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Effects of Eco-Enzyme Dosage and Application Methods on Growth and Yield Components of Peanut (*Arachis hypogaea* L.)

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Abstract
Peanut (*Arachis hypogaea* L.) is a valuable legume crop whose productivity depends on effective and environmentally friendly nutrient management. Eco-enzyme, a liquid organic product obtained from the fermentation of organic waste, has potential as a sustainable agricultural input; however, information regarding its optimal dosage and application method for peanut cultivation remains limited. This study aimed to evaluate the effects of eco-enzyme dosage, application method, and their interaction on the growth and yield components of peanut plants. The experiment was conducted using a factorial randomized block design with two factors. The first factor was eco-enzyme dosage at four levels: 0, 10, 15, and 20 mL plant^{-1}. The second factor was the application method, consisting of soil drenching and foliar spraying. Observations included vegetative growth parameters and yield components. Data were analyzed using analysis of variance (ANOVA) followed by a least significant difference test at the 5% level. The results showed that the eco-enzyme dosage significantly affected plant height at 30 and 45 days after planting, whereas the application method alone did not significantly influence most of the observed variables. However, a significant interaction between dosage and application method was observed for plant height at 45 days after planting, number of empty pods, fresh pod weight, dry pod weight, and seed weight. Higher eco-enzyme dosages combined with appropriate application methods tended to improve yield performance. In conclusion, eco-enzyme influenced peanut growth and yield selectively, and its effectiveness depended largely on the interaction between dosage and application method

Keywords: Application Method; Dosage; Eco-Enzyme; Growth And Yield; Peanut.

Introduction

Peanut (*Arachis hypogaea* L.) is an economically and nutritionally important legume crop, widely cultivated in tropical and subtropical regions as a major source of plant-based protein, edible oil, and raw material for agro-industry. In addition to its economic value, peanut plays a strategic ecological role through its symbiotic association with nitrogen-fixing rhizobia, which contributes to soil fertility and supports sustainable cropping systems. Despite these advantages, peanut productivity in many developing agricultural systems remains suboptimal, largely due to inefficient nutrient management practices and a continued reliance on synthetic fertilizers that may degrade soil quality over time (Z. Liu et al., 2023).

Growing environmental concerns and the rising cost of inorganic fertilizers have spurred an increased interest in sustainable nutrient management strategies, particularly the use of organic and biobased fertilizers. Liquid organic fertilizers have garnered increasing attention due to their

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rapid nutrient availability, ease of application, and potential to enhance soil biological activity while minimizing environmental impacts (Allouzi et al., 2022; Wang et al., 2024). Among these, eco-enzyme has emerged as a promising alternative input within sustainable agriculture frameworks.

Eco-enzyme is a fermented liquid produced from organic waste materials—such as fruit and vegetable residues—combined with sugar and water through anaerobic fermentation. This process generates a solution containing soluble macro- and micronutrients, organic acids, enzymes, and microbial metabolites that may positively influence soil health and plant physiological processes (Prasetio et al., 2021;Rachman et al., 2025). The use of eco-enzyme also aligns with circular economy principles by recycling organic waste into value-added agricultural inputs.

Recent studies have reported beneficial effects of eco-enzyme and similar liquid organic fertilizers on vegetative growth parameters, including plant height, leaf number, and biomass accumulation, in various horticultural and field crops (Siahaan et al., 2025; Tuapattinaya et al., 2024; Wiryono et al., 2021). In leguminous crops, including peanuts, fermentation-based liquid organic fertilizers have been shown to influence growth and yield components, suggesting their potential role in integrated nutrient management systems (Lizta & Fathurrahman, 2024; Rachman et al., 2025).

However, plant responses to eco-enzyme application are not uniform and appear to be highly dependent on treatment conditions. Differences in dosage, frequency, crop species, and environmental context can lead to variable outcomes, ranging from enhanced vegetative growth to inconsistent yield responses (Allouzi et al., 2022; Shi et al., 2022). This variability underscores the need for crop-specific and management-oriented evaluations rather than generalized assumptions regarding eco-enzyme effectiveness.

One critical but underexplored factor is the method of eco-enzyme application. Liquid organic inputs may be applied through soil drenching or foliar spraying, each involving distinct nutrient uptake pathways. Soil application primarily enhances root-mediated nutrient absorption and microbial interactions, while foliar application allows direct nutrient entry through leaf surfaces and stomata, potentially accelerating physiological responses (Wang et al., 2024). Recent studies on organic liquid fertilizers emphasize that interactions between dosage and application method can significantly influence nutrient use efficiency and yield formation (Shi et al., 2022;Zhou et al., 2022).

In peanut cultivation, yield formation is particularly sensitive to nutrient availability during the transition from vegetative to generative growth stages, when assimilate partitioning determines pod development and seed filling. Although several recent studies have examined the effects of eco-enzyme concentration or similar organic fertilizers on peanut growth and soil properties (Lizta & Fathurrahman, 2024; Rachman et al., 2025), most have evaluated single factors in isolation. Empirical evidence that simultaneously examines **the interaction between eco-enzyme dosage and application method**—especially in relation to yield components—remains limited.

