

## **Growth and Yield of Spinach (*Amaranthus tricolor* L.) Using Various Compositions of Planting Media**

*Pertumbuhan dan Hasil Bayam (*Amaranthus tricolor* L.) yang Menggunakan Berbagai Komposisi Media Tanam*

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### **ABSTRAK**

Bayam merupakan sayuran yang kaya akan nutrisi dan memiliki banyak manfaat untuk kesehatan. Tingginya tingkat konsumsi masyarakat terhadap tanaman bayam seiring dengan perkembangan jumlah penduduk, perlu peningkatan produksi dengan penggunaan pupuk organik. Penelitian ini bertujuan untuk mengetahui pengaruh komposisi media tanam antara tanah, pupuk kandang ayam, dan pupuk tandan kosong kelapa sawit terhadap pertumbuhan dan hasil tanaman bayam. Penelitian menggunakan rancangan acak lengkap (RAL) dengan 6 perlakuan yang diulang sebanyak 3 kali dan masing-masing unit perlakuan terdiri dari 5 tanaman sehingga total seluruh tanaman yaitu 90 tanaman. Hasil analisis keragaman menunjukkan bahwa perlakuan pemberian pupuk kandang ayam dan pupuk tandan kosong kelapa sawit berpengaruh sangat nyata terhadap tinggi tanaman, luas daun, berat segar tanaman, berat segar tajuk, berat segar akar dan berat kering tanaman. Pemberian pupuk kandang ayam dan pupuk tandan kosong kelapa sawit berpengaruh nyata terhadap jumlah daun, tetapi tidak berpengaruh nyata terhadap tingkat kehijauan daun dan rasio tajuk akar. Hasil penelitian menunjukkan perlakuan tanah: pupuk kandang ayam: pupuk tandan kosong kelapa sawit (1:2:2) menunjukkan hasil terbaik pada peubah tinggi tanaman, jumlah daun, luas daun, berat segar tanaman, berat segar tajuk, berat segar akar, dan berat kering tanaman. Komposisi tanah : pupuk kandang ayam : pupuk tandan kosong kelapa sawit (1:2:2) merupakan kombinasi media tanam terbaik untuk pertumbuhan dan hasil bayam. Budidaya bayam dengan menggunakan komposisi media tanam tanah, pupuk kandang ayam, pupuk tandan kosong kelapa sawit (1:2:2) dapat meningkatkan hasil tanaman.

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Kata kunci: pupuk kandang ayam, pupuk tandan kosong kelapa sawit, bahan organik

### **ABSTRACT**

Spinach was a vegetable that was rich in nutrients and has many health benefits. The high level of public consumption of spinach plants in line with population growth, it was necessary to increase production by using organic fertilizers. This research aimed to

determine the effects of the composition of the growing media among soil, chicken manure, and oil palm empty fruit bunches fertilizer on the growth and yield of spinach. The research used a completely randomized design (CRD) with 6 treatments repeated three times and each treatment unit consisted of 5 plants so that the total number of all plants was 90 plants. The results of the analysis of diversity showed that the treatment of chicken manure and oil palm empty fruit bunches fertilizer had a very significant effect on the plant height, leaf area, plant fresh weight, crown fresh weight, root fresh weight and plant dry weight. The provision of chicken manure and oil palm empty fruit bunches fertilizer had a significant effect on the number of leaves, but had no significant effect on the level of greenness of the leaves and the root shoot ratio. The results of the study showed that the soil treatment: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) provided the best results on the variables of plant height, number of leaves, leaf area, plant fresh weight, crown fresh weight, root fresh weight, and plant dry weight. The soil composition : chicken manure : oil palm empty fruit bunches fertilizer (1:2:2) was the best combination of planting media for the spinach growth and yield. Spinach cultivation using the composition of soil planting media, chicken manure, oil palm empty fruit bunches (1:2:2) could increase crop yields.

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Keywords: chicken manure, oil palm empty fruit bunches fertilizer, organic matter

## INTRODUCTION

Spinach (*Amaranthus tricolor L.*) was a leafy vegetable that was rich in vitamins, minerals and phytochemicals (Alegbejo, 2014; Hoang et al., 2020; Rahayu et al., 2013). The plant from the *Amaranthus* genus could be a good source of antioxidants (Karamać et al., 2019; Li et al., 2015). As a natural antioxidant, the consumption of spinach could prevent arthritis, cancer, cataracts, emphysema, retinopathy, atherosclerosis, cardiovascular disease, and obesity (Putri et al., 2016; Sarker & Oba, 2018). Because it was rich in nutrients and has many health benefits (Jiménez-Aguilar & Grusak, 2017) the spinach plant was widely consumed by the public (Riesty & Siswanti, 2021).

