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Original Article

Growth and yield response of butterfly pea (*Clitoria ternatea* L.) flower to planting media and organic fertilizer combination

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Abstract

The blue pea flower (*Clitoria ternatea* L.) is a leguminous plant that has been demonstrated to possess high antioxidant content. The plant is frequently employed as a medicinal herb, a source of color, and an ornamental plant, largely due to its attractive floral pigmentation. The objective of this study is to ascertain the efficacy of employing a combination of planting media and organic fertilizer on the growth and yield of pea flower plants. This research conducted between April and June 2024. The research was conducted at the Brenjonk Organic Farming Community Land in Sendang Hamlet, Penanggungan Village, Trawas District, Mojokerto Regency, East Java Province. The geographical location is at an altitude of 600-700 meters above sea level, with a rainfall of 2,000 mm per year, humidity of 66%, and an average air temperature of 18-20 ºC. This research used a completely randomized design (CRD) with two treatments: planting media (soil, soil and raw husk, soil and burnt husk, soil and compost) and several kinds of LOF (Liquid Organic Fertilizer) kepok banana peel (300 ml per plant) and Green Fertilizers green fertilizer (240 g per plant). The findings of this study indicate that the combination of planting media (soil and compost) and Green Fertilizers green fertilizer yielded superior results compared to other treatments.

Keywords: Butterfly pea flower, Fertilizers, Production

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Introduction

The Butterfly pea flower plant (*Clitoria ternatea* L.) is a member of the Fabaceae family of legumes, also known as the blue pea flower. Indonesia's tropical climate and nutrient-rich soil provide an optimal environment for plant growth. Butterfly pea flower plants are frequently utilized by Indonesians for ornamental purposes in fences, as ingredients in beverages, as a natural food coloring with minimal environmental impact, and as traditional medicinal ingredients (Marpaung, 2020). Environmental and internal factors can influence the flowering of butterfly pea plants. The environmental factors that exert influence are temperature, light, pH, and humidity. The internal factors that affect the flowering of bay flower plants are genetic. As posited by Ramdhan et al. (2015), the enzyme phenyl alanine ammonia lyase (PAL) exerts an influence on anthocyanin synthesis. Consequently, the plant growth medium requires the presence of nitrogen and potassium nutrients.

Liquid organic fertilizer (LOF) is defined as a liquid solution produced from the decay of organic matter derived from plant residues and animal waste. The macronutrients nitrogen (N), phosphorus (P), and potassium (K) and the micronutrients calcium (Ca), magnesium (Mg), sodium (Na), and zinc (Zn) present in banana peel waste are essential for the growth and development of fruit, stems, and flowers in plants. One of the benefits of using liquid organic fertilizer is its ability to overcome nutrient deficiencies, reduce nutrient leaching, and provide nutrients efficiently when needed. This is in accordance with Sitompul's research (2023), stating that the sample of liquid organic fertilizer from banana peel waste has a favorable pH level of Nitrogen, Phosphorus, Potassium, and Magnesium values making it suitable for fertilizing organic crops. Green Fertilizers green fertilizer (*Green Fertilizers diversifolia*) can be utilized as a green fertilizer due to its composition, which includes nutrients N and K that are essential for plant growth. Thus, efforts to enhance the growth and yield of butterfly pea flowers can be undertaken by optimizing cultivation through the integration of diverse planting media and the application of banana peel LOF and Green Fertilizers green fertilizer.

The acquisition of nutrients that can facilitate increased plant growth is dependent upon the utilization of planting media, which is the medium in which plants grow. Substrates utilized in optimal planting media must exhibit the following characteristics: they must not serve as a source of disease, possess adequate aeration, facilitate the desired amount of growth, and be capable of storing nutrients effectively. The utilization of an appropriate planting medium is of significant consequence with respect to the provision of essential support for the maintenance of optimal conditions for water, temperature, and nutrient requirements. The utilization of planting media, including raw rice husk, roasted rice husk, compost, and soil, exhibits disparate aeration and nutrient binding capabilities. As posited by Tambunan (2014), the utilisation of a lightweight, cost-effective, readily accessible, loose, and fertile planting medium is typically employed to facilitate optimal seedling growth. Accordingly, the efficacy of the combination of planting media and types of organic fertilizers on the production and yield of Butterfly pea flower plants was investigated.

