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Growth Responses of Alpukat (*Persea americana* Mill.) Var. YM to the Application of Vitamin B1 and Banana Leaf Litter Compost

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ABSTRACT

YM avocado is a superior product from Lebak, Banten, which requires sustainable cultivation for optimal growth. This study aims to improve the growth of YM avocado by applying vitamin B1 and banana leaf compost using a two-factor group randomized design. Data were analyzed using ANOVA, DMRT at the 5% level, and linear regression analysis. The factors were vitamin B1, with doses of 0, 15, 30, and 45 mg/l, and banana leaf compost, with doses of 0, 125, and 250 g/plant. The provision of vitamin B1 at a dose of 45 mg/l gave the highest growth results in the parameters of the number of leaves, leaf length-width ratio, plant height, leaf area, and leaf chlorophyll content, while the stem diameter showed the highest growth at a dose of 15 mg/l. Giving banana leaf compost at a dose of 250 gr/plant gave the highest growth in plant height, number of leaves, leaf area, and leaf chlorophyll content, while the dose of 125 gr/plant gave the highest growth in stem diameter parameters. It can be concluded that the provision of vitamin B1 and banana leaf compost can increase the growth of YM avocado plants.

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INTRODUCTION

Avocado (*Persea americana* Mill.) is a subtropical perennial plant native to Central America (Solares et al., 2023). In the 18th century, the avocado plant entered Indonesia. In Indonesia, the plant is known as “avocado” or “alpokat.” In 1920-1930, Indonesia officially introduced about 20 avocado varieties originating from Central America and the United States to obtain superior varieties. This plant belongs to the Lauraceae family and is classified as annual or long-lived (Hermanto, 2015).

One type avocado that can be found in Banten Province is the YM avocado, which is a superior commodity from Lebak Regency. In 2019, YM avocado was identified and characterized by the Banten Agricultural Technology Assessment Center and UPT PSBTPHP. Over time, the spread of YM

avocado has expanded and requires support from the local government and the people of Banten for its preservation and development. Currently, YM avocado has been registered with the Ministry of Agriculture as one of the plant varieties (Hermita et al., 2022).

Based on data from BPS (Central Bureau of Statistics) Banten Province, avocado production fluctuated from 2021 to 2023. In 2021, avocado production reached 1,444.40 tons, which increased to 2,402.60 tons in 2022. However, in 2023, avocado production decreased to 1,860 tons (Banten Province Central Statistics Agency, 2023).

The decline in avocado production by 2023 is one of the problems that must be addressed. Factors contributing to this decline are the lack of proper cultivation technology in the field. Most production still comes from traditional farms that have not implemented effective cultivation practices. In addition, the excessive use of chemical fertilizers has a negative impact on soil health and fertility, as well as plant health (Hermita et al., 2022; Sopian et al., 2023). One solution that can be done is to provide vitamins and organic fertilizers that can support plant growth during the vegetative period (Yustitia , 2017).

Vitamin B1 is one type of vitamin that can dissolve in water. Vitamin B1 is classified as a phytohormone, which is a substance in small amounts that can stimulate the growth and development of plant tissues (Khairunnisa and Tri, 2014). Vitamin B1 can support the smooth process of metabolism in plant tissues, prevent and reduce stress or stress in plants, spur rapid root growth, and increase the rate of absorption of nutrients needed (Christy et al., 2023).

In addition to vitamins, organic fertilizers are also needed to provide plant nutrient needs. Compost is one of the organic fertilizers obtained from the remaining organic materials, such as dry leaves, reeds, rice straw, and animal waste, which have been decomposed by microorganisms through the composting process (Triyanto and Juan, 2020). Dried banana leaves are one of the organic materials that can be used as a base material for composting. Dried banana leaves, often called klaras, are wasted from banana trees. The use of dried banana leaves aims to reduce agricultural waste (Rahman et al., 2021; Suparti and Marfuah, 2015).

Based on research conducted by Khairunnisa and Tri, (2014), giving vitamin B1 at a dose of 3 ml / l influences plant height and the number of gandaria leaves. Based on research conducted by Suriani (2023), the provision of banana leaf compost has an effect on the height of green mustard plants with a dose of 2000 gr. The provision of vitamin B1 doses must be accompanied by the provision of fertilizers that can meet the needs of macro elements to support the plant growth process. This research is based on the use of different doses and types of plants from previous studies.

