including nutrient and moisture retention, root architecture support, and regulation of aeration and temperature within the root zone (Farmia, 2020). Among the alternative substrates available for horticultural production, cocopeat, a fibrous material derived from coconut husks, has attracted considerable research attention owing to its favorable physical and chemical properties. Cocopeat maintains a pH range of 5.0 to 6.8, exhibits high water retention capacity, supports efficient gas exchange through its porous structure, and contains *Trichoderma* species that contribute to the suppression of soil-borne pathogens (Gowthami et al., 2024). These characteristics render it a viable and sustainable substitute for conventional soil-based media across a wide range of crop species.

Previous studies have demonstrated the productive capacity of cocopeat-based media in various vegetable and tuber crops. Research conducted by Santosa and Priyono (2023) examined the interaction between urea fertilizer and cow manure in influencing the growth and yield of kailan (*Brassica oleracea* L.). Their findings confirmed that organic matter significantly modifies substrate conditions, with balanced fertilizer and organic input combinations producing superior vegetative growth parameters. Similarly, a study on sweet corn (*Zea mays* Saccharata Sturt. L.) by Santoso et al. (2024) reported that NPK fertilizer combined with goat manure at optimal proportions produced the highest observed values for plant height, leaf number, and cob weight, indicating that substrate nutrient composition exerts a measurable and consistent effect on crop performance across different plant genera.

Phosphorus nutrition represents another critical dimension of taro crop management. As a macronutrient integral to adenosine triphosphate (ATP) synthesis and nucleic acid composition, phosphorus drives energy transfer and cell division within meristematic tissues, directly influencing root initiation, tiller formation, and corm development (Sianturi et al., 2024). Phosphorus fertilizers are also characterized by their non-hygroscopic nature, high water solubility, and capacity to accelerate fruit maturation and improve plant tolerance to biotic and abiotic stresses (Al-Rubie & Abdulkareem, 2024). Within taro specifically, phosphorus availability promotes the translocation of assimilates into storage tissues, thereby improving starch accumulation and overall corm quality. Adequate phosphorus supply has furthermore been linked to enhanced sugar content in underground storage organs, a parameter of particular relevance to both fresh consumption and processing applications.

Notwithstanding the documented roles of growing media composition and phosphorus nutrition individually, there remains a substantial knowledge gap concerning their combined application in taro cultivation. The majority of existing studies have examined either substrate type or fertilizer regime in isolation, frequently under conditions that differ considerably from the regosol soil environments prevalent in lowland Indonesian agricultural systems. No study to date has systematically evaluated the interaction between cocopeat-enriched growing media and graded phosphorus fertilizer doses in taro production conducted at field scale under Indonesian lowland conditions. This constitutes a clear empirical gap that limits the development of evidence-based cultivation recommendations for Indonesian taro farmers.

The present study was therefore conducted to investigate the effect of varying cocopeat growing medium compositions and phosphorus fertilizer doses, and their potential interaction, on the vegetative growth and yield characteristics of taro (*Colocasia esculenta* L.) under regosol soil conditions in Karanganyar Regency, Central Java. The central research question addressed is whether a specific combination of cocopeat-enriched media and phosphorus fertilizer produces a statistically significant and agronomically meaningful improvement in taro growth and tuber yield compared to conventional soil-based cultivation. It was hypothesized that the application of a soil-cocopeat-manure mixture at a 3:1:1 ratio in conjunction with phosphorus fertilizer at a dose equivalent to 200 kg/ha would yield the most favorable growth and production outcomes in this crop system.

RESEARCH METHODOLOGY

This study employed a factorial experiment arranged in a Completely Randomized Design (CRD) comprising two treatment factors (Mugwe & Runo, 2026). The first factor was the composition of the growing medium incorporating cocopeat (M), and the second factor was the applied dose of phosphorus fertilizer in the form of SP-36 (P). The levels of each factor were as follows.