Although it was a vegetable crop with a high level of public consumption, in reality it was not in accordance with the spinach production rate which tends to decrease (Sari & Fasta, 2020). The Indonesian Central Statistics Agency (2019) stated that the spinach production in 2015-2019 decreased by 1.21%. One of the improvements in spinach growth was the use of organic fertilizers (Agil et al., 2019). The use of organic fertilizers was better than that of inorganic fertilizers which, if used for a long period of term, will have a

negative effect on plants and soil fertility (Fadhilah et al., 2021). Chicken manure contains nitrogen and phosphorus and could be used as fertilizer (Han et al., 2017). It was one of the organic fertilizers that could be used and its price was relatively cheap for farmers (Masarirambi et al., 2012). The provision of chicken manure had a significant effect on increasing soil pH, soil organic C, soil available P, plant P and Ca uptake, plant height, root dry weight and plant crown (Hasibuan et al., 2014; Simanjuntak et al., 2016). The composition of the growing media soil, sand, chicken manure with a ratio of 1:1:1 was the best composition for the growth of red ginger (Aidin et al., 2016).

One of the efforts to fulfil nutrients and improve planting media was to use the oil palm empty fruit bunches fertilizer (Widiastuti et al., 2019). OPEFB was the residue from industrial processing that was disposed of without being used (Trisakti & Sijabat, 2020) or its utilization was limited to a source of potassium after the combustion process (Adiguna & Aryantha, 2020). The solid waste produced by the palm oil industry has the potential to be used as compost and was expected to improve soil fertility (Harahap et al., 2020). Therefore, the OPEFB could be used as an organic fertilizer (Warsito et al., 2016). The

provision of 1 kg of the compost made from the OPEFB and 0.2 kg of rice husk charcoal per polybag could increase the stem diameter, number of fruits, and weight of tomatoes (Fadhillah & Harahap, 2020). Based on the above description, the chicken manure and the oil palm empty fruit bunches provide benefits for plant growth. This research aimed to find out the best composition among the chicken manure, oil palm empty fruit bunches fertilizer and soil on the growth and yield of spinach plants.

## MATERIALS AND METHODS

This research was conducted in Kelurahan Ilir Barat I, Palembang City, South Sumatra. It started from October to November 2020. The tools used in this research were hoes, 1 kg cans, ruler, 40 x 40 cm polybag, Soil Plant Analysis Development (SPAD) and scales. The materials used in this study were water, spinach seeds, chicken manure, oil palm empty fruit bunches fertilizer, and soil.

The design used a completely randomized design (CRD) consisting of 6 treatments and 3 replications in order to obtain 18 treatment units. Each treatment unit contained 5 plants so that the total number of plants was 90 plants. The treatments used a comparison of the composition of the growing media among the soil, chicken manure, and oil palm empty fruit bunches fertilizer. The treatments were as followed: P1= soil: chicken manure (1:1), P2 = soil: oil palm empty fruit bunches fertilizer (1:1), P3 = soil : chicken manure : oil palm empty fruit bunches fertilizer (1:1:1), P4= soil: chicken manure (1:2), P5= soil: oil palm empty fruit bunches fertilizer (1:2), P6= soil: chicken manure: oil palm empty fruit bunches fertilizer. (1:2:2).

### Working Procedure

The planting medium used top soil and the soil media was cleaned before use in order to prevent the soil media from rocks, litter, and other materials. Then the soil was mixed with organic fertilizer according to

the treatment of each media composition (v:v) using a 1 kg could and then it was put into a polybag. The planting was carried out by spreading the spinach seeds as much as 0.05 g of seeds in each polybag evenly. Before spreading the soil, it was moistened first. The plant husbandry was conducted by watering, controlling weeds, and plant pests. The watering was carried out 1-2 times a day, in the morning and evening (adjusted to the weather conditions). The harvesting was handled when the plant was 28 days after planting by taking 3 samples to observe the results (Kogoya et al., 2018).

### Data Analysis

The obtained data were analyzed using the analysis of variance with F table. The analysis was carried out by comparing the F count. If the F count was smaller than the F table 5%, the treatment has no significant effect. If the F count was greater than the F table 5%, the treatment has a significant effect. If the F count was real, then it was continued with the 5% Least Significant Difference Test for the results of the significant difference between treatments.