In general, vitamin B1 is used in ornamental plants, such as orchids, through a tissue culture process (Latif et al., 2020). The application of vitamin B1 has not been widely studied in perennial plant commodities, while compost has been known to increase growth in several perennial plant commodities. The compost used in this study is compost made from banana leaf litter derived from agricultural waste, so that the waste from banana trees can be reused for plants. Vitamin B1 and banana leaf litter compost have their respective roles in supporting plant growth. Therefore, research was conducted by combining vitamin B1 and banana leaf litter compost. The purpose of this study was to determine the growth response of YM

avocado plants to the provision of vitamin B1 and banana leaf litter compost.

MATERIALS AND METHODS

Location and Time

This research was conducted in the Experimental Garden of Untirta Cadasari, Kaduela Village, Cadasari District, Pandeglang, Banten Province with an altitude of 364.64 masl, from February to May 2024.

Tools and Materials

The tools used include a chopping machine, planting hole-making machine, SPAD (Soil Plant Analysis Development), image-j, measuring cup, digital scale, pestle and mortar, 1.5-liter plastic bottle, drip tray, digital vernier, meter, shovel, hoe, ruler, funnel, scissors, camera, and stationery.

The materials used include YM avocado plants from shoot grafting, banana leaf litter, vitamin B1, 3% carbofuran, herbicides, EM4, cow manure, brown sugar, water, and label paper.

Research Design

Research design This study used a Randomized Group Design (RGD) with two factors. The first factor was vitamin B1 with doses 0, 15, 30, and 45 mg/l. The second factor was banana leaf litter compost with doses of 0, 125, and 250 gr/plant. The treatments were repeated 3 times so that there were 36 plant samples. Observation data were analyzed using regression analysis and Analysis of Variance (ANOVA) and further tests were carried out using the Duncan Multiple Range Test (DMRT) at the 5% level. This analysis was carried out using Microsoft Excel and DSAASTAT software.

Research Stages

The research stages began with land preparation, which included clearing the land of weeds, shrubs, and plant residues using a hoe or lawn mower. Next, planting holes were made using a soil drilling machine with a height, width, and length of about ±75 cm. Before planting, the planting holes were first treated with 3% carbofuran to prevent insect attacks on the plants. Planting was done in the morning.

Application of banana leaf litter compost was given at 0, 125, and 250 grams per plant which was only done once at 7 DAP (Days After Planting). The application of vitamin B1 is given at 0, 15, 30, and 45 mg/l dissolved in 1 liter of water and applied through a simple drip irrigation system. Vitamin B1 is given every two weeks. Observations were conducted every two weeks until 12 WAA (Week After Application)

RESULT AND DISCUSSION

Plant Height Increase (cm)

The growth of YM avocado plants shows an increase in height that continues to increase from 4 to 12 WAA. Based on the analysis of variance, it is known that different vitamin B1 treatments have a significant effect on the parameters of leaf number and leaf length-width ratio. Different banana leaf litter compost treatments had a significant effect on the parameter of the number of leaves. There is an interaction effect of the two treatments on the parameters. There is an interaction effect between the two treatments on the parameters of number of leaves, leaf length-width ratio, and stem diameter increase. Based on linear regression analysis showed that the provision of vitamin B1 and banana leaf litter compost had a very strong influence on the parameters of plant height gain, leaf area, and leaf chlorophyll content. The results of linear regression analysis of plant height increase are presented in Figures 1 and 2.