This gap in the literature is significant because the absence of interaction-focused studies constrains the practical optimization of eco-enzyme use at the field level. Without clear guidance on appropriate dosage–method combinations, farmers may apply eco-enzyme inefficiently, resulting in suboptimal crop responses or inconsistent productivity gains. Moreover, understanding these interactions is essential for positioning eco-enzyme not merely as an organic supplement, but as a scientifically validated component of sustainable peanut production systems.

Therefore, this study aims to evaluate the effects of different eco-enzyme dosages, application methods, and their interaction on the vegetative growth and yield components of peanut plants.

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By addressing this research gap, the study seeks to provide empirical evidence that supports more precise and effective use of eco-enzyme as a liquid organic input, contributing to environmentally sustainable and agronomically sound peanut cultivation practices.

Literature Review

Eco-Enzyme as a Sustainable Liquid Organic Fertilizer in Crop Production

Sustainable nutrient management has become a priority in agricultural research due to the environmental risks associated with prolonged reliance on synthetic fertilizers. Recent studies emphasize liquid organic fertilizers as viable alternatives because they improve nutrient efficiency while supporting soil biological processes (Allouzi et al., 2022;Wang et al., 2024). Among these inputs, eco-enzyme—produced through the fermentation of organic waste—has gained increasing attention over the last five years as a low-cost and environmentally friendly biofertilizer.

Eco-enzymes contain soluble macro- and micronutrients, organic acids, and microbial metabolites that can enhance nutrient availability and stimulate soil microbial activity (Rachman et al., 2025). Empirical studies across horticultural and field crops report improvements in vegetative growth parameters such as plant height, leaf number, and biomass accumulation following eco-enzyme application (Haryuni et al., 2024;Wiryono et al., 2021). These responses are commonly attributed to nitrogen availability and enhanced physiological activity during the vegetative phase.

However, recent evidence also indicates that eco-enzyme effects are not universal across crops or growth stages. Rachman et al. (2025) reported that eco-enzyme improved soil nutrient status but produced variable yield responses depending on crop type and management conditions. This suggests that eco-enzyme functions more as a growth modifier than as a complete substitute for fertilizer. Consequently, research has shifted toward identifying the conditions under which eco-enzyme application becomes agronomically effective, particularly in relation to dosage and application strategy.

Importance of Dosage Optimization for Growth and Yield Responses

Dosage is a critical determinant of the effectiveness of liquid organic fertilizers. Recent studies consistently demonstrate that plant responses to eco-enzyme are dose-dependent and often non-linear (Gustina et al., 2024;Lizta & Fathurrahman, 2024;Permatasari, 2025). At optimal concentrations, eco-enzymes enhance nutrient uptake and photosynthetic activity, whereas sub-optimal or excessive doses may result in limited or inconsistent responses.

In legume crops such as peanuts, nutrient demand varies significantly across developmental stages. Vegetative growth relies heavily on nitrogen availability, while reproductive success depends on assimilate translocation and balanced nutrient supply during pod formation (Liu et al., 2024). Studies conducted within the last five years on fermentation-based liquid fertilizers show that appropriate concentrations can improve plant height and biomass, but yield components respond more selectively (Shi et al., 2022;Lizta & Fathurrahman, 2024).

Despite these insights, many previous studies assessed eco-enzyme dosage as a single factor, without considering its interaction with application methods. This creates a knowledge gap, as nutrient availability from liquid inputs is influenced not only by concentration but also by how nutrients enter the plant–soil system. Therefore, examining eco-enzyme dosage across multiple levels remains essential to determine thresholds at which growth benefits translate into yield improvements, particularly for peanut cultivation systems.

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Role of Application Method and Its Interaction with Dosage

The method of applying liquid organic fertilizers—commonly soil drenching or foliar spraying—plays a key role in nutrient absorption pathways. Foliar application enables rapid nutrient uptake through leaf surfaces, while soil application promotes root absorption and microbial interactions (Pujiastuti et al., 2024;Wang et al., 2024). Recent studies highlight that neither method is inherently superior; instead, their effectiveness depends on fertilizer composition, dosage, and crop physiological stage (Shi et al., 2022).

Research on eco-enzyme application methods remains limited, especially in legume crops. Existing studies indicate that foliar spraying tends to enhance vegetative traits, whereas soil application may better support yield formation through sustained nutrient supply (Istanti et al., 2023; Sapta Sara et al., 2025). Importantly, several recent findings suggest that significant effects often emerge only when dosage and application method are evaluated simultaneously, rather than independently (Pujiastuti et al., 2024;Rachman et al., 2025).

This interaction perspective is particularly relevant for peanuts, where yield formation is highly sensitive to nutrient partitioning during the generative phase. Inadequate alignment between dosage and application method may lead to excessive vegetative growth without proportional yield gains. Thus, current research increasingly emphasizes factorial approaches to identify optimal combinations that maximize both growth efficiency and yield output.

In this context, the present study addresses a clear gap in the literature by systematically evaluating the interaction between eco-enzyme dosage and application method on peanut growth and yield components. By integrating these variables, the study contributes to a more precise understanding of how eco-enzyme can be positioned as a supporting input within sustainable peanut production systems.

