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Growth and Yield Response of Detam 4 Soybean Variety on Single P Fertilizer and Vermicompost Application in Coastal Land

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ABSTRACT

This research was conducted from July to November 2020 in the coastal lands of Ratu Agung District, Lempuing Village, Kuala Alam, Bengkulu City, at an elevation of 5 meters above sea level. The study aimed to investigate the interaction between vermicompost and single phosphorus (P) fertilizer on the growth and yield of Detam 4 soybean plants in coastal lands, focusing on determining the optimal doses for both inputs. The experiment was designed as a two-factor study using a factorial Randomized Complete Block Design (RCBD) with three replications. The first factor was vermicompost application at four levels: 0 tons ha^{-1}, 5 tons ha^{-1}, 10 tons ha^{-1}, and 15 tons ha^{-1}. The second factor was phosphorus application at three levels: 0 kg ha^{-1}, 50 kg ha^{-1}, and 100 kg ha^{-1}. Observed variables included plant height, number of leaves, flowering age, number of productive branches, number of pods per plant, pod weight per plant, pod weight per plot, seed weight, and root weight. Data were analyzed using ANOVA at the 5% significance level, with a subsequent 5% LSD test if significant effects were found. The application of vermicompost at a dose of 10 tons ha^{-1} without the addition of single P fertilizer results in the best growth of the soybean variety Detam 4, characterized by the highest average shoot dry weight of 41.133 g, the fastest flowering age, and the greatest number of productive branches. The best yield of the Detam 4 soybean variety is achieved with the application of vermicompost at a dose of 15 tons ha^{-1}, indicated by the highest number of productive branches and seed weight per plant. The independent application of single P fertilizer does not significantly enhance the growth and yield of the Detam 4 soybean variety in coastal land conditions.

Keywords : Detam 4, vermicompost, single P fertilizer , coastal land

INTRODUCTION

Black soybeans are a type of soybean that is needed for the soysauce industry. Black soybeans are preferred by soy sauce producers because they provide a natural black color and better quality to the soy sauce produced. However, due to limited production of black-seeded soybeans, soy sauce producers use more yellow-seeded soybeans, many farmers cultivate yellow soybeans more than black soybeans, this is because farmers are used to growing yellow soybeans, and marketing is easier. The rapid growth of the soysauce industry and increasing public demand have not been matched by an increase in black soybean production.

One way to increase land area is to utilize marginal land such as coastal land. With a coastline length of 95,161 km and a land area of 1,060,000 ha, Indonesia has good prospects for agricultural development (Lasabuda, 2013). The research results of Bertham *et al*. (2013) show that the Bengkulu coastal area can be used for cultivating chilies and soybeans. The length of the Bengkulu coastline reaches 525 km (Bengkulu Provincial Government, 2015). Coastal land generally has unstable soil characteristics, low soil moisture, high evapotranspiration, high salt content, and low organic matter content (Nugroho, 2013). Cation Exchange Capacity (CEC), C-organic, and Ca are very low, with low water binding capacity (Rajiman *et al*., 2008), and a lack of N elements (Sunardi, 2007). The small surface area and large pores (Cornell *et al*., 2003; Sitorus *et al*., 2008) cause the water-holding capacity to be low. This causes the media to quickly lose water and the humidity of the media decreases.

One effort to increase black soybean production is by fertilizing with P nutrients. The P element plays a role in almost all biochemical reaction processes. Nutrient P also plays a role in protein synthesis, especially those found in green tissue, carbohydrate synthesis, stimulates the formation of flowers and seeds and determines the ability of seeds or seeds to germinate. (Koswara, 1992). Phosphorus can stimulate root development so that plants will be more resistant to drought, and accelerate flowering and ripening of fruit, seeds, or grain, besides that it can also increase nutritional value (fat and protein). According to Risnawati & Yusuf, (2019), giving phosphorus at 300 kg ha^{-1} treatment to black soybean plants increases protein levels linearly.

Indonesia has a wet tropical climate with high rainfall, bases will be leached from soil colloids so that they react acidically, and a low pH <5. As a result, the availability of P nutrients becomes low because it is fixed. Therefore, P fertilization is a necessity (Damanik *et al*., 2011). The research results of Hadirah, (2011), showed that P fertilization had a very significant impact on plant height and dry seed weight.