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Methods

The research conducted between April and June of the 2024 calendar year. The research was conducted at the Benjonk Organic Farming Community Land in Sendang Hamlet, Penanggungan Village, Trawas District, Mojokerto Regency, East Java Province. The geographical location is at an altitude of 600-700 meters above sea level, with an annual rainfall of 2,000 mm, humidity of 66%, and an average air temperature of 18-20 ^{o}C.

The following tools were utilized in this research: polybags (35 x 35 cm), paddles, hoses, scales, choppers, filters, containers, shovels, measuring tape, scissors, plastic bottles, and labels. The materials utilized in this investigation included purple bay flower seeds, raw rice husks, husk charcoal, compost, soil, and banana peel liquid organic fertilizer (comprising banana peel, water, and brown sugar).

This research was arranged using a completely randomized design (CRD) with the treatment of planting media and the treatment of several kinds of Liquid Organic Fertilizer (LOF) kepok banana peel and Green Fertilizers fertilizer. The treatment of a combination of planting media (T) consists of 4 kinds of replicates with a per volume ratio (V:V), namely T0 = Soil (control), T1 = Soil and raw husk (1:1), T2 = Soil and burnt husk (1:1), T3 = Soil and compost (1:1). The treatment of several kinds of Banana Peel LOF (K) consists of 3 kinds, namely K1 = Kepok Banana Peel LOF and K2 = Green Fertilizers Fertilizer (240 g per plant). Based on the two treatment factors with each level, 12 treatment combinations were obtained. Each treatment combination was repeated 3 times to obtain 24 experimental units. Each unit consisted of 3 plants, eight of which were used as samples. So that the total plants used in this study were 72 plants. Then perform a Tukey test 5% (Honestly Significant Differences = HSD)

Plant height parameters were obtained using a tape measure. Height of the plants were measured from soil surface to the tip of the plant. Parameters of number of leaves, tendrils, and flower total were obtained manually when the plants were 7 days after planting (DAP). Flower wet weight and flower dry weight parameters were obtained using a digital scale when the plant has entered the first flowering period. Linear regression was obtained with the formula $Y = a + bx$. The value of the regression coefficient (b) shows the change in the value of Y as a result of a change in each unit of X value. A positive b value indicates that the Y character will increase. If the b value is negative, the Y character will decrease. The coefficient of determination (R^2) shows the amount of variation in Y that can be explained by the variation in X characters.

Results

The findings of this study indicated that there were notable discrepancies in several parameters. These included plant height, the number of leaves, tendrils, and flower total, flower wet and flower dry weight. The combination of planting media and the application of various organic fertilizers affects the growth and yield of bay flower plants.

The results of the analysis of variance demonstrated that there was an interaction between the treatment of a combination of planting media and the provision of various types of organic fertilizers on the plant height (cm) of 49 DAP. The treatment combination T3K2 exhibited the highest mean plant height at the 49-DAP stage, with a recorded height of 255.67 cm. The T1K1 treatment combination exhibited the lowest mean value of 147.48 cm, which was not significantly different from T0K1 (11.217 cm) and T1K2 (191.33 cm).

Table 1. IInteraction of Combination of Planting Media and Organic Fertilizer on the Height of Butterfly Pea Flower Plant Age 49 DAP.