Research Method

Time and Place of Research

The research was conducted from February to June at the experimental garden of the Faculty of Agriculture, Jabal Ghafur University. The research activities were conducted under controlled cultivation conditions using polybags as the experimental units.

Research Materials and Procedures

The materials used in this study included peanut seeds (Arachis hypogaea L.), ecoenzyme, planting medium, and water. The planting medium was placed in uniformly sized polybags and planted with one peanut seed. During the study, the plants were cared for uniformly through watering, weeding, and pest control. Ecoenzyme was applied according to the dosage and method of application. Application began when the plants were 7 days old and was carried out periodically at two-week intervals. In the watering treatment, the ecoenzyme solution was applied directly to the planting medium around the root zone. In the spraying treatment, the ecoenzyme solution was applied to the leaf surface using a sprayer until evenly distributed.

Experimental Design and Treatment

The study was designed using a factorial Randomized Block Design (RBD) with two treatment factors. The first factor was the ecoenzyme dosage, which consisted of four levels: D0 (without ecoenzyme), D1 (10 ml plant^{-1}), D2 (15 ml plant^{-1}), and D3 (20 ml plant^{-1}). The second factor was the method of administration (C) of ecoenzyme, which consisted of two levels: watering (C1) and spraying (C2). Each treatment combination was repeated three times, resulting in 24

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experimental units. Each polybag containing one peanut plant was treated as one experimental unit.

Observation Parameters

Observed parameters included vegetative growth and yield components of peanut plants. Vegetative growth parameters included plant height, number of leaves, number of branches, and flowering age. Yield parameters included number of pods, pod weight, root length, number of seeds, and seed weight, which were observed at harvest.

Data analysis

External variables such as watering frequency, weed control, and pest management were standardized across all treatments. No additional fertilizers were applied during the experiment. Data were analyzed using analysis of variance (ANOVA), followed by a 5% significance level mean comparison test when necessary. If the analysis results showed a significant effect, testing was continued with the Honestly Significant Difference (HSD) test at a significance level of 5%.

Results and Discussion

Result

The results of this study indicate that administering ecoenzyme to peanut plants can affect several plant observation parameters such as plant height, number of empty pods, wet pod weight, dry pod weight, and seed weight. The F-values from each observation on the dose and method of ecoenzyme administration on peanut plant growth and yield are presented in Table 1 below.

Table 1. Summary of F-Count for all observation variables of dose and method of administration of ecoenzyme on the growth and yield of peanut plants.

No.	Observation Variables	F-Count Value		
		Ecoenzyme (D) Dosage	Method of Administration (C)	Interaction (DxC)
1.	Plant Height 15hst	0.49 tn	0.05 tn	0.83 tn
2.	Plant Height 30hst	4.60 *	0.73 tn	2.30 tn
3.	Plant Height 45hst	5.77 **	1.85 tn	5.78 **
4.	Number of Leaves 15hst	0.95 tn	0.54 tn	0.99 tn
5.	Number of Leaves 30hst	1.70 tn	4.21 tn	1.31 tn
6.	Number of Leaves 45hst	2.43 tn	1.47 tn	0.68 tn
7.	Number of Branches	2.21 tn	0.19 tn	2.71 tn
8.	Flowering Age	0.82 tn	0.14 tn	0.57 tn
9.	Number of Pods	3.03 tn	0.53 tn	3.24 tn
10.	Number of Pomegranate Pods	3.02 tn	0.70 tn	2.29 tn
11.	Number of Empty Pods	1.97 tn	0.45 tn	3.54 *

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12.	Wet Pod Weight (g)	1.48 tn	0.51 tn	5.00 *
13.	Dry Pod Weight (g)	1.95 tn	1.66 tn	3.95 *
14.	Root Length (cm)	2.72 tn	0.26 tn	2.09 tn
15.	Number of Seeds Per Polybag	1.98 tn	0.11 tn	2.34 tn
16.	Seed Weight (g)	1.78 tn	2.34 tn	4.03 *

Description: (tn) has no real effect; (*) has a real effect; (**) has a very real effect

Based on the results of the analysis of variance, the ecoenzyme dosage factor (D) has a greater influence as the plant ages. This is evident from the F-value for the plant height parameter, which shows a significant effect at 30 days after planting and increases to a very significant effect at 45 days after planting. In contrast, the administration method factor (C) does not statistically have a significant effect on all observed variables. This indicates that changes in the administration method alone do not cause significant differences in the growth and yield of peanut plants, unless combined with the appropriate dosage.

The response of peanut plants to ecoenzyme treatment appears to be selective among growth and yield variables, so not all parameters respond uniformly to the treatment. This pattern aligns with the characteristics of legume plants, whose growth and reproductive responses are largely determined by developmental phase, initial nutrient status, and photosynthates allocation efficiency during the vegetative-generative transition.(Adisarwanto, 2008);(Trustinah et al., 2014).

The interaction between dose and administration method was the main factor influencing the results in this study, especially in the final growth phase and yield components. Statistically, the interaction between these two treatments significantly affected plant height at 45 days after planting. Furthermore, a significant effect was also observed on several important yield components, namely the number of empty pods, wet pod weight, dry pod weight, and seed weight. Since there was a significant effect on seed weight with an F-value of 4.03, the combination of dose and administration method of ecoenzyme jointly influenced the success of pod filling and the economic weight of peanut plants.