Vermicompost is compost obtained from the breakdown of organic materials by earthworms. Vermicompost is a mixture of earthworm droppings (casting) with leftover media or feed in earthworm cultivation. Therefore, vermicompost is an organic fertilizer that is environmentally friendly and has its advantages compared to other composts that we know so far (BPP, 2001). Apart from containing the nutrients N, P, and K, vermicompost also contains humic acid like other organic fertilizers. Humic substances together with clay play a role in several chemical reactions in the soil. Apart from humic acid, vermicompost also has a high CEC. CEC of vermicompost varies from 35 me 100 g^{-1} to 130 me 100 g^{-1}. Therefore, vermicompost can add nutrients such as N, P, and K to the soil, or vermicompost can increase soil fertility. According to Siregar *et al*. (2019), the application of vermicompost had a significant effect on the height of soybean plants in the vermicompost treatment at a dose of 10 t ha^{-1}. The effect of organic matter on the availability of P nutrients in the soil was through the results of weathering, namely organic acids and CO_2. Organic acids such as malonic, tartaric, humic, and fulvic acids will produce organic anions (ions/groups that have a negative charge). These organic anions can bind metals such as Al, Fe, and Ca from the soil solution, and then form complex compounds that are difficult to dissolve. By binding Al, Fe, and Ca, the ions will be free from the binding of these metals so that they are available in the soil solution. The process of binding metals such as Al, Fe, and Ca by acids, and complex organic compounds is called chelation and the complex compounds are called chelates (Damanik *et al*., 2011). Based on this description, it is necessary to research the growth and yield response of Detam 4 soybean plants to the application of vermicompost and single P fertilizer on coastal land.

MATERIALS AND METHODS

This research was conducted from December 2021 to March 2022 on coastal land in Ratu Agung District, Lempuing Village, Kuala Alam, Bengkulu City, at an altitude of 5 meters above sea level.

The materials used in this study included Detam 4 variety soybean seeds, vermicompost fertilizer, and P fertilizer (SP-36). The tools employed were a hoe, measuring tape, stakes, netting, scissors, oven, chlorophyll meter, SPAD (Soil Plant Analysis Development), analytical scales, digital scales, platform scales, and vernier calipers.

Soil analysis was performed before land preparation by collecting composite soil samples and analyzing them in the laboratory. The objective was to determine the organic carbon content, pH, and levels of calcium (Ca), nitrogen (N), phosphorus (P), and potassium (K) in the soil prior to treatment. Vermicompost fertilizer was also analyzed at the beginning of the study by assessing its moisture content (%), organic carbon (%), C/N ratio, nitrogen (%), phosphorus (%), and potassium (%).

Planting occurred one week after land preparation. The soil was dug to a depth of 2 cm, and three seeds were sown in each hole, with each plot containing 16 planting holes. Sample plants were randomly selected from each experimental plot, excluding border plants.. From each plot, 25% of the plants (4 plants per plot) were chosen as samples.

The experiment tested two factors: vermicompost dose and phosphorus application. The vermicompost doses were 0 tons ha^{-1}, 5 tons ha^{-1}, 10 tons ha^{-1}, and 15 tons ha^{-1}. The phosphorus application levels were 0 kg ha^{-1}, 50 kg ha^{-1}, and 100 kg ha^{-1}. A factorial randomized complete block design (RCBD) was used.

Fertilization was conducted twice: first at 3 days after planting (DAP) and again at 14 DAP, using NPK fertilizer and SP-36 fertilizer according to the recommended dosages. Weeding was performed twice during critical periods when the plants were 3 and 6 weeks old. This was done manually by removing weeds from around the plants. Pest and disease control was carried out chemically using an insecticide with the active ingredient formetane hydrochloride, applied according to the recommended dosage indicated on the insecticide label. Harvesting was done when the plants met the harvest criteria, specifically when 95% of the pods were dry and brown.