Factor I: Growing medium composition (M)

M0: Soil + manure (without cocopeat)
M1: Soil + cocopeat + manure at a volumetric ratio of 3:1:1
M2: Soil + cocopeat + manure at a volumetric ratio of 3:2:1

Factor II: Phosphorus (SP-36) fertilizer dose (P)

P0: 0 kg/ha, equivalent to 0 g per plant (control)
P1: 100 kg/ha, equivalent to 7.5 g per plant
P2: 200 kg/ha, equivalent to 15.0 g per plant
P3: 300 kg/ha, equivalent to 22.5 g per plant

The two factors produced 12 treatment combinations, each replicated three times, resulting in a total of 36 experimental units. The complete treatment combinations are described in Table 1.

Table 1 Treatment Combinations of Growing Medium Composition and Phosphorus Fertilizer Dose

Treatment Code	Growing Medium Composition	Phosphorus Dose
M0P0	Soil + manure (without cocopeat)	0 g/plant
M0P1	Soil + manure (without cocopeat)	7.5 g/plant
M0P2	Soil + manure (without cocopeat)	15.0 g/plant
M0P3	Soil + manure (without cocopeat)	22.5 g/plant
M1P0	Soil + cocopeat + manure (3:1:1)	0 g/plant
M1P1	Soil + cocopeat + manure (3:1:1)	7.5 g/plant
M1P2	Soil + cocopeat + manure (3:1:1)	15.0 g/plant
M1P3	Soil + cocopeat + manure (3:1:1)	22.5 g/plant
M2P0	Soil + cocopeat + manure (3:2:1)	0 g/plant
M2P1	Soil + cocopeat + manure (3:2:1)	7.5 g/plant
M2P2	Soil + cocopeat + manure (3:2:1)	15.0 g/plant
M2P3	Soil + cocopeat + manure (3:2:1)	22.5 g/plant

Source: Researcher’s Database (2025)
Note: M = growing medium composition; P = phosphorus fertilizer dose; numbers following M and P indicate the respective treatment level.

Table 1 presents the 12 treatment combinations resulting from the factorial arrangement of three growing medium compositions and four phosphorus fertilizer doses. Each combination is assigned a unique code in which the letter M denotes the growing medium factor and the letter P denotes the phosphorus factor. The control treatment (M0P0) received neither cocopeat nor phosphorus fertilizer, while the remaining combinations represent progressive additions of cocopeat and increasing phosphorus doses. This arrangement allows for the independent and combined assessment of both factors on taro growth and yield.

Observational data were analyzed using Analysis of Variance (ANOVA) at the 5% significance level to evaluate the main effects of each factor and their interaction. Where the F-test revealed a statistically significant difference among treatment means, further mean separation was conducted using the Honestly Significant Difference (HSD) test at the 5% probability level to determine which specific treatment means differed significantly from one another. The experiment was carried out at the Food Crop Horticulture (TPH) Tohudan Seed Garden, located at Dukuh Kepoh RT 03/06, Tohudan Village, Colomadu District, Karanganyar Regency, Central Java, Indonesia, from March 2025 to December 2025. The experimental site is situated at an altitude of 140 metres above sea level and is characterized by regosol soil, representative of the lowland agricultural landscape of Central Java.

The equipment used in this study included polybags as planting containers, a graduated measuring cylinder, a watering can, buckets, a digital balance, a hand trowel, an oven for dry-weight analysis, bamboo stakes for plant support, stationery, and a measuring tape and ruler for morphological measurements. The plant material consisted of locally sourced taro (*Colocasia esculenta* L.) seed corms obtained from Boyolali Regency, Central Java, selected to represent agronomic conditions typical of smallholder taro cultivation in the region. The fertilizer applied was SP-36 superphosphate, containing 36% P_2O_5. The growing substrate was prepared by combining field soil, cattle manure, and cocopeat at the volumetric ratios stipulated in the experimental design. Water was applied as needed for irrigation throughout the experimental period. Growth and yield parameters recorded in this study were as follows: plant height (cm), number of leaves (leaves per plant), leaf length (cm), stem length (cm), stem diameter (mm), tuber weight (g), tuber diameter (cm), tuber length (cm), and tuber sugar content (%). All measurements were conducted at standardized growth stages in accordance with established agronomic observation protocols to ensure consistency and reproducibility across all experimental units.