On the other hand, several variables showed no significant response to all treatments, whether single factors or interactions. These variables included the number of leaves throughout the observation period, the number of branches, the age at flowering, the length of roots, and the number of seeds per polybag. These results indicate that these parameters are more influenced by the genetic factors of the peanut plant itself or by shared macroenvironmental factors. Therefore, varying the dosage or method of application of the ecoenzyme failed to produce statistically significant changes in these variables.

The inconsistency of several vegetative parameters such as leaf number, branch number, and several other morphological variables can be interpreted as an indication that ecoenzymes are not always the main limiting factor in organ formation, especially when basic factors such as media fertility, water, and cultivation conditions are relatively uniform. Certain vegetative responses are often more stable because they are controlled by developmental regulation and nutrient adequacy “thresholds,” so that additional organic liquid inputs do not automatically translate into morphological changes in all indicators (Taiz et al., 2015; Marschner, 2012).

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The Effect of Ecoenzyme Administration

Based on the results of the analysis of variance, the treatment of ecoenzyme administration affected plant height at 30 and 45 hst. The results of the honestly significant difference test analysis at a 5% confidence level for observations of plant height at 30 and 45 hst are presented in the following table.

Table 2. Results of Further Tests Observing Plant Height with Ecoenzyme Administration

No.	Observation Parameters	BNJ 5%	Ecoenzyme (D) Dosage (ml plants^{-1})			
			D0 (0)	D1 (10)	D2 (15)	D3 (20)
1.	Plant Height 30 HST	2.97	24.75 a	24.35 a	22.06 b	25.73 a
2.	Plant Height 45 HST	3.70	46.48 a	43.74 a	43.34 a	41.22 b

Note: Numbers accompanied by the same letter in the same row show no significant difference in the honest significant difference test at a 5% confidence level.

Table 2 shows that the height of peanut plants at 30 days after planting (dap) following the administration of Ecoenzyme doses D0, D1, and D3 was not significantly different from each other, but all three were significantly different from the D2 treatment. Administration of Ecoenzyme dose D3 (20 ml plant^{-1}) can increase the height of peanut plants. This is because Ecoenzyme contains natural organic materials and microorganisms that can increase soil and plant fertility. According to(Novianto, 2022)Ecoenzyme is a product of the fermentation process of natural organic materials from fruit and vegetable waste. The liquid extract of ecoenzyme contains nitrate (NO3), which is used as a nitrogen source to meet plant nutrient needs.

The difference in the height response of peanut plants to ecoenzyme administration indicates that ecoenzyme application affects the effectiveness of vegetative growth. Further test results in Table 2 show a significant difference in plant height with ecoenzyme administration. This indicates that plant responses to ecoenzymes are selective and depend on the physiological sensitivity of each growth parameter, particularly during the active vegetative phase of the plant (Taiz et al., 2021; Marschner, 2012). The nutrients contained in ecoenzymes can be optimally absorbed by plants, thereby enhancing plant growth. Plants will grow optimally if the fertilizer used is appropriate in terms of type, dosage, timing, and application method.(Septiarini Zuliati, Cindy Cahyani Br Sitepu, Ismadi & Nasution, Mira Humaira, Almuna Ramadhani, 2025).

The Effect of Ecoenzyme Administration Method

In this study, the ecoenzyme administration methods consisted of two methods: watering (C1) and spraying (C2). The analysis of variance results showed that the ecoenzyme administration method did not significantly impact any of the observed variables. The average observation results for each ecoenzyme administration method are shown in the following table.

Table 3. Average Results of Each Observation for Each Method of Ecoenzyme Administration

No.	Observation Parameters	Average Observation Value	
		C1	C2

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1.	Plant Height 15 days after planting	16.69	16.84
2.	Plant Height 30 days after planting	23.91	24.53
3.	Plant height 45 hst	43.08	44.31
4.	Number of Leaves 15hst	43.50	45.29
5.	Number of Leaves 30hst	96.63	112.54
6.	Number of Leaves 45hst	321.54	370.21
7.	Number of Branches	3.96	3.92
8.	Number of Pods	78.63	74.79
9.	Number of Pomegranate Pods	75.63	71.17
10.	Number of Empty Pods	6.00	7.25
11.	Wet Pod Weight (g)	180.29	170.96
12.	Dry Pod Weight (g)	63.17	55.63
13.	Root Length (cm)	57.63	58.96
14.	Flowering Age	25.54	25.79
15.	Number of Seeds Per Polybag	129.04	125.54
16.	Seed Weight (g)	59.71	51.00

Based on Table 3, the average observation value shows that the C2 treatment had a greater effect on plant vegetative growth than the C1 treatment. This is evident from the consistent and better plant growth from 15 HST to 45 HST, where at the end of the observation, the average plant height reached 44.31 cm. A clear difference was seen in the number of leaves, where at 45 HST, the C2 treatment produced 370.21 leaves, while the C1 treatment only achieved 321.54 leaves. In addition, the C2 treatment also showed longer root growth, reaching 58.96 cm. From all of these things, it can be concluded that the method of administering ecoenzymes in the C2 treatment is more effective in encouraging cell division and the growth of plant vegetative organs.