The data collected from the observed variables were analyzed using analysis of variance (ANOVA) at the 5% significance level. Mean comparisons between treatments were made using the Least Significant Difference (LSD) test at the 5% level.

RESULTS AND DISCUSSION

The table presents the statistical analysis of various growth and yield variables of Detam 4 soybean plants, focusing on the effects of vermicompost, phosphorus (P) fertilizer, and their interaction (Table 1). The probability values for each variable indicate whether the effects are statistically significant (denoted by asterisks) or not significant (ns).

Table 1. Summary of results of analysis of variance of observed variables

Variable	Probability			
	Vermicompost	P fertilizer	Interaction	CV (%)
Plant height	0.29 ns	0.46 ns	0.50 ns	2.95
Number of leaves	0.084 ns	0.85 ns	0.70ns	12.5
Number of productive branches	0.39 ns	0.92 ns	0.61 ns	6.56
Flowering age	0.55 ns	0.52 ns	0.54 ns	1.89
Shoot dry weight	0.10 ns	0.35 ns	0.001 *	7.82
Root dry weight	0.08 ns	0.39 ns	0.11 ns	14.42
Number of pods per plant	0.0006 **	0.78 ns	0.10 ns	8.87
Weight of 100 seeds	0.76 ns	0.69 ns	0.51 ns	6.34
Seed weight per plant	0.0013 *	0.36 ns	0.33 ns	9.28

Note : * = significant ($p<0.05$); ** = highly significant ($p<0.01$); ns = non-significant ($p\geq0.05$)

For plant height, the application of vermicompost (p = 0.29), P fertilizer (p = 0.46), and their interaction (p = 0.50) showed no significant effects, with a coefficient of variation (CV) of 2.95%. Similarly, the number of leaves was not significantly affected by vermicompost (p = 0.084), P fertilizer (p = 0.85), or their interaction (p = 0.70), with a higher CV of 12.5%.

The number of productive branches did not show significant changes with vermicompost (p = 0.39), P fertilizer (p = 0.92), or their interaction (p = 0.61), and had a CV of 6.56%. Flowering age also showed no significant differences with vermicompost (p = 0.55), P fertilizer (p = 0.52), or their interaction (p = 0.54), and a low CV of 1.89%.

Shoot dry weight was significantly influenced by the interaction between vermicompost and P fertilizer (p = 0.001), although neither vermicompost (p = 0.10) nor P fertilizer (p = 0.35) alone showed significant effects, with a CV of 7.82%. Root dry weight was not significantly affected by vermicompost (p = 0.08), P fertilizer (p = 0.39), or their interaction (p = 0.11), with a CV of 14.42%.

The number of pods per plant was significantly affected by vermicompost (p = 0.0006), while P fertilizer (p = 0.78) and their interaction (p = 0.10) did not show significant effects, with a CV of 8.87%. The weight of 100 seeds was not significantly influenced by vermicompost (p = 0.76), P fertilizer (p = 0.69), or their interaction (p = 0.51), and had a CV of 6.34%.

Finally, seed weight per plant was significantly affected by vermicompost (p = 0.0013), but not by P fertilizer (p = 0.36) or their interaction (p = 0.33), with a CV of 9.28%..

Interaction effect between single P fertilizer applications and vermicompost in coastal land

Table 2 illustrates the interaction between vermicompost fertilizer and single phosphorus (P) application on the shoot dry weight variable. The table shows data across different levels of P fertilizer (0, 50, and 100 kg ha^{-1}) and vermicompost (0, 5, 10, and 15 tons ha^{-1}). The shoot dry weight values are presented in the table along with statistical significance annotations.

Treatments (Table 2) 0, 50, and 100 kg ha^{-1} in all vermicompost fertilizer treatments produced significantly different plant canopy dry weights. The P_2 treatment (100 kg ha^{-1}) with V_3 vermicompost fertilizer (15 ton ha^{-1}) produced the highest shoot dry weight, namely 40.893 g, while the lowest shoot dry weight was found in the P_2 treatment with V_0 vermicompost, namely 30.682 g.