Treatment	Heights (cm)	
Combination of Plant Media	Combination of Plant Media	
	LOF Banana Peel	Green Fertilizers
Soil	112,17 ab	149,50 b
Soil and Raw Rice Husk	147,83 a	191,33 ab
Soil and Raw Rice Burnt	57,00 b	210,83 bc
Soil and Compost	77,33 bc	255,67 c
Tukey 5%	26,53	

The combination of soil and compost planting media yielded the most favorable outcomes in terms of butterfly pea flower plant height, with an average of 21 (16.00 cm), 35 (36.78 cm), 56 (98.61 cm), and 70 (140.94 cm) DAP. The application of Green Fertilizers green organic fertilizer has a pronounced impact on the height of panicle plants at 21, 35, and 56 DAP, with increases of 13.51, 27.84, and 41.96 cm, respectively. The combined treatment of planting media and organic fertilizer did not significantly impact the height of butterfly pea flower plants at the 7-DAP stage. Furthermore, the provision of organic fertilizers at the 70-DAP stage did not significantly influence the height of butterfly pea flower plants.

The results of the analysis of variance demonstrated that there was an interaction between the treatment of the combination of planting media and the provision of various kinds of organic fertilizers on the growth of the number of leaves of butterfly pea flower plants at the ages of 35, 56, and 70 DAP. The highest mean value for each interaction was 23.00, 44.86, and 55.72 cm, respectively, in the combination of soil and compost planting media with the provision of Green Fertilizers Green fertilizer (T3K2). The lowest mean values were observed in T1K1 (treatment of a combination of soil planting media and banana peel liquid organic fertilizer), with values of 13.00, 21.33, 21.33, and 40.56 cm at the respective ages. The application of organic fertilizers has a notable impact on the growth of butterfly pea flower leaves, particularly at the 14 DAP (2.00 cm) and 21 DAP (3.97 cm) growth stages.

Table 2. Average plant height (cm) Butterfly pea flower 7, 21, 35, 56 and 70 DAP

Treatment	Heights (cm) Age of Plant				
Combination of Plant Media	**7 DAP**	**21 DAP**	**35 DAP**	**56 DAP**	**70 DAP**
Soil	7,47 a	11,69 b	21,60 b	56,64 b	84,64 b
Soil and Raw Rice Husk	6,97 a	9,28 a	15,00 a	27,31 a	39,69 a
Soil and Raw Rice Burnt	7,33 a	13,82 c	27,61 c	73,67 b	106,64 b
Soil and Compost	7,47 a	16,00 d	36,78 d	98,61 c	140,94 c
Tukey 5%	tn	2,09	5,34	27,79	23,10
Types of Organic Fertilizers					
LOF Banana Peel	7,40 a	11,89 a	22,65 a	31,99 a	86,24 a
Green Fertilizers	7,22 a	13,51 a	27,84 b	41,96 b	99,72 a
Tukey 5%	tn	tn	2,80	11,41	tn

Table 3. Interaction of the Average Number of Leaves (Leaves) of Butterfly pea Flower 35-70 DAP

Treatment		Number of Leaves (leaf blade) Combination of Plant media			
Age of plant	**Types of Organic Fertilizers**	**Soil**	**Soil and Raw Rice Husk**	**Soil and Raw Rice Burnt**	**Soil and Compost**
35 HST	LOF Banana Peel	11,78 a	1,54 bc	7,57 cd	18,11 de
	Green Fertilizers	13,33 ab	4,90 bcd	17,56 de	23,00 e
	Tukey 5%			7,57	
56 HST	LOF Banana Peel	18,69 a	12,44 b	23,42 bc	32,67 cd
	Green Fertilizers	23,32 ab	16,89 bc	32,29 cd	44,86 d
	Tukey 5%			23,47	
70 HST	LOF Banana Peel	23,36 a	14,39 a	29,67 bc	41,86 cd
	Green Fertilizers	27,71 a	19,08 abc	37,08 cd	55,72 d
	Tukey 5%			27,10	

The results of the analysis of variance demonstrated shows that the treatment of organic fertilizer has a significant effect on the parameter of the number of leaves of telang flower plants at the age of 21 DAP. The provision of green fertilizer showed the highest average of 3,97 leaf and LOF banana peel showed the lowest average of 2,92 leaf.