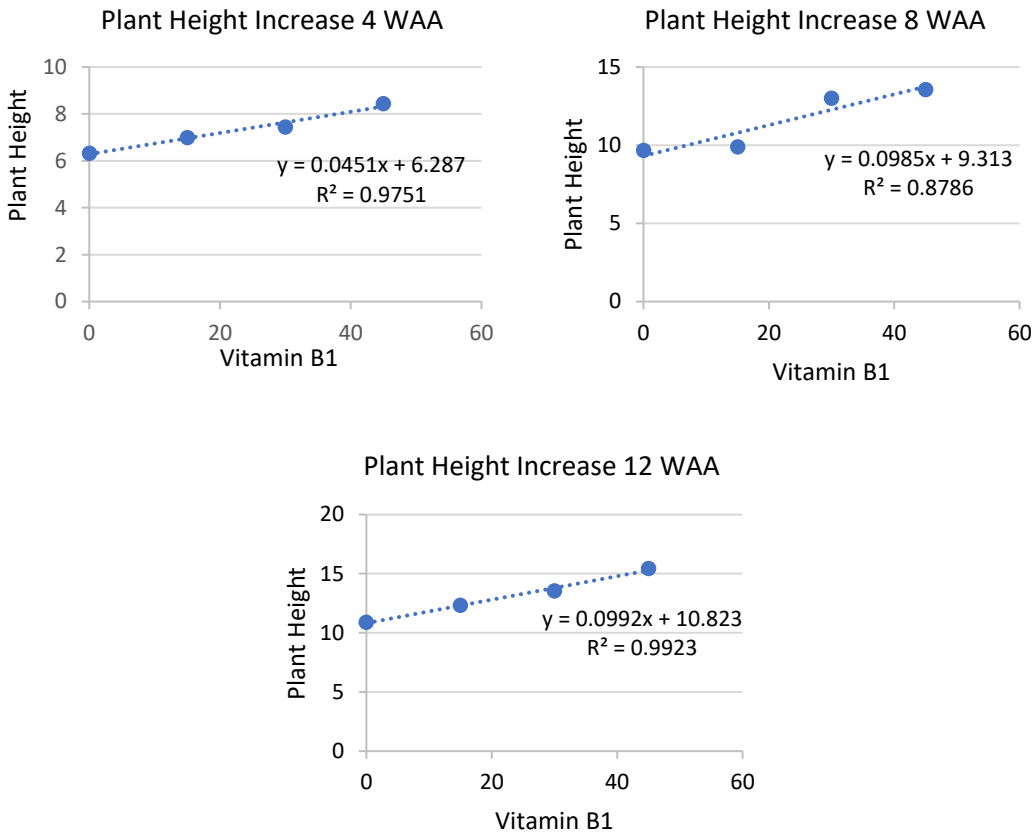

Figure 1. Linear regression of vitamin B1 treatment on plant height at 4, 8, and 12 WAA.

The linear regression graph of vitamin B1 treatment on plant height at 4, 8, and 12 WAA (Figure 1) shows an increasing linear line. This indicates a positive linear relationship between vitamin B1 treatment and banana leaf litter compost. The higher the dose of vitamin B1, the higher the increase in plant height of YM avocado. The regression equation for vitamin B1 treatment on plant height at age 4 WAA is y = 0.0451x + 6.287 with a coefficient of determination (R2) = 0.9751, age 8 WAA y = 0.0985x + 9.313 with R2 value = 0.8786, and age 12 WAA y = 0.0992x + 10.823 with R2 value = 0.9923. This explains that the effect of vitamin B1 on the increase in height of YM avocado plants is 97.51% at age 4 WAA, 87.86% at age 8 MSA, and 99.23% at age 12 WAA. In other words, the level of closeness between vitamin B1 and the increase in plant height at 4, 8, and 12 MSA shows a very strong influence.

Vitamin B1 plays a role in the process of cell division by triggering plant metabolism to convert carbohydrates into energy so that plant height growth continues to increase over time. By giving vitamin B1, it is expected that plant stress can be controlled. Fridayanti et al. (2023) also suggested that plant wilting stress can be controlled by giving vitamin B1. The use of vitamin B1 can trigger plant metabolic activities, so that changes in temperature, environment, and planting media that cause plant stress can be overcome.