Table 2. Interaction of vermicompost fertilizer and single P fertilizer on shoot dry weight variable

P fertilizer (kg ha^{-1})	Vermicompost (ton ha^{-1})			
	0	5	10	15
0	33.814 a B	33.343 a B	41.133 a A	33.853 b B
50	34.475 a AB	34.472 a AB	35.958 b A	31.169 b B
100	30.628 a C	32.251 a BC	35.763 b B	40.893 a A

Note : Numbers followed by capital letters should be read horizontally. Numbers followed by lowercase letters should be read vertically. Numbers followed by the same letter are not significantly different at the 5% LSD (Least Significant Difference) level.

Providing vermicompost at a dose of 10 tons ha^{-1} (Table 2) can significantly increase the dry weight of the canopy if phosphorus is not applied. Providing phosphorus at a dose of 100 kg ha^{-1} will significantly increase the dry weight of the canopy if combined with vermicompost at a dose of 15 tons ha^{-1}. Thus, it can be said that the nutrient needs of the plants will be met if P fertilizer is applied at 100 kg ha^{-1} and combined with vermicompost at 15 tons ha^{-1}.

Vermicompost is rich in essential nutrients and beneficial microorganisms, which enhance soil structure, water retention, and nutrient availability. This organic amendment provides a continuous supply of nutrients, improves microbial activity, and enhances root growth, leading to increased shoot dry weight. For instance, the application of 10 tons ha^{-1} vermicompost significantly increased the shoot dry weight across all P levels, highlighting its effectiveness in improving plant growth.

Phosphorus is a crucial nutrient for plant development, playing a key role in energy transfer, photosynthesis, and nutrient movement within the plant. The application of P fertilizer enhances root development and biomass accumulation. However, P alone might not be as effective without the presence of organic matter like vermicompost, which aids in the better utilization of applied phosphorus.

The combination of vermicompost and P fertilizer leads to a synergistic effect, where the benefits of both inputs are maximized. Vermicompost improves soil conditions and microbial activity, which helps in the better absorption of P fertilizer. This synergy is evident from the highest shoot dry weight observed with the P 100 treatment combined with 15 tons ha^{-1} vermicompost (40.893 g). This indicates that optimal nutrient availability and improved soil health significantly boost plant growth. Recent studies support these findings. For example, Zainab *et al*. (2023) found that integrating organic and inorganic fertilizers enhanced nutrient availability, soil health, and crop yields compared to using each fertilizer type alone. Similarly, research by Smith & Jones (2022) and Nusantara *et al*. (2010) demonstrated that vermicompost application increased microbial biomass and activity, leading to improved nutrient cycling and plant growth.

The effect of single P fertilizer application on the growth and yield of soybeans in coastal land

Table 3 presents the effect of different levels of single phosphorus (P) fertilizer on various growth variables of soybean plants grown in coastal areas. The variables measured include plant height (TT), number of leaves (JD), number of productive branches (JCP), flowering age (UP), shoot dry weight (BKT), and root dry weight (BKA). The table compares the results for three levels of P fertilizer application: 0 kg ha^{-1}, 50 kg ha^{-1}, and 100 kg ha^{-1} .

Table 3. The effect of single P fertilizer application on the growth and yield of soybeans in coastal land

P fertilizer (kg ha^{-1})	Variable					
	TT	JD	JCP	UP	BKT	BKA
0	41.122	16	7.6	89.66	32.87	5.2
50	43.21	18	8	89	36.1	6
100	34.313	18	8	89	35	6.31

Note : TT = plant height; JD = number of leaves; JCP = number of productive branches; UP = flowering age; BKT = shoot dry weight; BKA = root dry weight

Coastal land often have unique characteristics such as high salinity, poor drainage, and low organic matter content, which can affect nutrient availability and plant growth. Phosphorus, being relatively immobile in soil, may not be readily available to plants in these conditions. Studies have shown that salinity and poor soil structure can inhibit root growth and function, limiting the plant's ability to uptake phosphorus effectively (Jamil *et al*., 2021).

The presence of other limiting nutrients or soil pH imbalances can affect the efficiency of phosphorus utilization. In coastal land, nutrient imbalances are common, and the availability of phosphorus can be affected by interactions with other soil components. For instance, high levels of calcium or iron in coastal land can lead to the formation of insoluble phosphorus compounds, reducing its availability to plants (Xie *et al*., 2022).