Table 4. Average Application Of Organic Fertilizer To The Parameter Of Leaf Count 7 And 21 DAP

Treatment	Number of Leaves (leaf blade) Age of Plant	
Combination of Planting Media	**7 DAP**	**21 DAP**
Soil	0,78 a	3,22 a
Soil and Raw Rice Husk	0,89 a	3,78 a
Soil and Raw Rice Burnt	0,94 a	3,06 a
Soil and Compost	1,00 a	3,72 a
Tukey 5%	tn	tn
Types of Organic Fertilizers		
LOF Banana Peel	0,86 a	2,92 a
Green Fertilizers	0,94 a	3,97 b
Tukey 5%	tn	0,56

The results of the analysis of variance demonstrated that the treatment of a combination of planting media had a highly significant impact on the growth of the number of tendrils of butterfly pea flower plants. The highest mean number of tendrils was 3,56, which was observed in plants treated with a combination of soil and burnt husk planting media. In contrast, the lowest mean number of tendrils was 5,67, which was observed in plants treated with a combination of soil and raw husk planting media.

The results of the analysis of variance demonstrated that the treatment of a combination of planting media had a highly significant impact on the total number of flowers. The mean number of flowers produced by butterfly pea flower plants was found to be the highest on soil and compost planting media (112.06 flowers), followed by the provision of Green Fertilizers green fertilizer (73.86 flowers). The lowest mean number of flowers was observed in treatments with soil and raw husk planting media (18.56 flowers) and banana peel liquid organic fertilizer (53.03 flowers).

Table 5. Average Number Of Tendrils Plant Butterfly Pea Flowers

Treatment	Number of Tendrils
Combination of Plant Media	
Soil	5,67 a
Soil and Raw Rice Husk	5,00 a
Soil and Raw Rice Burnt	3,56 a
Soil andCompost	2,00 b
Tukey 5%	1,24
Types of Organic Fertilizers	
LOF Banana Peel	0,23 a
Green Fertilizers	0,71 a
Tukey 5%	tn

Table 6. Average total plant flower count butterfy pea flower

Treatment	Flower Total
Combination of Plant Media	
Soil	52,00 b
Soil and Raw Rice Husk	18,56 a
Soil and Raw Rice Burnt	71,17 a
Soil and Compost	112,06 c
Tukey 5%	25,76
Types of Organic Fertilizers	
LOF Banana Peel	53,03 a
Green Fertilizers	73,86 b
Tukey 5%	13,49

The results of the analysis of variance demonstrated that the treatment of a combination of planting media and the provision of diverse organic fertilizers had a markedly significant impact on the total wet weight of flowers. The combination of plant growing media resulted in the

highest average wet weight of total flowers, with T3 (soil and compost) reaching 44.82 g. Conversely, the lowest total wet weight of flowers was observed in T1 (soil and raw husk), at 7.42 g. The application of organic fertilizers to butterfly pea flower plants resulted in an average wet weight of 29.54 g (K2) and 21.21 g (K1) for the highest and lowest total flowers, respectively.

Table 7. Rata-Rata Berat Basah Bunga Total Tanaman Bunga Butterfly pea

Treatment Combination of Plant Media	Wet Flower Weight Total (gram)
Soil	20,80 b
Soil andRaw Rice Husk	7,42 a
Soil andRaw Rice Burnt	28,47 b
Soil andCompost	44,82 c
Tukey 5%	10,30
Types of Organic Fertilizers	
LOF Banana Peel	21,21 a
Green Fertilizers	29,54 b
Tukey 5%	5,40

The results of the analysis of variance demonstrated that the treatment of a combination of planting media and the application of diverse types of organic fertilizers had a markedly significant impact on the total wet weight of flowers. The combination of plant growing media that resulted in the highest average wet weight of total flowers was T3 (soil and compost), which was 8.96 g. In contrast, the lowest total flower wet weight was observed in T1 (soil and raw husk), which was 1.48 g. The highest and lowest average total flower dry weight due to the application of organic fertilizers on butterfly pea flower plants was 5.91 g (K2) and 4.24 g (K1), respectively.