RESULT AND DISCUSSION

Vegetative Growth of Taro

Table 2 Summary of ANOVA Results for Taro Vegetative Growth Parameters

Growth Parameter	F-value (Cocopeat)	F-value (Phosphorus)	F-value (Interaction)
Plant height (cm)	23.44 **	1.06 ns	1.75 ns
Number of leaves	5.93 **	1.10 ns	1.10 ns
Leaf length (cm)	23.04 **	1.70 ns	1.06 ns
Stem length (cm)	17.17 **	1.12 ns	2.01 ns
Stem diameter (mm)	5.92 **	1.03 ns	1.10 ns

Source: Researchers's Analysis (2025)
*Note: ** = highly significant (p < 0.01); ns = not significant*

Table 2 summarizes the F-values obtained from the ANOVA for each vegetative growth parameter across the two treatment factors and their interaction. F-values marked with ** indicate a highly significant effect at the 1% probability level, while those marked ns indicate that the observed differences among treatment means were within the range of random experimental variation and were therefore not statistically meaningful. The table demonstrates a consistent pattern in which the cocopeat growing medium factor produced highly significant effects across all five parameters, whereas the phosphorus factor and the interaction term yielded non-significant F-values throughout.

The ANOVA results presented in Table 2 indicate that the growing medium composition incorporating cocopeat exerted a highly significant effect on all five observed vegetative growth parameters. In contrast, neither the phosphorus fertilizer dose nor the interaction between the two factors produced a statistically significant effect on any vegetative variable, suggesting that the physical properties of the growing medium were the primary determinant of vegetative development in taro under the conditions of this experiment.

Plant height responded most strongly to cocopeat composition, with the 3:1:1 ratio treatment (M1) producing the highest mean of 72.13 cm compared to 55.67 cm in the control treatment without cocopeat (Table 3). This outcome is attributable to cocopeat's capacity to maintain stable substrate moisture while preserving adequate pore space for root aeration, enabling more efficient absorption of water and mineral nutrients and consequently supporting maximal upward vegetative growth. The absence of a significant phosphorus effect on plant height is consistent with the established understanding that phosphorus primarily regulates energy transfer and early root formation rather than directly stimulating internode elongation (Zhu et al., 2022), a finding further corroborated by Erdal and Aktaş

(2025), who reported that cocopeat-containing media exhibit superior water retention and porosity relative to conventional soil substrates.

Table 3 HSD Test Results for Plant Height (cm) as Affected by Cocopeat Growing Medium Composition and Phosphorus Fertilizer Dose

Treatment	SP-36 0 g	SP-36 7.5 g	SP-36 15.0 g	SP-36 22.5 g	Mean (Cocopeat)
Without cocopeat (M0)	—	—	—	—	55.67 a
Cocopeat 3:1:1 (M1)	—	—	—	—	72.13 b
Cocopeat 3:2:1 (M2)	—	—	—	—	—
Mean (SP-36)	—	—	—	—	—

Source: Researchers's Analysis (2025)
Note: Means followed by the same letter within a column indicate no significant difference at the 5% HSD level.

Table 3 presents the mean plant height values for each growing medium treatment across all phosphorus doses, together with the overall cocopeat treatment means used for HSD comparison. The rightmost column contains the mean values with letter notations derived from the HSD test, where means sharing the same letter are not significantly different from one another. The results clearly show that M1 (3:1:1 ratio) produced the highest mean plant height of 72.13 cm, designated with the letter b, which is significantly greater than the mean of 55.67 cm recorded in M0, designated with the letter a. The absence of letter notations in the individual phosphorus dose columns reflects the non-significant effect of phosphorus on this parameter.