## RESULTS

The results of the analysis of diversity showed that the treatment of chicken manure and oil palm empty fruit bunches fertilizer had a very significant effect on plant height, leaf area, plant fresh weight, crown fresh weight, root fresh weight, plant dry weight. The treatment of chicken manure and oil palm empty fruit bunches fertilizer had a significant effect on number of leaves, but had no significant effect on the leaf greenness and root shoot ratio (Table 1).

### Plant Height

The results of the analysis of diversity showed that the composition of the planting media had a very significant effect on the plant height. The highest plant height was obtained from the treatment of soil composition: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) with

an average height of 35.77 cm while the lowest plant height was obtained by the soil treatment: chicken manure (1:2) with an average height of 18.49 cm (Table 2).

### Number of Leaves

The results of the analysis of diversity showed that the composition of the growing media had a significant effect on the number of leaves. The highest number of leaves was obtained from the treatment of soil composition: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) with an average of 9.11 leaves while the lowest number of leaves was obtained by the soil

treatment: chicken manure (1:1) with an average of 7.07 cm (Table 3).

### Level of Leaf Greenness

The results of the analysis of diversity showed that the composition of the growing media did not significantly affect the level of greenness of the leaves. The highest level of greenness of the leaves was obtained by the treatment of soil composition: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) with an average of 22.47, while the lowest level of greenness of the leaves was obtained by the soil treatment: oil palm empty fruit bunches fertilizer (1:1) with an average of 17.75 (Figure 1).

Table 1. The calculated F value and Coefficient of Variation (CV) application of planting media composition to the observed variables

Observed Variables	F Value	CV (%)
Plant Height	9.46 **	13.23
Number of Leaves	3.69 *	8.86
Level of Leaf Greenness	1.16 <sup>ns</sup>	12.10
Leaf Area	7.77 **	35.06
Plant Fresh Weight	7.03 **	44.49
Crown Fresh Weight	7.25 **	43.85
Root Fresh Weight	6.65 **	50.83
Plant Dry Weight	6.97 **	37.91
Ratio of root shoots	1.29 <sup>ns</sup>	12.23
F Value 5%	3.11	
F Value 1%	5.06	

Note: \*) significant; \*\*) very significant; tn) no significant; CV: Coefficient of Variation

Table 2. Plant height in various compositions of planting media

Compositions of planting media	Average Amount Plant Height (cm)	LSD 5% = 6.10
P <sub>1</sub>	22.28	ab
P <sub>2</sub>	24.06	abc
P <sub>3</sub>	25.15	dc
P <sub>4</sub>	18.49	a
P <sub>5</sub>	29.93	cd
P <sub>6</sub>	35.77	d

Note: The numbers followed by the same letter mean that they were not significantly different in the LSD test of 5%

Table 3. Number of leaves in various compositions of planting media

Compositions of Planting Media	Average Amount Number of Leaves (strands)	LSD 5% = 1.21
P <sub>1</sub>	7.07	a
P <sub>2</sub>	7.44	a
P <sub>3</sub>	7.66	a
P <sub>4</sub>	7.08	a
P <sub>5</sub>	7.80	a
P <sub>6</sub>	9.11	b

Note: The numbers followed by the same letter mean that they were not significantly different in the LSD test of 5%

### Leaf Area

The results of the analysis of diversity showed that the composition of the planting media had a very significant effect on leaf area. The highest leaf area was obtained from the soil composition treatment: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) with an average leaf area of 409.68 cm<sup>2</sup> while the lowest leaf area was obtained from the soil treatment : chicken manure (1:2) with an average leaf area of 101.80 cm<sup>2</sup> (Table 4).

### Plant Fresh Weight

The results of the analysis of diversity showed that the composition of the growing media had a very significant effect on the fresh weight of the plant. The highest plant fresh weight was obtained from the treatment of soil composition: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) with an average weight of 28.32 g, while the lowest plant fresh weight was obtained by the soil treatment: chicken manure (1:2:2) with an average weight of 5.68 g (Table 5).

### Crown Fresh Weight

The results of the analysis of diversity showed that the composition of the growing media had a very significant effect on the fresh weight of the crown. The highest crown fresh weight was obtained by the treatment of soil composition: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) with an average weight of 24.68 g, while the lowest plant fresh weight was obtained by the soil treatment: chicken manure (1:2) with an average weight of 4.55 g (Table 5).

### Root Fresh Weight

The results of the analysis of diversity showed that the composition of the growing media had a very significant effect on the fresh weight of the roots. The highest fresh root weight was obtained from the treatment of soil composition: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) with an average weight of 3.65 g, while the lowest plant fresh weight was obtained by the soil treatment: chicken manure (1:2) with an average weight of 0.70 g (Table 5).