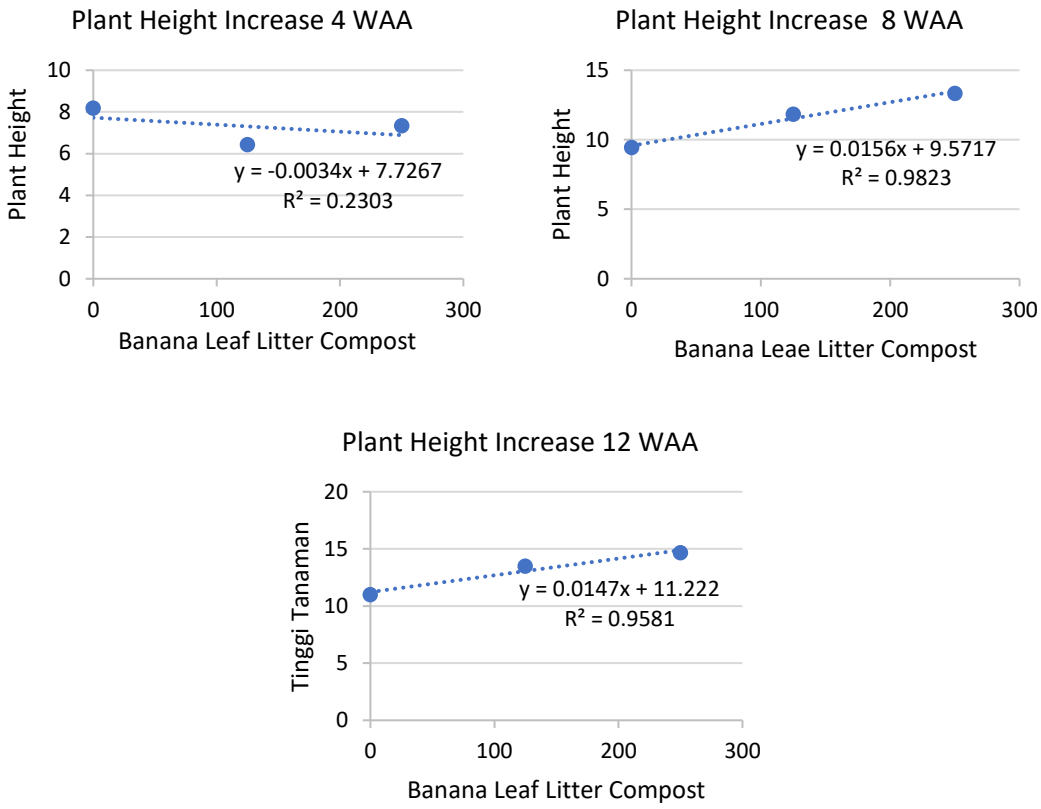

Figure 2. Linear regression of banana leaf litter compost treatment on plant height at 4, 8, and 12 WAA.

The linear regression graph of banana leaf litter compost treatment on plant height (Figure 2) shows different results. At the age of 4 WAA, the graph shows a decreasing linear line, while at ages 8 and 12 WAA, the graph shows an increasing linear line. Compost application on plant height at the age of 4 WAA has a negative linear relationship with the regression equation y = -0.0034x + 7.7267 and R2 = 0.2303. In other words, the effect of banana leaf litter compost on the increase in height of YM avocado plants is 23.03%. This shows that the level of closeness between banana leaf litter compost and plant height increase at 4 WAA has a weak effect. This is because the YM avocado plant is an annual plant, so its growth takes a longer time. Therefore, at the age of 4 WAA has not shown a strong influence. Madusari et al. (2019) also suggested that annual plants tend to experience slow growth, so the plant body does not show significant differences at a young age.

Meanwhile, at 8 and 12 WAA, compost application showed a positive linear relationship. The regression equation at 8 WAA was y = 0.0156x + 9.5717 with R2 = 0.9823, and at 12 WAA y = 0.0147x + 11.222 with R2 = 0.9581. This shows that the effect of compost on plant height at age 8 WAA is 98.23% and at age 12 WAA is 95.81%. This means that the level of closeness between banana leaf litter compost and plant height at the age of 8 and 12 WAA has a very strong effect. This is thought to be because compost is an organic fertilizer that is slowly released. This means that the nutrients in compost are received gradually by plants, so it takes a longer time for the effect to be visible. Ariyanti et al. (2021) also stated that compost is an environmentally friendly organic fertilizer with slow-release properties, namely the release of nutrients