A similar pattern was observed for leaf number, leaf length, stem length, and stem diameter, all of which showed highly significant responses to cocopeat composition and non-significant responses to phosphorus application. With respect to leaf number, the 3:1:1 treatment produced the highest mean of 12.04 leaves per plant compared to 11.04 in the control (Table 4). The stable moisture retention of cocopeat-containing media supports sustained photosynthetic activity, which in turn stimulates continuous leaf primordia initiation. Phosphorus, while essential to ATP synthesis and nucleic acid formation, does not directly regulate leaf emergence rate, explaining its non-significant effect on this parameter (Fitriatin et al., 2024). These results align with Syahriana et al. (2025), who demonstrated that cocopeat-based media produced superior vegetative performance relative to conventional substrates across multiple horticultural species.

Table 4 HSD Test Results for Number of Leaves as Affected by Cocopeat Growing Medium Composition and Phosphorus Fertilizer Dose

Treatment	SP-36 0 g	SP-36 7.5 g	SP-36 15.0 g	SP-36 22.5 g	Mean (Cocopeat)
Without cocopeat (M0)	32.0	32.5	33.0	35.0	11.04 a
Cocopeat 3:1:1 (M1)	37.0	36.0	34.5	37.0	12.04 b
Cocopeat 3:2:1 (M2)	32.0	35.5	36.0	34.5	11.50 ab
Mean (SP-36)	33.67	34.67	34.50	35.50	—

Source: Researchers's Analysis (2025)
Note: Means followed by the same letter within a column indicate no significant difference at the 5% HSD level.

Table 4 presents the mean number of leaves per plant for each treatment combination, along with the cocopeat treatment row means and the phosphorus dose column means. The HSD letter notations in the rightmost column indicate that M1 (3:1:1) produced the highest leaf count of 12.04 and differed significantly from M0 (11.04), while M2 (11.50) occupied an intermediate position that did not differ significantly from either M0 or M1. The phosphorus row means at the bottom of the table show a slight numerical increase with rising dose, but the absence of letter notations confirms that these differences were not statistically significant, consistent with the ANOVA result for this parameter.

For leaf length, the 3:2:1 treatment (M2) produced the highest mean of 32.46 cm, significantly exceeding the 25.54 cm recorded in the control (Table 5). Leaf elongation is primarily governed by turgor pressure and cellular water absorption rates, both of which are directly supported by the high water-holding capacity of cocopeat. These findings are consistent with Kim and Yoo (2024), who reported that cocopeat-perlite media exhibited high total porosity, low bulk density, and superior water retention, properties that collectively enhance metabolic activity and leaf development in the root zone. Stem length followed a comparable trend, with M1 recording the highest mean of 51.21 cm against 39.75 cm in the control (Table 6), corroborating the findings of Muhsanati et al. (2024) on sweet potato, who attributed similar outcomes to cocopeat-driven improvements in substrate porosity and nutrient availability. Stem diameter likewise peaked under M1 at 55.60 mm compared to 45.60 mm without cocopeat (Table 7), consistent with Febriani et al. (2021), who confirmed that cocopeat incorporation enhances soil physical properties and supports overall vegetative development. Across all five parameters, the increase in vegetative performance correlates logically with the improved root environment created by cocopeat, as a well-developed root system supported by adequate aeration and moisture directly enables greater shoot biomass accumulation.

Table 5 HSD Test Results for Leaf Length (cm) as Affected by Cocopeat Growing Medium Composition and Phosphorus Fertilizer Dose

Treatment	SP-36 0 g	SP-36 7.5 g	SP-36 15.0 g	SP-36 22.5 g	Mean (Cocopeat)
Without cocopeat (M0)	—	79.0	81.5	71.5	25.54 a
Cocopeat 3:1:1 (M1)	99.5	91.0	97.5	99.0	32.25 ab
Cocopeat 3:2:1 (M2)	103.5	95.5	87.5	103.0	32.46 b
Mean (SP-36)	94.00	89.33	85.50	92.17	—

Source: Researchers's Analysis (2025)
Note: : Means followed by the same letter within a column indicate no significant difference at the 5% HSD level.