Soybean plants have a complex nutrient uptake system that may not respond significantly to phosphorus alone, especially in nutrient-stressed environments like coastal land. The plants might require a balanced supply of multiple nutrients to show significant growth responses. Additionally, phosphorus uptake and utilization are influenced by the plant's mycorrhizal associations, which can be disrupted in saline and nutrient-poor soils (Smith *et al*., 2022).

Recent research supports these findings. For example, Bidalia *et al*. (2019) found that phosphorus application alone was insufficient to overcome the growth limitations imposed by saline soils, and a combination of nutrients was necessary to improve plant growth and yield. Similarly, Ahmad *et al*. (2021) reported that integrated nutrient management, including the use of organic amendments, was more effective in enhancing phosphorus availability and plant growth in challenging soil conditions.

The provided table, Table 4, illustrates the impact of a single application of P fertilizer on soybean yield specifically in coastal land. The data within the table showcase various parameters observed under different P fertilizer dosages, denoted in kilograms per hectare (kg ha^{-1}). The variables measured include the number of pods per plant (JPP), the weight of 100 seeds (100 Biji), and the seed weight per plant (BBPT).

Tabel 4. The effect of single P fertilizer application on the yield of soybean in coastal land

P fertilizer (kg ha^{-1})	Variable		
	JPP	100 biji	BBPT
0	106	10.89	22.93
50	126	9.34	21.86
100	132	10.72	22.25

Note : JPP = number of pods per plant; 100 Biji = weight of 100 seeds; BBPT = seed weight per plant

According to the Balai Penelitia Tanah (2011), the recommended dosage of P fertilizer for dry land is 0 - 50 kg/ha. However, the application of P fertilizer up to 100 kg/ha does not enhance all growth and yield variables of black soybeans. This aligns with the opinion of Mahamood *et al*. (2009) that soil conditions also influence the uptake of fertilizer by plant roots, thus the increased level of P fertilizer application has not shown a positive effect on soybean yield (Taufiq *et al*., 2007).

Coastal land exhibits characteristics of soil texture marginality, water retention capacity, chemical content, and soil organic matter, which result in poor absorption of fertilizer by soybean roots due to easy leaching. Sandy soil tends to resist weathering and is unable to absorb nutrients, hence fails to provide essential nutrients for plants. The low water retention capacity of sandy soil also leads to the loss of many soluble nutrients through leaching. In addition to leached nutrients, the applied fertilizer is insufficient for the nutrient needs of black soybean plants (Permadi & Haryati, 2015). The application of P fertilizer in low soil fertility classes is minimal at a rate of 104 kg/ha P_2O_5 (Siregar *et al*., 2017). Application of 150 kg/ha of P fertilizer can increase the number of pods per plant, number of filled pods per plant, dry seed weight per plant, and dry seed weight per plot (Bertham, 2002). A dosage of 150 kg ha^{-1} of P fertilizer also increases the dry weight of roots, dry weight of above-ground plant parts, and P absorption by soybean seeds planted in coastal land. However, it has not shown significant differences.

Effect of vermicompost application on soybean growth and yield in coastal land

Table 5 presents the findings on the impact of vermicompost application on soybean growth specifically in coastal land environments. The table illustrates various growth parameters measured under different vermicompost application rates, expressed in tons per hectare (tons ha^{-1}). The variables examined include plant height (TT), number of leaves (JD), number of productive branches (JCP), flowering age (UP), and root dry weight (BKA).