that take place slowly, so that using large amounts of compost in large quantities is not harmful to plants. According to Ahmed et al. (2023) compost contains organic matter that is slowly decomposed by microorganisms. This process causes the release of nutrients to occur gradually, so that plants can absorb nutrients over a longer period. Composted organic matter releases nitrogen slowly (1-3% of total N/year). Organic matter breaks down into forms that plants can absorb, such as NH_4^+ (through ammonification) and NO_3 (through nitrification). Phosphorus is a macronutrient that is very important for plant growth. Plants absorb P from the soil in the form of phosphate ions, especially H_2PO_4- and HPO_4^{2-} found in soil solution, while potassium is absorbed by plants in the form of K^+ ions. Potassium is classified as a mobile element in plants both in cells, tissues and xylem and phloem (Baroroh et al., 2015). Firgiyanto et al. (2023) stated that the effect of slow-release fertilizers causes an increase in avocado seedling growth to occur at a slow rate.

Increase in Number of Leaves (strands)

Leaves are part of the plant that plays a role in the photosynthesis process. The average increase in the number of leaves from vitamin B1 and banana leaf litter compost is presented in Table 1.

Table 1. Average growth in the number of leaves of avocado (*Persea americana* Mill.) var. YM on vitamin B1 and banana leaf litter compost.

Plant Age (WAA)	Vitamin B1 (V)	Banana Leaf Litter Compost (K)			Average
		K_0 (0 gr)	K_1 (125 gr)	K_2 (250 gr)	
4	V_0 (0 mg/l)	15,33ABC	26,00A	1,67CD	14,33
	V_1 (15 mg/l)	2,33CD	21,33ABC	31,33AB	18,33
	V_2 (30 mg/l)	26,33A	1,33CD	18,00ABC	15,22
	V_3 (45 mg/l)	7,00ABCD	0,00D	7,00BCD	4,67
	Average	12,75	12,17	14,50	13,14
8	V_0 (0 mg/l)	61,67	46,33	47,33	51,78
	V_1 (15 mg/l)	15,67	20,00	42,33	26,00
	V_2 (30 mg/l)	40,33	42,00	23,67	35,33
	V_3 (45 mg/l)	81,33	14,00	49,00	48,11
	Average	49,75	30,58	40,58	40,31
12	V_0 (0 mg/l)	9,33C	100,00A	80,33AB	63,22c
	V_1 (15 mg/l)	66,67AB	29,67BC	144,67A	80,33bc
	V_2 (30 mg/l)	77,00AB	108,00A	83,67AB	89,56b
	V_3 (45 mg/l)	123,00A	156,67A	133,67A	137,78a
	Average	69,00b	98,58a	110,58a	92,72

Note: Numbers followed by the same letter in the same column or row indicate no significant difference based on the 5% DMRT test.

The provision of vitamin B1 and banana leaf litter compost showed a real to very real interaction at 4 and 12 WAA. At 4 WAA, the highest number of leaves from both treatments was found in vitamin B1 30 mg/l (V_2) and banana leaf litter compost 0 g/plant (K_0) with an average of 26.33 leaves. At 12 WAA, the highest number of leaves from both treatments was found in vitamin B1 45 mg/l (V_3) and banana leaf litter compost 125 g/plant (K_1) with an average of 156.67 leaves. From this it can be seen that the longer the time of administration of vitamin B1 and banana leaf compost, the higher the dose needed to increase the number of leaves. The provision of vitamin B1 in YM

avocado plants plays an important role in converting carbohydrates into energy in plant metabolism. This energy is then used in the respiration process to synthesize important compounds needed for the process of cell division and elongation, as well as the formation of new leaves. This is in line with Friendly et al. (2021) in their research which states that the provision of vitamin B1 can accelerate cell division at the apex of leaf shoots, thereby accelerating the growth of new leaves. The increase in the number of leaves affects the formation of chloroplasts. In this process, energy is needed which comes from the respiration process.

Providing banana leaf litter compost on the parameters of increasing the number of leaves of YM avocado plants plays a role in providing the nutrients needed by the plants. The nitrogen element contained in compost is very important to support the plant growth process during the vegetative period because nitrogen plays a role in the photosynthesis process. Nuraeni et al. (2019) also stated that in general the element N is needed for the formation and growth of vegetative plant parts, such as the formation of leaves, stems, and roots.