Table 5 presents mean leaf length values across all treatment combinations. The cocopeat treatment means in the rightmost column reveal that M2 (3:2:1) recorded the highest mean leaf length of 32.46 cm and was assigned the letter b, which differed significantly from M0 at 25.54 cm, assigned the letter a. M1 at 32.25 cm was assigned the letter ab, indicating it did not differ significantly from either M0 or M2. The phosphorus dose row means at the bottom show minor numerical variation across doses without reaching statistical significance, confirming that phosphorus fertilization had no meaningful influence on leaf elongation in taro under the conditions of this experiment.

Table 6 HSD Test Results for Stem Length (cm) as Affected by Cocopeat Growing Medium Composition and Phosphorus Fertilizer Dose

Treatment	SP-36 0 g	SP-36 7.5 g	SP-36 15.0 g	SP-36 22.5 g	Mean (Cocopeat)
Without cocopeat (M0)	123.5	128.0	114.5	111.0	39.75 a
Cocopeat 3:1:1 (M1)	160.5	138.0	162.0	154.0	51.21 b
Cocopeat 3:2:1 (M2)	159.5	149.5	128.0	162.5	49.96 b
Mean (SP-36)	147.83	138.50	134.83	142.50	—

Source: Researchers's Analysis (2025)
*Note: ** = Means followed by the same letter within a column indicate no significant difference at the 5% HSD level.*

Table 6 presents mean stem length values across all treatment combinations. The cocopeat treatment means show that both M1 (51.21 cm) and M2 (49.96 cm) produced significantly longer stems compared to M0 (39.75 cm), as indicated by their shared letter b against M0's letter a. The data confirm that any level of cocopeat incorporation, regardless of the specific ratio used, produced a meaningful improvement in stem elongation relative to the conventional substrate. The phosphorus dose means at the bottom of the table show no consistent directional trend and no significant differences, consistent with the ANOVA finding that phosphorus had no significant effect on this parameter.

Table 7 HSD Test Results for Stem Diameter (mm) as Affected by Cocopeat Growing Medium Composition and Phosphorus Fertilizer Dose

Treatment	SP-36 0 g	SP-36 7.5 g	SP-36 15.0 g	SP-36 22.5 g	Mean (Cocopeat)
Without cocopeat (M0)	142.5	140.0	132.15	132.5	45.60 a
Cocopeat 3:1:1 (M1)	143.7	180.4	174.2	168.95	55.60 b
Cocopeat 3:2:1 (M2)	151.1	149.6	161.75	190.25	54.39 b
Mean (SP-36)	145.77	156.67	156.03	163.90	—

Source: Researchers's Analysis (2025)
Note: Means followed by the same letter within a column indicate no significant difference at the 5% HSD level.

Table 7 presents mean stem diameter values across all treatment combinations. The cocopeat treatment means demonstrate that M1 (55.60 mm) and M2 (54.39 mm), both designated with the letter b, produced significantly larger stem diameters than M0 (45.60 mm), designated with the letter a. The numerical values within individual phosphorus dose columns show a slight upward trend as dose increases under cocopeat-containing treatments, yet this variation did not reach statistical significance across the factor as a whole. These results reinforce the consistent finding across all vegetative parameters that cocopeat composition, rather than phosphorus fertilization, was the decisive factor governing the structural development of taro during the vegetative growth phase.

Taro Yield Parameters

Table 8 Summary of ANOVA Results for Taro Yield Parameters

Yield Parameter	F-value (Cocopeat)	F-value (Phosphorus)	F-value (Interaction)
Tuber weight (g)	0.12 ns	0.57 ns	1.51 ns
Tuber length (cm)	0.48 ns	0.33 ns	0.91 ns
Tuber diameter (cm)	0.02 ns	0.93 ns	1.11 ns
Tuber sugar content (%)	1.61 ns	6.93 **	0.19 ns

Source: Researchers's Analysis (2025)
*Note: ** = highly significant ($p < 0.01$); ns = not significant*

Table 8 summarizes the F-values from the ANOVA for all four yield parameters measured at harvest. In contrast to the vegetative growth results in Table 2, the cocopeat growing medium factor produced non-significant F-values for all yield parameters, indicating that differences in substrate composition no longer exerted a statistically meaningful influence on taro tuber characteristics by the time of harvest at 11 months after planting. The phosphorus factor produced a highly significant F-value only for tuber sugar content (6.93 **), while its effects on tuber weight, tuber length, and tuber diameter were non-significant. No significant interaction was detected between the two factors for any yield parameter, indicating that the effects of cocopeat composition and phosphorus dose on taro yield were independent of one another throughout the experimental period.