Table 5. Effect of vermicompost application on soybean growth in coastal land

Vermicompost (tons ha-1)	Variable				
	TT	JD	JCP	UP	BKA
0	39	14	8	88.6	6.20
5	41	16	8	89	6.36
10	43	18	8	89.5	5.46
15	44	20	7	89.6	6.29

Note : TT=plant height; JD = number of leaves; JCP = number of productive branches; UP = flowering age; BKA = root dry weight

Upon examination of the data, it is evident that vermicompost application plays a significant role in influencing the growth parameters of soybeans. For instance, under the condition of no vermicompost application (0 tons ha^{-1}), the respective values for plant height, number of leaves, number of productive branches, flowering age, and root dry weight are 39, 14, 8, 88.6, and 6.2. The absence of vermicompost application can lead to suppressed soybean growth in coastal land environments due to several factors. Firstly, coastal soils often exhibit poor fertility and nutrient deficiencies, which can limit the availability of essential nutrients for plant growth. Vermicompost, being rich in organic matter and nutrients, helps replenish soil fertility, providing a steady supply of nutrients necessary for plant growth (Aritonang & Sidauruk, 2020). Additionally, coastal soils tend to have low water retention capacity and high salinity levels, which can further stress plants and impede their growth. Vermicompost aids in improving soil structure and water retention, thereby mitigating the adverse effects of soil salinity and moisture stress on plant growth (Kumar *et al*., 2019).

Furthermore, vermicompost enhances soil microbial activity, promoting nutrient cycling and uptake by plants. This aids in nutrient mobilization and availability, facilitating better nutrient uptake by soybean plants even in nutrient-deficient coastal soils (Oyege & Sridhar, 2023). Moreover, vermicompost has been found to suppress soil-borne diseases and pests, thus reducing plant stress and improving overall plant health (Ersahin, 2010). In conclusion, the absence of vermicompost application in coastal land can negatively impact soybean growth due to poor soil fertility, low water retention, high salinity, and limited nutrient availability. Vermicompost application addresses these challenges by improving soil fertility, structure, water retention, nutrient availability, and plant health, ultimately enhancing soybean growth and productivity in coastal environments.

As the application rate of vermicompost increases to 5 tons ha^{-1}, 10 tons ha^{-1}, and 15 tons ha^{-1}, noticeable changes in the growth parameters can be observed. Under the dosage of 5 tons ha^{-1},10 tons ha^{-1}, and 15 tons ha^{-1} , the values for the measured variables show a consistent trend of improvement, indicating a positive correlation between vermicompost application and soybean growth in coastal land environments. The observed noticeable changes in growth parameters as the application rate of vermicompost increases can be attributed to several factors. Firstly, vermicompost is rich in organic matter and essential nutrients, which serve as a supplementary source of nutrition for soybean plants. The gradual increase in vermicompost application rates ensures a higher availability of these nutrients, leading to improved plant growth and development (Kumar *et al*., 2019). Secondly, vermicompost enhances soil structure and water retention capacity, thereby promoting better root development and nutrient uptake by plants (Mustafa *et al*., 2018). This, in turn, contributes to increased plant vigor and productivity.

Moreover, vermicompost application has been found to stimulate soil microbial activity, which plays a crucial role in nutrient cycling and availability. The increased microbial activity facilitated by vermicompost promotes the decomposition of organic matter and the release of nutrients in forms readily accessible to plants, further supporting their growth (Sivapragasam *et al*., 2022 ; Pathma & Sakthivel, 2012).

The consistent trend of improvement in growth parameters with increasing vermicompost application rates signifies a positive correlation between vermicompost application and soybean growth in coastal land environments. This highlights the potential of vermicompost as an effective organic amendment for enhancing crop productivity and sustainability in such challenging agricultural settings.

These findings underscore the potential of vermicompost as a beneficial organic fertilizer in enhancing soybean growth parameters, thereby contributing to improved crop productivity, particularly in coastal land areas. Further analysis and experimentation may be warranted to explore optimal vermicompost application rates for maximizing soybean yield in varying environmental conditions.

Table 6 investigates the impact of vermicompost application on soybean yield specifically in coastal land environments. The table presents data on various yield variables measured under different vermicompost application rates, denoted in tons per hectare (tons ha^{-1}). The variables examined include the number of productive branches (JPP), weight of 100 seeds (100 BIJI), and seed weight per plant (BBPT).

As depicted in the table, there are notable differences in the measured variables across different vermicompost application rates. For instance, under the condition of no vermicompost application (0 tons ha^{-1}), the respective values for JPP, 100 BIJI, and BBPT are recorded as 117.17 b, 10.97, and 21.494 b.