Leaves play a role in enhancing a plant's ability to photosynthesize. They serve as the primary photosynthetic organ, thus directly related to increased vegetative biomass formation. Optimal leaf formation is related to nutrient balance, particularly nitrogen and phosphorus, which accelerate the development of young plant tissue (Hopkins & Hüner, 2009). Based on research results,(Saputri & Anisya, 2024)Ecoenzyme solutions from banana, papaya, and pineapple peels contain macronutrients (N, P, K, and organic carbon), which are essential for plants.

Although the C2 treatment was better in terms of physical growth, the C1 treatment was more efficient in terms of flower formation and harvest yield. Plants in the C1 treatment began flowering earlier, at 25.54 days after planting. The main advantage of C1 lies in the quality of its production results, where the number of pods produced was greater, namely 78.63, and the productivity level of full pods was higher, namely 75.63 compared to C2. Meanwhile, the C2 treatment had a higher number of empty pods, namely 7.25. The dominance of C1 was increasingly felt in the final seed weight, where the seed weight per polybag reached 59.71 grams,

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while C2 only reached 51.00 grams. According to Lestari (2022) Ecoenzyme contains lipase, trypsin, and amylase enzymes and can inhibit pathogenic bacteria. Ecoenzyme produces nitrates and carbohydrates, which the soil needs as nutrients.

Overall, there were differences in growth outcomes between the two treatments. Treatment C2 encouraged greater physical growth, particularly in terms of leaves and height, but competition for nutrients occurred, with more nutrients allocated to the leaves and stems, resulting in suboptimal seed pod formation. Meanwhile, treatment C1 maintained a balance between physical plant growth and seed filling, resulting in higher dry weight of pods and seeds. Therefore, if the goal is to maximize seed yields, the ecoenzyme supplementation method in treatment C1 is considered more effective.

Treatment Interaction

The results of the 5% BNJ follow-up test on the interaction between dose and method of ecoenzyme administration showed that the method of ecoenzyme use and administration affected several observation parameters. The results of the follow-up test are presented in Table 4 below.

Table 4. Interaction of Ecoenzyme Dose Treatment and Administration Method on Several Observation Parameters

No.	Combination Treatment	Plant height 45 hst	Number of Empty Pods	Wet Pod Weight	Dry Pod Weight	Seed Weight
1	D0C1	47.97 a	13.67 a	207.17 a	71.67 a	68.50 a
2	D1C1	45.00 ab	6.33 a	178.67 a	65.00 a	62.17 a
3	D2C1	43.63 ab	0.67 a	167.00 a	54.67 a	50.83 a
4	D3C1	43.85 ab	3.33 a	168.33 a	61.33 a	57.33 a
5	D0C2	43.17 ab	5.33 a	120.00 b	32.17 b	28.50 b
6	D1C2	43.52 ab	7.00 a	186.33 a	60.00 a	54.83 a
7	D2C2	37.57 b	5.67 a	156.17 a	52.67 a	48.83 a
8	D3C2	44.87 ab	11.00 a	221.33 a	77.67 a	71.83 a

Note: Numbers accompanied by the same letter in the same column show no significant difference in the honest significant difference test at a 5% confidence level.

The analysis of growth parameters in Table 4 shows that the method of ecoenzyme application and its dosage affect growth differently. For plant height at 45 days after planting, the D0C1 treatment combination showed the highest vegetative growth of 47.97 cm, which was significantly different from the D2C2 combination. However, most other combinations showed no significant differences. This indicates that peanut plant height has a relatively uniform response to the interaction between the dose and method of ecoenzyme application at this stage. On the other hand, there was no significant difference in the number of empty pods among all treatment combinations. This indicates that the formation of empty pods is more influenced by environmental factors or plant genetic traits than by the interaction of the treatments tested.

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A clearer response was seen in yields, particularly in pod and seed weight. The D3C2 combination produced the best and most consistent results. Wet pod weight reached 221.33 grams, dry pod weight 77.67 grams, and seed weight 71.83 grams. In contrast, the D0C2 combination showed a significant and significantly different yield decrease compared to the other treatments, with an average seed weight of only 28.50 grams. This indicates a collaboration between increasing the dose and the ecoenzyme application method in encouraging the transfer of photosynthesis products to the reproductive parts of the plant. Without ecoenzyme application (D0), the spraying method (C2) actually resulted in significantly lower production, demonstrating the importance of nutritional supplements through ecoenzymes to increase peanut yields using this application method.

Discussion

This study provides empirical evidence that the effectiveness of eco-enzyme application in peanut (*Arachis hypogaea L.*) cultivation is not uniform across growth stages or agronomic parameters, but instead depends strongly on dosage, application method, and—most importantly—the interaction between these two factors. The findings highlight the complexity of plant responses to liquid organic inputs and emphasize that eco-enzymes function more as modulators of physiological processes than as direct substitutes for conventional fertilizers.