The ANOVA results in Table 8 present a markedly contrasting pattern to the vegetative findings. Growing medium composition produced no significant effect on any yield parameter, while phosphorus fertilizer dose exerted a highly significant effect exclusively on tuber sugar content. No significant interaction was detected between the two factors for any yield variable.

Tuber weight, tuber length, and tuber diameter all showed non-significant responses to both treatment factors. The highest mean tuber weight of 278.67 g was recorded under M1P2, while the lowest of 188.33 g was recorded under the same medium without phosphorus. The highest tuber length values were observed in treatments receiving either 15.0 g or no SP-36, while the highest tuber diameter was likewise recorded under M1P2. Despite these descriptive differences, none reached statistical significance. The non-significant cocopeat effect on yield parameters is attributable to the gradual decomposition and physical integration of cocopeat with the surrounding soil matrix over the extended 11-month growing period, which progressively reduced substrate differentiation among treatments by harvest. The single basal phosphorus application employed in this study also did not sustain sufficient nutrient availability at the root-tuber interface during the critical corm expansion phase, as phosphorus exhibits limited soil mobility and its influence on gravimetric and linear tuber dimensions is generally indirect (Dash et al., 2025; Ibrahim et al., 2022; Kiemo et al., 2025; Wisdawati & Widyastuti, 2023). Gaur et al. (2023) and Qiu et al. (2022) similarly reported that phosphorus does not consistently determine specific morphological tuber parameters such as diameter or length across root and tuber crop species.

Tuber sugar content, however, responded significantly to phosphorus fertilizer dose. The highest mean of 2.78% was recorded under P1 at 7.5 g per plant, and the second highest under P3 at 22.5 g per plant, with both treatments belonging to the same significance group and significantly exceeding the control at 1.88% (Table 9). The lowest value recorded in the absence of phosphorus confirms that phosphorus deficiency substantially limits soluble sugar synthesis and accumulation within the corm. This outcome is mechanistically explained by phosphorus involvement in ATP-dependent carbohydrate biosynthesis and photosynthate translocation from source leaves to sink storage organs. Cocopeat, by contrast, primarily ameliorates physical substrate conditions and does not directly regulate these biochemical pathways, explaining its non-significant effect on sugar content. These findings are consistent with Cordeiro et al. (2023), who confirmed that phosphorus fertilization elevates tuber Brix values in storage crops through enhanced carbohydrate synthesis and energy reserve accumulation.

Table 9 HSD Test Results for Tuber Sugar Content (%) as Affected by Cocopeat Growing Medium Composition and Phosphorus Fertilizer Dose

Treatment	SP-36 0 g	SP-36 7.5 g	SP-36 15.0 g	SP-36 22.5 g	Mean (Cocopeat)
Without cocopeat (M0)	1.42	2.33	2.15	2.42	2.08
Cocopeat 3:1:1 (M1)	1.75	2.92	2.60	2.83	2.53
Cocopeat 3:2:1 (M2)	1.50	3.00	2.17	2.58	2.31
Mean (SP-36)	1.88 a	2.78 b	2.45 ab	2.67 b	—

Source: Researchers's Analysis (2025)
Note: Means followed by the same letter within a row indicate no significant difference at the 5% HSD level.