Table 8. Average Dry Weight of Total Butterfly Pea Flowers

Treatment Combination of Plant Media	Dry Weight Flower Total (gram)
Soil	4,16 b
Soil and Raw Rice Husk	1,48 a
Soil and Raw Rice Burnt	5,69 b
Soil and Compost	8,96 c
Tukey 5%	2,06
Types of Organic Fertilizers	
LOF Banana Peel	4,24 a
Green Fertilizers	5,91 b
Tukey 5%	1,08

The results of the regression analysis, as illustrated in Figure 1, yield a line equation of y = 3.9245x - 37.977. The correlation between the number of leaves and the number of flowers is positive. The equation indicates that an increase in the number of leaves is associated with a proportional increase in the number of flowers on Butterfly pea flower plants, with a coefficient of 3.9245. The increase in the number of flowers commences when the plant has reached a total of 37.977 leaves. The R2 value represents the coefficient of determination, indicating that the number of leaves exerts an influence on the number of flowers by 0.9905%. The remaining variance is attributed to other variables.

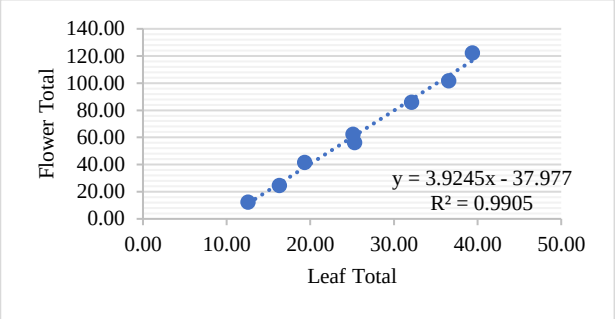

Figure 1. Curva Regression Number Of Leaves Total With Flowers Total

The regression analysis, as illustrated in Figure 2, yielded a line equation of y = -21.794x - 151.83. The regression analysis indicates that the number of tendrils has a significant impact on the number of flowers produced by Butterfly pea flower plants. The equation indicates that a reduction in the number of tendrils is associated with an increase in the number of flowers.