Effect of Ecoenzyme Dosage on Vegetative Growth

Ecoenzyme dosage significantly affected plant height at 30 and 45 days after planting (DAP), indicating that its influence becomes more pronounced as plants transition from early vegetative to advanced vegetative growth stages. This pattern suggests that ecoenzyme-derived nutrients and bioactive compounds require time to become biologically available and physiologically effective within the plant–soil system. Similar delayed responses have been reported for other organic liquid fertilizers, where mineralization and microbial mediation govern nutrient release (Marschner, 2012; Taiz et al., 2021).

The enhanced plant height at higher ecoenzyme doses can be attributed to the presence of soluble nitrogen forms, organic acids, and microbial metabolites produced during fermentation. Nitrogen plays a central role in cell division and elongation, chlorophyll synthesis, and overall vegetative vigor (Hopkins & Hüner, 2009). Previous studies have confirmed that ecoenzyme contains nitrate compounds and organic nutrients capable of supporting vegetative growth when applied at appropriate concentrations (Novianto, 2022; Wiryono et al., 2021). However, the absence of a linear response across all doses suggests that peanut plants exhibit an optimal threshold, beyond which additional inputs may not proportionally enhance growth.

Limited Effect of Application Method as a Single Factor

The method of ecoenzyme application—either soil drenching or foliar spraying—did not significantly affect most growth and yield parameters when analyzed as a single factor. This finding indicates that, under uniform cultivation conditions, the plant's physiological response is not solely determined by the route of application, but rather by the availability and balance of nutrients absorbed over time.

From a physiological perspective, both soil and foliar pathways can facilitate nutrient uptake, albeit through different mechanisms. Soil application enhances root-mediated absorption and microbial interactions, while foliar spraying enables rapid nutrient entry through stomata and cuticular pathways (Marschner, 2012). The lack of statistical significance suggests that neither pathway alone was limiting under the experimental conditions, consistent with findings in other legume and horticultural crops receiving liquid organic fertilizers (Siregar et al., 2025; Saputri &

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Anisya, 2024).

Interaction Between Dosage and Application Method

The most critical outcome of this study lies in the significant interaction between ecoenzyme dosage and application method, particularly for plant height at 45 DAP and key yield components such as empty pod number, fresh pod weight, dry pod weight, and seed weight. This interaction highlights that the effectiveness of ecoenzyme is maximized not by dosage or method alone, but by their optimal combination.

Notably, higher ecoenzyme doses combined with foliar spraying produced superior yield outcomes, especially in seed and pod weight. This suggests that foliar application at sufficient concentrations may enhance the translocation of photosynthates toward reproductive organs, improving pod filling efficiency. Similar synergistic effects between nutrient concentration and foliar application have been reported in studies on peanuts and other legumes, where nutrient availability during the reproductive phase is critical for yield determination (Adisarwanto, 2008; Trustinah et al., 2014).

Conversely, treatments without ecoenzyme but applied via foliar spraying resulted in significantly lower yields, underscoring that application method alone cannot compensate for nutrient insufficiency. This finding reinforces the principle that organic liquid fertilizers function as complementary inputs rather than substitutes for essential nutrient supply (Lizta & Fathurrahman, 2024; IA et al., 2025).

Differential Responses of Vegetative and Generative Parameters

Several vegetative parameters, including leaf number, branch number, flowering time, and root length, were not significantly affected by either factor or their interaction. This outcome suggests that these traits are more strongly governed by genetic regulation and baseline environmental conditions than by supplemental organic inputs. According to plant developmental theory, once minimum nutrient requirements are met, additional inputs may not substantially alter morphogenetic traits (Taiz et al., 2021).

In contrast, yield-related parameters exhibited higher sensitivity to treatment interactions, reflecting the greater nutritional demand during the generative phase. Seed filling in peanuts is highly dependent on assimilate availability and efficient nutrient partitioning, both of which can be influenced by external inputs during pod development (Hopkins & Hüner, 2009). The observed improvement in pod and seed weight therefore indicates that ecoenzyme contributes more effectively to yield formation than to early morphological development.

Agronomic and Sustainability Implications

From an agronomic perspective, the results suggest that ecoenzyme has potential as a supporting component in integrated nutrient management systems for peanut cultivation. Its effectiveness is optimized when applied at appropriate doses and combined with suitable application methods, rather than used indiscriminately. This aligns with sustainable agriculture principles, which emphasize efficiency, reduced dependency on synthetic inputs, and environmentally friendly practices (Prasetio et al., 2021).

However, given that not all parameters responded significantly, ecoenzyme should be positioned as a complementary input rather than a sole fertilizer source. Its integration with soil fertility management, crop-specific nutrient requirements, and site-specific conditions is essential to achieve consistent and economically viable outcomes.

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Conclusion

This study demonstrates that eco-enzyme application has a selective yet meaningful influence on the growth and yield performance of peanut (*Arachis hypogaea L.*), with its effectiveness strongly determined by dosage levels and application methods, particularly through their interaction. While eco-enzyme dosage significantly affected vegetative growth—most notably plant height at 30 and 45 days after planting—the application method alone showed limited direct effects on most observed parameters. However, when dosage and application method were combined, their interaction produced significant improvements in several key yield-related components, including the number of empty pods, fresh pod weight, dry pod weight, and seed weight. These findings confirm that eco-enzyme functions most effectively when applied in an optimized and integrated manner rather than as a standalone input.