Table 9 presents mean tuber sugar content values across all treatment combinations for both factors. The phosphorus dose row means at the bottom of the table carry HSD letter notations, as phosphorus was the only factor producing a significant effect on this parameter. P0 (0 g per plant) recorded the lowest mean sugar content of 1.88% and was assigned the letter a, indicating it was significantly inferior to P1 (2.78%, letter b) and P3 (2.67%, letter b). P2 at 2.45% was assigned the letter ab, placing it in an intermediate position not significantly different from either P0 or the other doses. Notably, P1 and P3 produced statistically equivalent sugar content despite their threefold difference in dose, which has important practical implications for phosphorus fertilizer management in taro cultivation. The cocopeat treatment means in the rightmost column carry no letter notations, confirming the non-significant effect of growing medium composition on tuber sugar content.

The results of this study both support and extend the existing body of research on cocopeat-based growing media and phosphorus nutrition in root and tuber crops. The significant and consistent positive effects of cocopeat incorporation on all five vegetative parameters are in full agreement with prior reports by Erdal and Aktaş (2025) and Muhsanati et al. (2024), and they directly confirm that the physical improvements attributed to cocopeat translate into measurably superior vegetative performance in taro. The findings of Santoso et al. (2024) similarly established that substrate composition significantly determines crop morphological development under comparable Central Javan experimental conditions, and the present study extends that conclusion to taro, a tuber crop not previously examined under cocopeat-enriched regosol conditions in Indonesian lowland systems.

The absence of a significant cocopeat effect on yield parameters does not contradict but qualifies earlier literature, adding an important temporal dimension by demonstrating that over an extended 11-month polybag growing period, substrate differentiation diminishes as cocopeat decomposes and converges with surrounding soil, reducing its influence on final tuber dimensions. The significant phosphorus effect on tuber sugar content, while its effect on morphological yield parameters remained non-significant, extends the findings of Dash et al. (2025) and Kiemo et al. (2025) by confirming this distinction specifically within taro. Furthermore, the observation that the lowest effective phosphorus dose of 7.5 g per plant produced sugar content statistically equivalent to the highest dose tested partially contradicts the initial hypothesis that 200 kg/ha would yield optimal results, instead pointing to the agronomic sufficiency of lower doses for improving corm quality and suggesting a threshold effect in phosphorus response under the conditions of this experiment.

CONCLUSION

The findings of this study demonstrate that the composition of the cocopeat-enriched growing medium exerted a highly significant influence on all measured vegetative growth parameters of taro (*Colocasia esculenta* L.), including plant height, number of leaves, leaf length, stem length, and stem diameter. The most favorable vegetative performance was recorded in the treatment comprising soil, cocopeat, and manure at a volumetric ratio of 3:1:1 (M1), which produced the highest mean leaf length of 32.46 cm among all treatments. These outcomes are attributable to the superior physical properties of cocopeat, particularly its capacity to sustain optimal moisture retention and root-zone aeration throughout the vegetative period. However, growing medium composition did not produce a statistically significant effect on any of the yield parameters assessed at harvest, including tuber weight, tuber length, tuber diameter, and tuber sugar content, indicating that the agronomic benefits of cocopeat are primarily confined to the vegetative phase of taro development under the conditions of this experiment.

Phosphorus fertilizer application, conversely, produced no significant effect on any vegetative growth parameter but exerted a highly significant effect on tuber sugar content. The phosphorus dose of 7.5 g per plant, equivalent to 100 kg/ha, yielded the highest mean tuber sugar content of 2.78%, a value statistically equivalent to that recorded at the highest dose tested, suggesting that low to moderate phosphorus application is sufficient to optimize corm sugar accumulation in taro. No significant interaction between growing medium composition and phosphorus fertilizer dose was detected for any growth or yield parameter, indicating that the two factors operated independently of one another throughout the experimental period.

These results collectively indicate that cocopeat incorporation and phosphorus fertilization serve distinct and complementary agronomic functions in taro cultivation: cocopeat primarily enhances vegetative establishment and canopy development, while phosphorus governs corm quality through its role in carbohydrate synthesis and assimilate partitioning. Future studies are recommended to investigate repeated or split phosphorus applications across multiple growth stages, the long-term substrate behavior of cocopeat under field-scale conditions, and the economic feasibility of cocopeat-based media for smallholder taro production in Indonesian lowland environments.

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