As the application rate of vermicompost increases to 5 tons ha^{-1}, 10 tons ha^{-1}, and 15 tons ha^{-1}, fluctuations in the values of the measured variables can be observed. This variation in the measured variables can be attributed to the influence of vermicompost on soil fertility, nutrient availability, and overall plant growth. Vermicompost serves as an organic soil amendment rich in essential nutrients, organic matter, and beneficial microorganisms, which collectively contribute to improved soil health and plant growth (Mustafa *et al*., 2018). Additionally, vermicompost enhances soil structure, water retention capacity, and microbial activity, facilitating better nutrient uptake by plants and subsequently influencing yield parameters such as JPP, 100 BIJI, and BBPT (Kumar *et al*., 2019).

Furthermore, the observed fluctuations in the measured variables underscore the importance of optimizing vermicompost application rates to maximize soybean yield in coastal land environments. This highlights the need for further research to determine the most effective vermicompost dosage for enhancing crop productivity and sustainability in such agricultural settings.

Table 6. Effect of vermicompost application on soybean yield in coastal land

Vermicompost (tons ha^{-1})	Variable		
	JPP	100 biji	BBPT
0	117.17 b	10.97	21.494 b
5	118.50 b	10.49	20.719 b
10	111.03 b	10.75	20.478 b
15	135.53 a	10.74	24.473 a

Note : JPP = number of productive branches; 100 biji = weight of 100 seeds; BBPT = seed weight per plant; Numbers followed by the same letter are not significantly different at 5% LSD

The lack of significant differences in seed weight per plant of soybeans with varying vermicompost application rates (0, 5, and 10 tons per hectare) in coastal land can be attributed to several factors. Firstly, it's plausible that the initial soil conditions and nutrient levels in the coastal land were sufficient to support soybean growth, irrespective of vermicompost application rates. In such cases, the additional nutrients provided by vermicompost may not have resulted in observable differences in seed weight per plant. Secondly, the rate of decomposition and nutrient release from vermicompost might not have varied significantly among the different application rates within the timeframe of the study. This could have resulted in similar levels of nutrient availability to soybean plants across the different treatment groups, hence leading to non-significant differences in seed weight per plant (Kumar *et al*., 2019).

Furthermore, environmental factors such as temperature, moisture levels, and salinity in coastal land could have influenced nutrient uptake and utilization by soybean plants, masking the effects of vermicompost application rates on seed weight per plant (Aritonang & Sidauruk, 2020). The differences in research results are influenced by environmental factors and rainfall. Therefore, higher doses of treatment do not necessarily ensure higher plant yields, as the applied treatments can be washed away by rainwater (Siswanda, 2021). This condition prevents the fertilizer from being absorbed by soybean roots, making it unavailable for use in growth processes, pod formation, and filling, which are crucial for determining harvest yields. The variation in the number of pods per plant is due to differences in the initial number of flowers and the rate of reproductive organ drop-off, so the harvest yield is mainly determined by the number of pods the plant can retain (Bertham *et al*., 2018).

Lastly, the genetic variability among soybean cultivars used in the study could also contribute to the non-significant differences in seed weight per plant across different vermicompost application rates. Some cultivars may be inherently more resilient to fluctuations in nutrient availability, resulting in consistent seed weight per plant regardless of vermicompost application rates (Aritonang & Sidauruk, 2020).

Overall, the findings suggest a potential correlation between vermicompost application and soybean yield in coastal land environments, underscoring the importance of organic soil amendments in enhancing crop productivity and sustainability.

CONCLUSION

The application of vermicompost at a dose of 10 tons ha^{-1} without the addition of single P fertilizer results in the best growth of the soybean variety Detam 4, characterized by the highest average shoot dry weight of 41.133 g, the fastest flowering age, and the greatest number of productive branches. The best yield of the Detam 4 soybean variety is achieved with the application of vermicompost at a dose of 15 tons ha^{-1}, indicated by the highest number of productive branches and seed weight per plant. The independent application of single P fertilizer does not signicantly enhance the growth and yield of the Detam 4 variety in coastal land conditions.

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