Leaf Area (cm^2)

Based on the results of linear regression analysis, the leaf area parameter shows a strong influence between variables. The results of linear regression analysis of the leaf area of YM avocado plants can be seen in Figure 3.

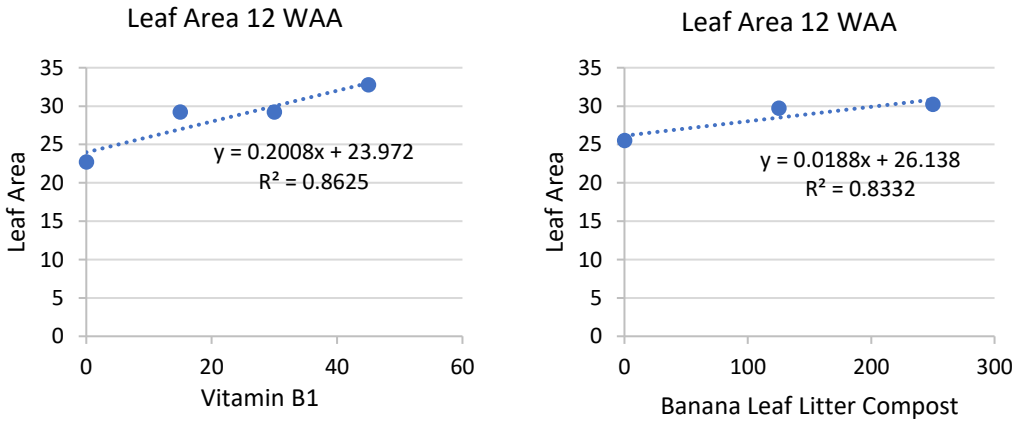

Figure 3. Linear regression of vitamin B1 treatment and compost on leaf area aged 12 WAA.

The linear regression graph of vitamin B1 treatment and banana leaf litter compost on leaf area at 12 WAA (Figure 3) shows an increasing linear line. This indicates a positive linear relationship with the equation y = 0.2008x + 23.972 and R2 value = 0.8625, in the banana leaf litter compost treatment, y = 0.0188x + 26.138 and R2 value = 0.8332. It can be explained that the effect of vitamin B1 and banana leaf litter compost on the leaf area of YM avocado plants is 86.25% and 83.32%. This means that the level of closeness between vitamin B1 and banana leaf litter compost with leaf area has a very strong effect.

The application of vitamin B1 and banana leaf compost (Figure 3) shows that dosing of vitamin B1 and banana leaf compost results in increased leaf area in YM avocado plants. Zuhroh et al. (2023) also stated in their research that vitamin B1 can promote cell division. This is supported by Yustitia, (2017), who noted that vitamin B1 stimulates hormonal activity in plant tissues, thereby

encouraging cell division and the formation of new cells.

Leaf area can also be influenced by the number of leaves that grow. As the number of leaves increases, the leaf area also expands. Wijiyanti et al. (2019) also suggested that, generally, the leaf area of a plant is influenced by the number of leaves. The greater the number of leaves, the wider the leaf area of the plant. Additionally, nutrients play a role in the photosynthesis process to enhance leaf area. According to Sitompul et al. (2016) nitrogen is involved in the formation of leaf chlorophyll during photosynthesis. When chlorophyll levels are adequate, leaves can absorb more light, so photosynthesis runs efficiently and allows leaves to reach maximum length and width.

Stem Diameter Increase (mm)

Stem diameter is a growth parameter that aims to determine the circumference of the plant stem. The average stem diameter of vitamin B1 and banana leaf compost is presented in Table 2.

Table 2. Average stem diameter of avocado (*Persea americana* Mill.) var. YM on vitamin B1 concentration and banana leaf litter compost.