From a practical agronomic perspective, the results highlight that higher eco-enzyme dosages, combined with appropriate application strategies—particularly foliar spraying—tend to enhance yield performance, especially in terms of seed and pod weight. This suggests that eco-enzyme application can enhance assimilate allocation during the reproductive phase, which is crucial for peanut productivity. Nevertheless, the absence of significant effects on several vegetative parameters, such as leaf number, branching, flowering time, and root length, suggests that eco-enzyme should be regarded as a complementary input rather than a substitute for comprehensive nutrient management practices.

In terms of sustainable agriculture development, the findings offer important practical implications. Eco-enzyme, derived from fermented organic waste, represents an environmentally friendly input that can contribute to waste recycling, reduce dependency on synthetic fertilizers, and support more sustainable nutrient management systems. Its use aligns with sustainable agriculture principles by promoting resource efficiency, lowering potential environmental risks associated with excessive chemical fertilizer use, and supporting biologically based soil–plant interactions. Therefore, eco-enzyme application has potential value as part of integrated nutrient management strategies, particularly in smallholder or low-input farming systems where sustainability and cost efficiency are major considerations.

Based on the results of this study, several applicable recommendations can be proposed. First, farmers and practitioners are advised to apply eco-enzyme at moderate to higher dosages in combination with suitable application methods, especially during critical growth stages leading into the reproductive phase, to maximize yield benefits. Second, eco-enzyme should be integrated with other organic or inorganic fertilizers rather than used as a single nutrient source, ensuring balanced nutrient availability and stable crop performance. Third, extension programs and sustainable agriculture initiatives can promote the utilization of eco-enzymes as a locally adaptable and environmentally sound practice, particularly in regions with abundant organic waste resources.

Finally, further research is recommended to refine eco-enzyme application strategies under field conditions, evaluate its long-term effects on soil health and microbial activity, and assess its economic feasibility at the farm level. Studies involving different crop varieties, soil types, and climatic conditions will be essential to strengthen the general applicability of eco-enzyme use in sustainable agricultural systems. Overall, this study provides scientific evidence that eco-enzyme can contribute to more sustainable peanut production when applied thoughtfully, supporting both productivity goals and environmental sustainability.

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References

Adisarwanto, T. (2008). *Budidaya kacang tanah*. Penebar Swadaya.

Allouzi, M. M. A., Allouzi, S. M. A., Keng, Z. X., Supramaniam, C. V., Singh, A., & Chong, S. (2022). Liquid biofertilizers as a sustainable solution for agriculture. *Heliyon*, *8*(12), e12609. https://doi.org/10.1016/j.heliyon.2022.e12609

Gustina, L., Zuyasna, & Nura. (2024). Effect of eco-enzymes on vegetative and generative growth in several kipas putih soybean (Glycine max (L) Merr.) mutant lines. *IOP Conference Series: Earth and Environmental Science*, *1297*(1), 012061. https://doi.org/10.1088/1755-1315/1297/1/012061

Haryuni, H., Wahid, M. N., Priyadi, S., Aziez, A. F., & Maryanti, I. E. (2024). The Effect of Eco-enzymes and Husk Charcoal on the Growth of Vanilla Seeds. *Indian Journal Of Agricultural Research*, *Of*. https://doi.org/10.18805/IJARe.AF-820

Istanti, A., Indraloka, A. B., & Utami, S. W. (2023). Karakteristik Pupuk Cair Eco-Enzyme Berbahan Dasar Limbah Sayur Dan Buah Terhadap Kandungan Nutrisi Dan Bahan Organik. *Agriprima : Journal of Applied Agricultural Sciences*, *7*(1), 79–85. https://doi.org/10.25047/agriprima.v7i1.503

LESTARI, R. I. (2022). Pengaruh Pemberian Macam Eco Enzyme dan Pupuk Kandang Sapi Terhadap Hasil Tanaman Kacang Tanah (Arachis hypogaea L.). *Braz Dent J.*, *33*(1), 1–12.

Liu, Y., Lan, X., Hou, H., Ji, J., Liu, X., & Lv, Z. (2024). Multifaceted Ability of Organic Fertilizers to Improve Crop Productivity and Abiotic Stress Tolerance: Review and Perspectives. *Agronomy*, *14*(6), 1141. https://doi.org/10.3390/agronomy14061141

Liu, Z., Song, Y., Ge, L., Pan, X., Zhao, Y., Cheng, L., Li, Y., Wang, W., & Liu, X. (2023). Impact of Various Organic Fertilizerson the Growth, Yield, and Soil Environmentof Peanuts Subjected to ContinuousCropping Obstacles. *Polish Journal of Environmental Studies*, *32*(4), 3683–3693. https://doi.org/10.15244/pjoes/164404

Novianto. (2022). *Response Of Liquid Organic Fertilizer Eco Enzyme (Ee) On Growth And Production Of Shallot (Allium ascalonicum. L)*. *4*(1).