### Plant Dry Weight

The results of the analysis of diversity showed that the composition of the growing media had a very significant effect on the dry weight of the plant. The highest plant dry weight was obtained from the treatment of soil composition: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) with an average weight of 2.38 g, while the lowest plant dry weight was obtained by the soil treatment: chicken manure (1:2) with an average weight of 0.63 g (Table 6).

### Ratio of Root Shoot

The results of the analysis of diversity showed that the composition of the growing media did not significantly affect the root shoot ratio. The highest root shoot ratio was obtained from the treatment of soil composition: chicken manure (1:1) with an average of 7.54, while the lowest root shoot ratio was obtained by the soil treatment: chicken manure: oil palm empty fruit bunches (1:2:2) with an average of 6.36 (Figure 2).

Table 4. Leaf area in various compositions of planting media

Compositions of Planting Media	Average Amount of Leaf Area (cm <sup>2</sup> )	LSD 5% = 124.23
P <sub>1</sub>	131.04	ab
P <sub>2</sub>	148.27	ab
P <sub>3</sub>	169.57	ab
P <sub>4</sub>	101.80	a
P <sub>5</sub>	234.62	b
P <sub>6</sub>	409.68	c

Note: The numbers followed by the same letter mean that they were not significantly different in the LSD test of 5%

Table 5. Plant fresh weight, crown fresh weight, and root fresh weight in various compositions of planting media

Compositions of Planting Media	Plant Fresh Weight (g)	LSD 5% = 9.84	Crown Fresh Weight (g)	LSD 5% = 8.47	Root Fresh Weight (g)	LSD 5% = 1.36
P <sub>1</sub>	7.16	a	6.37	ab	0.79	a
P <sub>2</sub>	8.52	a	7.65	ab	0.87	a
P <sub>3</sub>	9.54	a	8.44	ab	1.10	a
P <sub>4</sub>	5.68	a	4.55	a	0.70	a
P <sub>5</sub>	15.35	a	13.42	b	1.93	a
P <sub>6</sub>	28.32	b	24.68	c	3.65	b

Note: The numbers followed by the same letter mean that they were not significantly different in the LSD test of 5%

Table 6. Plant dry weight in various compositions of planting media

Compositions of Planting Media	Plant Dry Weight (g)	LSD 5% = 0.76
P <sub>1</sub>	0.71	a
P <sub>2</sub>	0.82	a
P <sub>3</sub>	0.96	a
P <sub>4</sub>	0.63	a
P <sub>5</sub>	1.30	a
P <sub>6</sub>	2.38	b

Note: The numbers followed by the same letter mean that they are not significantly different in the LSD test of 5%

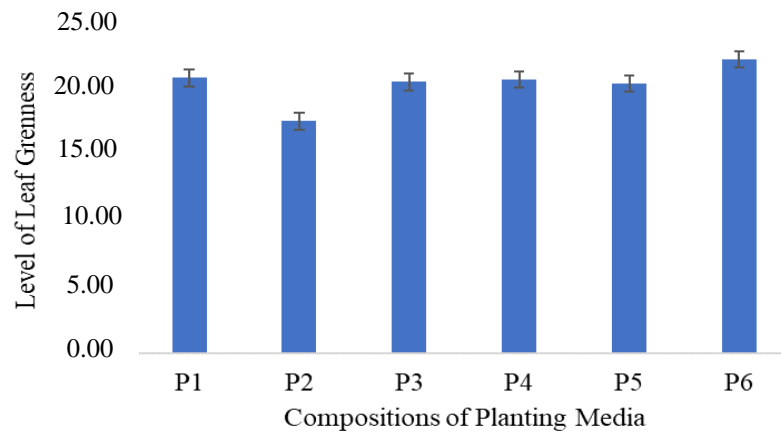


Figure 1. Average amount of leaf greenness level in various compositions of planting media

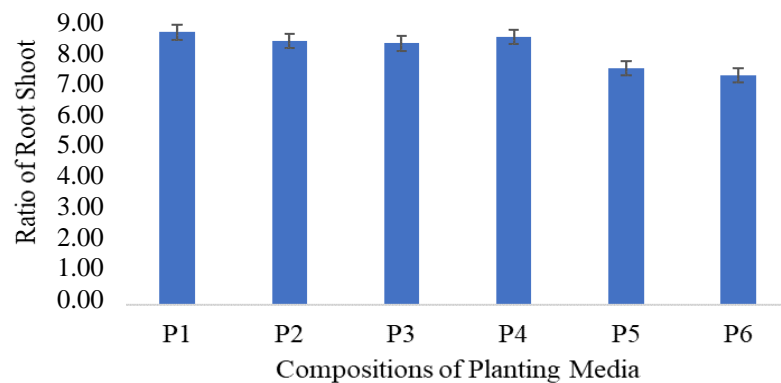


Figure 2. Average amount of root shoot ratio in various compositions of planting media