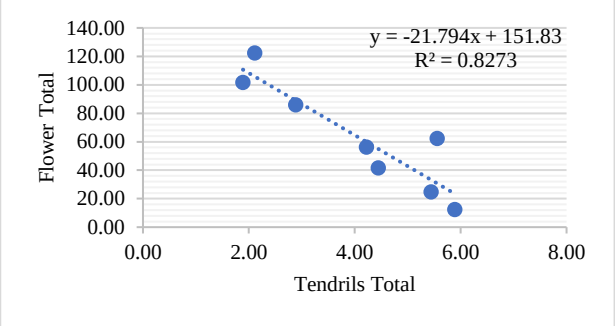

Figure 2. Curva Regression Tendrils Total With Flowers Total

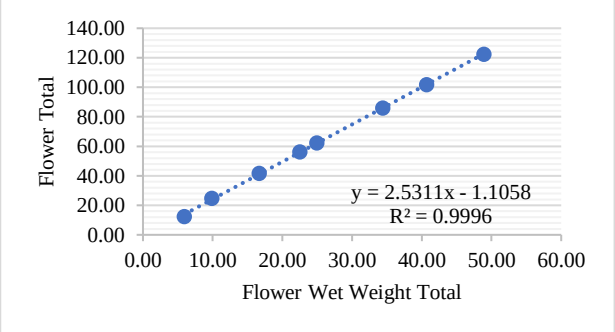

Figure 3. Curva Regression Flower Wet Weight Total With Flowers Total

As illustrated in Figure 3, the regression analysis yielded the following line equation: y = 2.5311x - 1.1058. The relationship between the wet weight of the flower and the number of flowers on Butterfly pea flower plants is positive. The equation indicates that an increase in the total weight of flowers results in a proportional increase in the number of flowers on Butterfly pea flower plants, with an increase of 3.9245 flowers for each additional gram of wet weight. The increase in the number of flowers commences when the plant has reached a total of 2.5311 leaves. The value of R2 represents the coefficient of determination, indicating that the wet weight of flowers exert an influence on the number of flowers by 0.8273. The remaining influence is attributed to other variables.

Disclosure of interest

The parameter of plant height for butterfly pea flowers exhibits an interaction at the age of 49 DAP, which is 85.22 cm. The provision of sufficient nutrients has a beneficial effect on plant height growth, as the process of photosynthesis and metabolism positively influences cell growth, enzyme performance, and the formation of plant physiology, including plant height. This finding aligns with the research conducted by Sparta et al. (2021), which demonstrated that the application of Green Fertilizers green fertilizer can facilitate enhanced plant height growth. The nutrients present in planting media and Green Fertilizers green organic fertilizer influence plant height due to their composition, which includes nitrogen and carbon-organic nutrients that facilitate the growth of plant organs. The presence of sufficient nutrients is conducive to enhanced plant productivity. Conversely, inadequate nutrient levels impede plant growth (Handayani et al., 2020).

The parameters for the highest number of leaves on butterfly pea flower plants at the ages of 35, 49, 56, 73, and 70 DAP were 23.00; 57.11; 73.22; 73.22; and 96.22 (strands), respectively, in the T3K2 combination. This phenomenon can be attributed to the increased organic matter content in the soil resulting from the use of compost planting media. This organic matter plays a crucial role in stimulating the activity of microorganisms that facilitate the decomposition process and the provision of nutrients. Among these nutrients, nitrogen is of particular importance for the vegetative growth of butterfly pea flower plants. The number of leaves on a plant is more influenced by the availability of macronutrients in the form of nitrogen (Meylia and Koesriharti, 2018). Meanwhile, Green Fertilizers green fertilizer provides an adequate amount of nitrogen, thereby facilitating accelerated leaf growth and an increase in the number of leaves formed. Mebinta et al., (2020) posits that an increase in the number of plant leaves will result in a larger leaf area and a greater surface area available for photosynthesis, provided that the plants in question receive a sufficient supply of nitrogen. The incorporation of compost enhances soil structure, resulting in a more porous and aerated soil matrix.

The combined treatment of soil and compost planting media has a marked effect on the number of tendrils of butterfly pea flower plants, with an average of 5.67. The incorporation of compost into soil can enhance the number of tendrils in Butterfly pea flower plants by optimizing nutrient availability, improving soil structure, and facilitating microbial activity. The element phosphorus (P) is essential for root formation and nutrient absorption, enabling optimal plant stem growth (Purba, 2021). This creates optimal conditions for vegetative growth, which directly impacts the number and strength of tendrils produced by plants. The increase in plant height or tendrils is indicative of the quality of the growing medium employed (Hamim, 2019).

Leaves are the primary organ of plants engaged in photosynthesis, the process by which plants convert sunlight into energy. The number of leaves a plant produce is directly correlated with its potential to produce the energy necessary for growth and flowering. In other words, an increase in leaf number can facilitate the growth of an increased number of flowers. Additionally, leaves facilitate the absorption of nutrients through photosynthesis, enabling their circulation throughout the plant, including the flowers. A sufficient number of leaves is necessary for plants to have the energy and nutrients required to support flower formation. Conversely, an insufficient number of leaves may be inadequate to supply the requisite energy for flower production. Additionally, the relationship between leaves and flowers can be influenced by environmental factors, including light, soil nutrients, and water availability. For example, plants with optimal access to sunlight and water tend to exhibit increased leaf and flower production, whereas less favorable conditions may result in decreased leaf and flower growth. Overall plant growth affects the nitrogen nutrient content obtained by plants, the number of leaves that produce more photosynthate because the chlorophyll produced increases (Waskito, 2018).