Pebri Lizta, R., & Fathurrahman, F. (2024). Pengaruh Konsentrasi Pupuk Eco Farming Terhadap Pertumbuhan dan Hasil Beberapa Varietas Kacang Tanah (Arachis hypogaea L.). *Jurnal Agroteknologi Agribisnis Dan Akuakultur*, *4*(2), 119–128. https://doi.org/10.25299/jaaa.2024.18695

Permatasari, F. (2025). Experiment on the Effect of Pineapple Ecoenzyme on the Morphological Growth of Green Beans (Vigna radiata L.) as an Effort to Promote Environmentally

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Friendly Fertilization. *Jurnal Penelitian Pendidikan IPA*, *11*(12), 704–712. https://doi.org/10.29303/jppipa.v11i12.13426

Prasetio, V. M., Ristiawati, T., & Philiyanti, F. (2021). Manfaat Eco-Enzyme pada Lingkungan Hidup serta Workshop Pembuatan Eco-Enzyme. *Darmacitya : Jurnal Pengabdian Kepada Masyarakat*, *1*(1), 21–29.

Pujiastuti, E. S., Simanjuntak, J., Tarigan, J. R., & Sumihar, S. T. T. (2024). The Effect of Biofertilizer Type and Chicken Manure Dosage on the Growth and Yield of Kale (Brassica oleraceae L.). *Journal of Experimental Agriculture International*, *46*(9), 344–353. https://doi.org/10.9734/jeai/2024/v46i92831

Rachman, I. A., Umasugi, B., Aji, K., Hakim, N. F. A., Sofyan, A., & Hasan, A. D. A. (2025). Effect of eco-enzyme application on soil nutrient and plant productivity of green mustard-peanut in inceptisol. *Kultivasi*, *24*(2), 196–205. https://doi.org/10.24198/kultivasi.v24i2.64591

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Saputri, D. A., & Anisya, S. (2024). *EKOENZIM SEBAGAI PUPUK CAIR ORGANIK UNTUK MENINGKATKAN PERTUMBUHAN SAWI HIJAU (Brassica juncea L .) Ecoenzyme as an Organic Liquid Fertilizer to Improve The Growth of Green Mustard (Brassica juncea L .)*. *6*(1), 37–44.

Septiarini Zuliati, Cindy Cahyani Br Sitepu, Ismadi, W. I., & Nasution, Mira Humaira, Almuna Ramadhani, T. H. (2025). Agrotekma APPLICATION OF ECO-ENZYME AND BIOCHAR ON THE GROWTH AND. *J. Agrotekma*, *9*(2), 52–60. https://doi.org/10.31289/agr.v9i2.13412

Shi, X., Hao, X., Li, N., Li, J., Shi, F., Han, H., Tian, Y., Chen, Y., Wang, J., & Luo, H. (2022). Organic Liquid Fertilizer Coupled With Single Application of Chemical Fertilization Improves Growth, Biomass, and Yield Components of Cotton Under Mulch Drip Irrigation. *Frontiers in Plant Science*, *12*, 763525. https://doi.org/10.3389/fpls.2021.763525

Siahaan, E. S., Siregar, A. S., Anggraini, J. I., Br Tambunan, M. C., Triana, R., Atmaja, W. P., Syahputri, Y. N., Idramsa, I., & Febriyossa, A. (2025). Efektivitas Ecoenzyme Limbah Kulit Jeruk Sebagai Pupuk Organik Cair Terhadap Pertumbuhan Vegetatif Bayam Hijau (Amaranthus hybridus). *Jurnal Sains Agro*, *10*(1), 23–36. https://doi.org/10.36355/jsa.v10i1.1743

Trustinah, Kasno, A., & Harnowo, D. (2014). Potensi dan peluang pengembangan kacang tanah di Indonesia. *Jurnal Penelitian Tanaman Pangan*, *33*(2), 85–96.

Tuapattinaya, P. M. J., Tiven, J. G., Fretes, G. D., Madubun, G., & Lopulalan, G. (2024). ECO-ENZYME: LIQUID ORGANIC FERTILIZER ON THE GROWTH OF MUSTRAIN PLANTS (Brassica chinensis) AS SUPPORTING LITERACY AND NUMERATION.

This is an Creative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License

BIOMA : Jurnal Ilmiah Biologi, *13*(2), 41–51. https://doi.org/10.26877/bioma.v13i2.1098

Wang, J., Yang, X., Huang, S., Wu, L., Cai, Z., & Xu, M. (2024). Long-term combined application of organic and inorganic fertilizers increases crop yield sustainability by improving soil fertility in maize-wheat cropping systems1. *Journal of Integrative Agriculture*, S2095311924002466. https://doi.org/10.1016/j.jia.2024.07.003

Wiryono, B., Sugiarta, S., Muliatiningsih, M., & Suhairin, S. (2021). Effectiveness of eco-enzyme utilization to enhance plant growth in hydroponic systems. *Proceedings of the National Seminar on Agriculture*, *2*, 63–68.

Zhou, Z., Zhang, S., Jiang, N., Xiu, W., Zhao, J., & Yang, D. (2022). Effects of organic fertilizer incorporation practices on crops yield, soil quality, and soil fauna feeding activity in the wheat-maize rotation system. *Frontiers in Environmental Science*, *10*, 1058071. https://doi.org/10.3389/fenvs.2022.1058071

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