Plant Age (WAA)	Vitamin B1 (V)	Banana Leaf Litter Compost (K)			Average
		K_0 (0 gr)	K_1 (125 gr)	K_2 (250 gr)	
4	V_0 (0 mg/l)	1,50ABC	2,33A	1,67ABC	1,83
	V_1 (15 mg/l)	1,37ABC	1,93AB	2,10AB	1,80
	V_2 (30 mg/l)	1,10BC	1,80ABC	2,37A	1,76
	V_3 (45 mg/l)	1,87ABC	0,90C	1,67ABC	1,48
	Average	1,46	1,74	1,95	1,72
8	V_0 (0 mg/l)	2,77	3,10	2,17	2,68
	V_1 (15 mg/l)	2,27	3,37	3,07	2,90
	V_2 (30 mg/l)	2,10	2,70	3,13	2,64
	V_3 (45 mg/l)	3,00	1,70	2,80	2,50
	Average	2,53	2,72	2,79	2,68
12	V_0 (0 mg/l)	4,40A	4,23AB	2,67BC	3,77
	V_1 (15 mg/l)	2,93ABC	4,43A	3,50ABC	3,62
	V_2 (30 mg/l)	3,73ABC	3,43ABC	4,03ABC	3,73
	V_3 (45 mg/l)	3,73ABC	2,57C	3,97ABC	3,42
	Average	3,70	3,67	3,54	3,64

Note: Numbers followed by the same letter in the same column or row indicate no significant difference based on the 5% DMRT test.

The application of vitamin B1 and banana leaf compost on stem diameter growth (Table 2) shows a significant interaction effect. At 4 WAA, the highest increase in stem diameter was observed with 30 mg/l of vitamin B1 (V_2) and 250 g/plant of banana leaf compost (K_2), averaging 2.37 mm. At 12 WAA, the highest increase in stem diameter was recorded with 15 mg/l of vitamin B1 (V_1) and 125 g/plant of banana leaf compost (K_1), averaging 4.43 mm. This indicates that as the plant ages, the dosage required for the highest increase in diameter becomes lower. It is suspected that the plant's age affects its nutrient needs for optimal growth. This is consistent with Simatupang (2019), who explained in his research that the increase in plant growth due to additional doses will decrease if the dose exceeds the needs of the plant.

The interaction that occurs from the application of vitamin B1 and banana leaf

compost is closely related to nutrient availability and the plant's metabolic processes. One crucial nutrient is potassium. Potassium (K) plays a significant role in stem thickening and strengthening. When potassium levels in the soil meet the plant's needs, the process of stem diameter formation can be optimized. Fitri et al. (2017) also highlighted in their research that potassium contributes to enhancing plant vigor, which can affect stem diameter.

Leaf Length-to-Width Ratio (cm)

The leaf length-to-width ratio is an observation derived from the combination of leaf length and width parameters to determine the leaf shape. The average leaf length-to-width ratio with the application of vitamin B1 and banana leaf compost is presented in Table 3.

Table 3. Average Leaf Length-to-Width Ratio of YM Avocado (*Persea americana* Mill.) with Application of Vitamin B1 and Banana Leaf Compost Concentrations

Plant Age (WAA)	Vitamin B1 (V)	Banana Leaf Litter Compost (K)			Average
		K_0 (0 gr)	K_1 (125 gr)	K_2 (250 gr)	
12	V_0 (0 mg/l)	2,20B	2,47B	2,40B	2,36ab
	V_1 (15 mg/l)	1,77B	2,03B	2,03B	1,94b
	V_2 (30 mg/l)	2,10B	2,27B	2,07B	2,14ab
	V_3 (45 mg/l)	3,60A	2,33B	2,03B	2,66a
	Average	2,42	2,28	2,13	2,28

Note: Numbers followed by the same letter in the same column or row indicate no significant difference based on the 5% DMRT test.

The application of vitamin B1 and banana leaf compost on the leaf length-to-width ratio (Table 3) shows an interaction effect. The highest ratio was observed with the application of vitamin B1 and banana leaf compost (V_3K_0), which yielded a value of 3.60 cm. This indicates an elongation of the leaf shape. As the ratio value increases, the leaves become more elongated. Conversely, a lower ratio value results in a more rounded leaf shape. This finding aligns with Nirmala et al. (2024), who stated that the leaf length-to-width ratio is the division of leaf length by leaf width. A larger ratio value suggests that the leaf is longer relative to its width, while a smaller ratio indicates a more rounded leaf shape.