Compost contains macronutrients such as nitrogen, phosphorus and potassium, as well as microelements that are important for the formation of new tissues. Nitrogen, in particular, plays an important role in stimulating vine growth as it supports cell division and elongation in the meristems of the plant. Compost increases soil porosity, improves soil structure, and increases aeration. This allows the roots to grow more freely and absorb nutrients more efficiently, which contributes to the growth of longer, more branched tendrils. The organic matter in compost becomes a food source for beneficial soil microorganisms, such as bacteria and fungi. These microorganisms aid in the further decomposition of organic matter, releasing nutrients that are easily absorbed by plants (Utami et al., 2024). This process creates a healthy soil environment, which supports the growth of plant tendrils. Compost has a better water-holding capacity than regular soil, so plants get a steady supply of water. Tendrils need sufficient moisture to grow, especially in the early stages of formation. Compost also contains natural compounds such as growth hormones (auxins and cytokinins) produced during the decomposition process. These hormones stimulate the growth of shoots and tendrils, accelerate stem elongation, and increase the branching of tendrils.

The combination of nutrient availability, water storage ability, and biological activity in compost enables bay flower plants to produce flowers of better quality and quantity. Compost is rich in macro and micro nutrients such as nitrogen, phosphorus and potassium, which are essential for the generative phase of the plant, including flower formation. Soils rich in organic matter from compost have a higher cation exchange capacity (CEC), making them better able to store and provide stable amounts of nutrients to plants (Lay et al., 2023). green fertilizer improves soil aeration and water holding

capacity. This creates a favorable environment for root growth and efficient nutrient uptake, enabling plants to produce better quantity and quality flowers. Paitan also contains natural compounds such as auxins and cytokinins that stimulate flowering and plant growth. These hormones accelerate flower formation and increase generative biomass, resulting in greater wet and dry weight of flowers. This is especially important for plants such as bay flowers, which require a steady supply of water to support optimal flower formation as well as maintain tissue turgor that affects wet weight and dry weight. Thus, the plants grow healthier and are able to produce more flowers and higher wet and dry weights.

Leaves are the main organ of photosynthesis that produces energy in the form of carbohydrates. This energy is used by plants for the growth of generative organs such as flowers. A greater number of leaves can increase photosynthetic capacity, so plants have more energy to support flower formation (Ruhimat, 2023). Leaves produce growth hormones such as auxin and cytokinin that play a role in flower formation. The more leaves, the higher the production of hormones that can stimulate the flowering process. An increase in total wet weight of flowers with an increase in the number of flowers may indicate that the plant is undergoing the flower production process. However, if the total wet weight of flowers does not increase in proportion to the number of flowers, it may be that the size or mass of each flower is smaller. The relationship between flower number and total flower wet weight is also influenced by environmental factors, including the availability of water, nutrients, and sunlight (Dewi, 2022). If environmental conditions are not optimal, plants may produce fewer flowers or a lower overall weight. Providing adequate nutrients (such as nitrogen, phosphorus and potassium from organic fertilizers such as compost or paitan) supports the formation of more flowers while ensuring optimal flower biomass filling.

Conclusion

In this study, combination of soil, compost planting media (T3) and Green Fertilizers green fertilizer (K2) was the most effective treatement to support the Butterfly pea flower growth. This combination resulted in the highest average values for key parameters, including the number of leaves, tendrils, plant height, flowers, total flower wet weight, and total flower dry weight. Additionally, a significant correlation was observed between the number of flowers and other variables, such as the number of leaves, tendrils, and total flower wet weight.

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