## DISCUSSION

The soil composition : chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) gave the best results on the variables of plant height, number of leaves, leaf greenness, leaf area, plant fresh weight, crown fresh weight, root fresh weight and plant dry weight. This effect occurred in the treatment with the chicken manure and oil palm empty fruit bunches fertilizer with a higher composition producing higher yields than the treatment with a lower fertilizer composition or with the soil composition: chicken manure and the soil: oil palm empty fruit bunches fertilizer. The provision of organic matter is a strategy in reducing soil degradation, increasing nutrient content, and improving soil aggregates (Yang et al., 2014).

Anastasia et al. (2014) stated that one of the parameters of soil fertility is soil porosity. Provision of organic matter can increase soil porosity and spinach growth. In acid soil provided with the chicken manure, there was an increase in soil fertility and an improvement in the physical, chemical, and biological properties of the soil (Sari et al., 2016). The provision of chicken manure resulted in higher soil organic matter, N, P, K, Ca, and Mg (Adekiya & Agbede, 2017). There are N-Total (6.79%), P<sub>2</sub>O<sub>5</sub> (3.13%), and K<sub>2</sub>O (8.33%) with a pH of 9.59 in oil palm empty fruit bunches fertilizer (Toiby et al., 2015). The highest plant height was obtained from the treatment of soil composition: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) (Table 2). Chicken manure and compost oil palm empty fruit bunches are rich in N, P, and K elements (Drózdź et al., 2020; Toiby et al., 2015). The provision of a balanced organic matter can help the growth of spinach plants because the nutrients needed are well available and well absorbed by the plants. According to Shaji et al. (2021), as a source of natural minerals, organic fertilizers contain plant essential nutrients in sufficient quantities. The number of leaves in the soil composition: chicken manure: oil palm

empty fruit bunches fertilizer (1:2:2) produced more leaves than the other treatments (Table 3). In other words, the nutrient content of the soil composition: chicken manure: oil palm empty fruit bunches fertilizer contains sufficient nutrient elements to form leaves. The availability of nutrients, particularly nitrogen affects plant vegetative growth and crop yields (Zong-Min et al., 2012). An increase in the number of leaves corresponds to that in leaf area. The soil composition: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) produced the widest yield on the leaf area variable (Table 4).

Plant fresh weight is a measurement of the fresh weight of plant biomass as an accumulation of material produced by plants during their growth. The fresh weight treatment of soil composition: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) produced the highest yield among other treatments (Table 5). It is suspected because the composition of soil treatment: chicken manure : oil palm empty fruit bunches fertilizer could bind the water so that plant absorption was not hampered. Plant fresh weight is a combination of plant growth and development of plant tissue such as number of leaves, leaf area, and plant height and is influenced by nutrient availability and plant water content (Manuhuttu et al., 2014). The soil composition: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) produced the highest yield at fresh weight of crown (Table 5).

Fresh weight of roots with the soil composition: chicken manure: oil palm empty fruit bunches fertilizer (1:2:2) produced the highest yield compared to other treatments (Table 5). This is suspected because the nutrients needed by the plants were available and sufficient in a suitable form to be directly absorbed by the plants to support the plant growth, including the root formation. Dry weight is the accumulation of various photosynthetic food reserves during the plant growth. The dry weight variable has a very significant

effect indicating the accumulation of organic compounds that have been successfully synthesized by the plants, this can be influenced by the sufficiency of nutrients needed by the plants. Soil fertility and plant biomass production are influenced by soil organic matter (Wijanarko et al., 2012). Plants need a source of nutrients and optimum conditions in order that these nutrient sources can be converted into biomass or dry weight (Körner, 2015). Based on the observations on the treatment of soil composition: chicken manure: oil palm empty fruit bunches fertilizer with a ratio of 1:2:2 produced the best results on the variables of plant height, number of leaves, and leaf area which indicated the photosynthesis process went well.

### CONCLUSION

The soil composition : chicken manure : oil palm empty fruit bunches fertilizer (1:2:2) showed the best results on the variables of plant height, number of leaves, leaf area, plant fresh weight, crown fresh weight, root fresh weight, and plant dry weight. In the cultivation of spinach plants, it is suggested that agricultural cultivation activities apply the composition of soil planting media, chicken manure, oil palm empty fruit bunches fertilizer (1:2:2) to increase crop yields.

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