The elongated shape of the leaves indicates that these leaves are able to absorb more light because it allows the leaves not to cover other leaves, so that sunlight can be absorbed more optimally. Sunlight absorbed by the leaves plays an important role in the photosynthesis process. Leaves that are able to absorb a lot of sunlight have the potential to accelerate the rate of photosynthesis. This is clarified by Zulkifli et al. (2022) which states that plants really need light where in conditions of relatively much light, plants tend to have a larger leaf length.

Leaf Chlorophyll Content (units)

Leaf chlorophyll content is a parameter to determine the chlorophyll content in leaves which is measured using the SPAD tool. Based on the results of linear regression analysis, leaf chlorophyll content parameters show a strong influence between variables. The results of linear regression analysis of chlorophyll levels in YM avocado plant leaves can be seen in Figure 4.

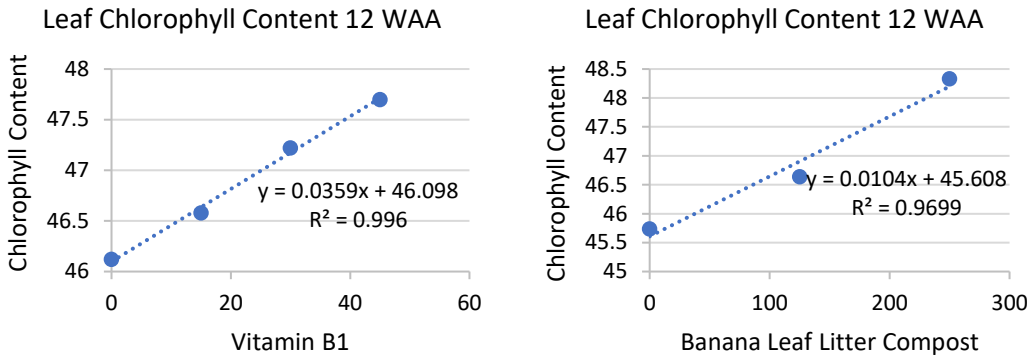

Figure 4. Linear regression of vitamin B1 treatment and banana leaf litter compost on chlorophyll levels in leaves aged 12 WAA.

The linear regression graph of vitamin B1 treatment and banana leaf litter compost on leaf chlorophyll levels (Figure 4) shows an increasing linear line. This indicates a positive linear relationship. The linear regression equation for vitamin B1 treatment with leaf chlorophyll content is y = 0.0359x + 46.098 and the determinant coefficient value (R2) = 0.996 in the banana leaf litter compost treatment is y = 0.0104x + 45.608 and the R value2 = 0.9699. This can be explained by the fact that the effect of vitamin B1 and banana leaf litter compost on the chlorophyll content of YM avocado plant leaves is 99.6% and 96.99%. This means that the level of relationship between vitamin B1 and banana leaf litter compost has a very strong effect on leaf chlorophyll levels.

Leaf chlorophyll content is determined by the nutrients present in the leaves. The primary nutrient required for chlorophyll formation is nitrogen. Nitrogen is essential for leaves in significant amounts for the photosynthesis process. Adequate nitrogen levels facilitate the photosynthesis process, leading to effective chlorophyll formation. Wijiyanti et al. (2019) also stated that a plant's ability to photosynthesize is influenced by nitrogen content, which is a component of chlorophyll molecules. Nitrogen plays a crucial role as a pigment constituent of chlorophyll.

CONCLUSIONS

1. The application of vitamin B1 had a significant to very significant effect on the leaf length-to width ratio parameter and showed a very strong influence based on linear regression analysis for plant height increase, leaf area, and leaf chlorophyll content parameters.
2. The application of banana leaf compost had a significant effect on the number of leaves parameter and showed a very strong influence based on linear regression analysis for plant height at 8 and 12 WAA, leaf area, and leaf chlorophyll content at 12 WAA.
3. There was a significant to very significant interaction effect on stem diameter increase and the number of leaves at 4 and 12 WAA, as well as on the leaf length-to-width ratio at 12 WAA.

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